Bazian

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Individual-Level Behaviour Change

External evidence review 2: review of evidence of effectiveness of interventions and behaviour change techniques in individual level interventions.

Evidence review for Public Health Guidance

Developed by Bazian for NICE

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List of Abbreviations

A&E	Accident and Emergency
ACS	acute coronary syndrome
AUDIT-C	Alcohol Use Disorders Identification Test – Consumption questions
BASICS	Brief Alcohol Screening and Intervention for College Students
BCT	behaviour change techniques(s)
BCT-C	behaviour change technique cluster
CABG	coronary artery bypass graft
CARET	C-morbidity Alcohol Risk Evaluation Tool
CDT	Serum carbohydrate deficient transferrin
CHF	congestive heart failure
CI	confidence interval
COPD	Chronic obstructive pulmonary disease
CV	cardiovascular
CVD	cardiovascular disease
DDQ	Daily Drinking Questionnaire
ED	emergency department
ES	evidence statement
FRAMES	Feedback, Responsibility, Advice, Menu of Options, Empathy, Self-Efficacy
HIV	human immunodeficiency virus
IF	intervention function
IUD	intrauterine device
MI	myocardial infarction
MSM	men who have sex with men
N	number
NICE	National Institute for Health and Clinical Excellence
PCI	percutaneous coronary intervention
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
RCT	randomised control trial
SES	socioeconomic status
SIGN	Scottish Intercollegiate Guidelines Network
SMD	standardised mean difference
SR	systematic review
STATA	type of statistical software
STD	sexually transmitted disease
STI	sexually transmitted infection
TLFB	time-line follow-back
T2DM	type 2 diabetes mellitus
VHSG	Vestfold Heartcare Study Group

1 Executive Summary

1.1 Introduction

This evidence review supports the partial update of NICE public health guidance (PH6) by assessing the evidence base for individual level behaviour change interventions, with a particular focus on the behaviour change techniques used in these interventions.

Individual behaviours can have a substantial impact on people's health, and play a role in the development of non-communicable diseases, and communicable diseases in the case of sexual health. Interventions that can effectively alter these behaviours may have a substantial impact on the burden of disease throughout the UK.

Advances have been made in behaviour change technology since the publication of NICE's 2007 public health guidance in behaviour change. These advances include research in the arenas of health behaviour theory as well as the proposal of extensive lists, or 'taxonomies', that specify and define discrete behaviour change techniques (BCTs), which are categorised into sixteen theoretical clusters (Michie 2013). These taxonomies offer the opportunity to identify the 'active ingredients' of previously published behaviour change interventions, and combining BCT coding with meta-regression analysis can help to identify the discrete BCTs, or theoretical clusters, most strongly associated with behaviour change (Michie 2009).

For this review, descriptions of eligible behaviour change interventions were coded for several components, including theory use (i.e. whether and which behaviour change theories were used to inform the intervention), the content of the intervention (the presence of BCTs and BCT clusters), and the proposed function of the intervention (intervention functions). Meta-regression analyses were used to identify which of the intervention components were most associated with behaviour change. A narrative review of interventions was also conducted to describe possible variation across population groups.

This is the second of three external evidence reviews commissioned by NICE to update the current public health guidance on behaviour change (PH6). This is a review of the evidence of effectiveness of interventions and BCTs in individual-level interventions for eliciting and maintaining behaviour change in the fields of sexual health, alcohol, smoking, diet and physical activity. This report should be interpreted alongside the findings of the other two reviews, as well as existing NICE guidance.

1.2 Aims and Objectives

This review (Review 2) aims to answer the following four questions:

1. a. Which interventions are effective at changing behaviour and/or sustaining behaviour change in individual-level interventions?

   b. Which specific behaviour change techniques and combinations of behaviour change techniques are effective at changing behaviour in the long term (over 6 months) and/or sustaining behaviour change in individual-level interventions?

2. Which behaviour change techniques are effective for changing and/or sustaining change in specific behaviours only, such as alcohol or smoking, and which are more generalisable (i.e. effective across a range of behaviours)?

3. How do the effects of individual interventions vary across different population groups?

4. Which theories explain when, why and how behaviour change is maintained?

1.3 Methods

Briefly, the steps in this review were:

- Identification of relevant studies by systematic searching of electronic literature databases.

- Selection of relevant studies relating to individual-level behaviour change interventions that met inclusion criteria.
- Assessment of the quality of the included studies.
- Extraction of data from the best quality included studies, including the coding of BCTs, intervention function, and theory use for each of the interventions (see Box 1).
- Meta-regression to identify which BCTs are associated with effectiveness (see Box 2).
- Summarisation of findings and the drafting of evidence statements relating to BCTs, intervention function, and theory use that address the questions of the review.

Box 1: Data extraction

Alongside outcome data, the following data were extracted from each of the interventions.

1) Behaviour change techniques (BCTs) and clusters

Purpose: To identify the techniques used within interventions to (attempt to) bring about changes in behaviour. BCTs are assumed to be the 'active content' of interventions, and are discrete from elements of delivery, setting, format, intensity, duration and fidelity.

Method: A reliable taxonomy of 89 BCTs was used to code descriptions of intervention and control treatments. The taxonomy categorises each BCT into one of 16 theoretical clusters, and so by coding for BCTs BCT clusters were also coded for.

2) Intervention function

Purpose: To identify the functions served by the intervention; e.g. to educate, to incentivize, or to enable change.

Method: A list of nine discrete intervention functions was used to code interventions.

3) Theory use

Purpose: To identify whether theory was used in designing the intervention.

Method: We coded for whether a theory was mentioned in the published report, and if so, which specific theory was mentioned.

Box 2: Data analysis

For each behaviour area in turn, and all behaviours combined, three main types of analysis were undertaken.

1) Meta-analysis

Purpose: To determine the effect of behaviour change interventions within and across the behaviour areas by synthesising all available data, regardless of BCTs, intervention function, or theory use. This provided an overall estimate of the effect of the interventions on behaviour.

2) Univariate meta-regressions

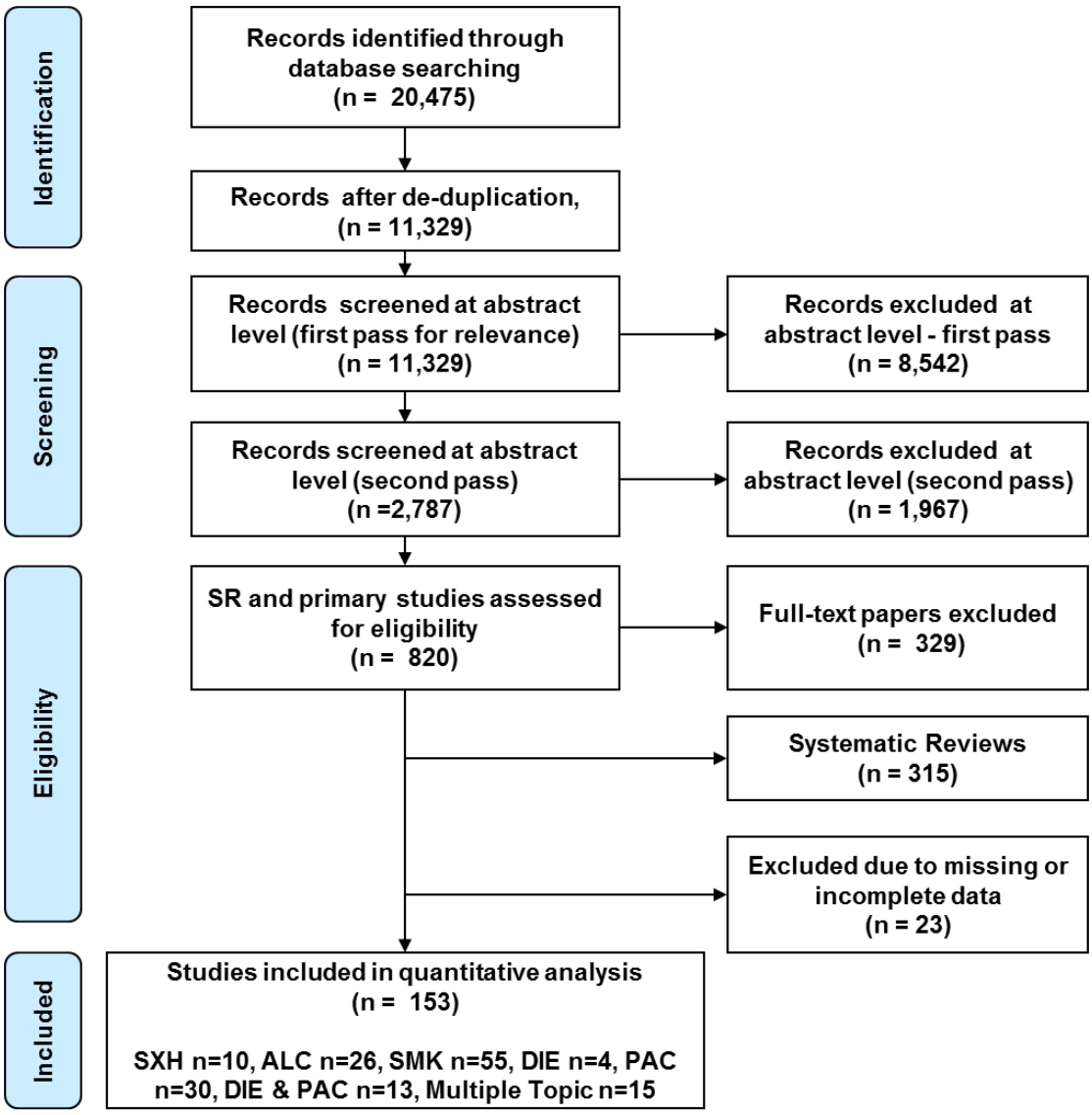
Purpose: To assess whether between-study variation in intervention effectiveness can be attributed to the presence or absence of a BCT (or BCT cluster, intervention function, or the use of theory) *in isolation*.

3) Multivariate meta-regression

Purpose: To assess whether between-study variation in intervention effectiveness can be attributed to BCTs, BCT clusters, intervention functions, or use of theory *when controlling for other components* within the meta-regression model.

Of the 11,329 unique records identified, 153 were included in the quantitative review and meta-regression.

PRISMA diagram



Throughout the narrative review and Evidence Statements, BCTs have been annotated to reflect the consistency in the direction and the significance of effect of the interventions in which they were reported. For instance, within a given behaviour area, BCTs coded A1 are found only in interventions with a positive direction of effect which were found to be statistically significant in one intervention.

Table i: BCT annotation based on direction and significance of effect

Direction of effect across all interventions in the specified behaviour area	
A	BCT found in interventions with a positive direction of effect only (i.e. effect favours intervention)
B	BCT found in interventions with a negative direction of effect only (i.e. effect favours control)
C	BCT found in interventions with positive and negative directions of effect (i.e. inconsistent direction of effect – some favouring intervention, some favouring control)
Significance and consistency of effect across all interventions in the specified behaviour area	
1	BCT found in one intervention with a significant positive effect
2	BCT found in more than one intervention with a significant positive effect

Trials addressing more than one behaviour area of interest (for instance, an intervention among patients with cardiovascular disease that addresses smoking, diet and physical activity) are denoted with an asterisk (*) throughout the review and Evidence Statements.

1.4 Results

Meta-analyses across and within sexual health, alcohol, smoking, diet and physical activity trials was conducted to determine if individual level interventions in these areas could alter the targeted behaviours.

The meta-analyses revealed that individual level interventions are effective and can effect statistically significant changes in health related behaviour. The pooled effect size within each of the five areas was significant, as was the

effect when all interventions were pooled together. The largest effect sizes were seen in diet (SMD 0.33), smoking (SMD 0.28*)* and physical activity (SMD 0.22). These effects were small, and there was substantial between-study variance in effect in each of these behavioural areas. Interventions had a very small, significant pooled effect on sexual health behaviours (SMD 0.14) and alcohol consumption (SMD 0.11). There was moderate variance between studies targeting sexual health, and low variance between studies aimed at altering alcohol behaviours. When considered together, meta-analysis revealed an overall small, significant effect of individual level behaviour change interventions (SMD 0.23), with substantial levels of between study variance in effect. See Table ii for a summary of the meta-analysis results.

Table ii: Meta-analysis results - overall and topic specific effect sizes and heterogeneity

Topic	Effect size (SMD, 95% CI)	Heterogeneity (I^2, 95% CI)
Sexual health	0.14, 0.05 to 0.24 Very small	45.9%, 0% to 69.1% Moderate
Alcohol	0.11, 0.06 to 0.16 Very small	24.7%, 0 to 46.9% Low
Smoking	0.28, 0.21 to 0.36 Small	68.1%, 59.2 to 74.2% Substantial
Diet	0.33, 0.24 to 0.42 Small	76.1%, 64.4 to 82.6% Substantial
Physical activity	0.22, 0.15 to 0.29 Small	83.9%, 80.2% to 86.6% Substantial
Overall	0.23, 0.19 to 0.26 Small	66.0%, 60.6% to 70.7% Substantial

Univariate and multivariate analyses were carried out to investigate how effectiveness varied according to intervention content and overall function. Variables (BCT clusters and intervention function) identified as accounting for >1% of between study variance in the univariate meta-regression were included in multivariate models.

The final multivariate meta-regression assessed whether between-study variation in intervention effectiveness could be attributed to the presence or absence of a BCT (or BCT cluster, intervention function, or the use of theory)

when controlling for other variables. These analyses were conducted for BCT clusters, intervention functions and theory use in each behavioural area, and for BCTs, BCT clusters, intervention functions and theory use in the overall analysis that combined interventions across the five topics. Table iii provides a comparison of the results (both significant and non-significant) from the final multivariate models.

Sexual health

The univariate analysis identified no BCT clusters, intervention functions or use of theory that accounted for the between-study variance in effect. As such, no variables were available for a multivariate model.

Alcohol

The univariate analysis identified five variables that accounted for some of the variance seen among alcohol interventions. Two of the variables remained in the final multivariate model, and accounted for 100% of the between-study variance:

- BCT cluster 3 Feedback and monitoring – techniques in this cluster involve recording behaviour or its outcomes, and/or providing feedback on a behaviour or its outcomes. Interventions that reported use of techniques in this cluster were associated with significantly larger effects compared to interventions that did not report use of this cluster (regression coefficient 0.12, 95% CI 0.04 to 0.21; p=0.006).
- Intervention function 2 Persuasion – this function is coded for interventions that use communication to induce positive or negative feelings, or to stimulate action. Interventions that reported use of this function were associated with significantly smaller effects compared to interventions that did not report its use (regression coefficient -0.09, 95% CI -0.17 to -0.004; p=0.04).

Smoking

The univariate analysis identified five variables that accounted for some of the variance seen among smoking interventions. In the final multivariate model, one variable was found to be significantly associated with intervention effectiveness:

- BCT cluster 11 Goals and planning – techniques in this cluster involve managing behaviour or outcome goals, and/or how behaviour or outcomes will be achieved. Interventions that reported use of this cluster were associated with significantly smaller effects than interventions that did not report use of this cluster (regression coefficient -0.14, 95% CI -0.27 to -0.004; p=0.04).

Diet

The univariate analysis identified three variables that accounted for some of the between-study variance seen among dietary interventions. The final multivariate model found that no BCT clusters, intervention functions or use of theory was significantly associated with intervention effectiveness when controlling for the other variables.

Physical activity

The univariate analysis identified seven BCT clusters and intervention functions that accounted for some of the between-study variance among physical activity interventions. The final multivariate model identified two variables that were significantly associated with intervention effectiveness:

- BCT cluster 5 Repetition and substitution – techniques in this cluster involve practising, rehearsing or repeating a behaviour, or directly replacing a new wanted behaviour for an existing unwanted behaviour. Interventions reporting use of techniques in this cluster were associated with significantly larger effects than interventions not reporting this cluster (regression coefficient 0.18, 95% CI 0.05 to 0.31; p=0.006).
- Intervention function 7 Environmental restructuring – this function is coded for interventions that change the physical or social context in which the

behaviour is (or could be) performed. Interventions that reported use of this function were associated with significantly larger effects compared to interventions that did not report its use (regression coefficient 0.16, 95% CI 0.02 to 0.30; p=0.030).

Overall analysis

Univariate analysis of BCT clusters, intervention functions and theory use revealed that four variables explained some of the between-study variance across all sexual health, alcohol, smoking, diet and physical activity interventions. In the final multivariate model only one of these was significantly associated with intervention effectiveness when controlling for the other variables:

- Intervention function 7 Environmental restructuring – this function is coded for interventions that change the physical or social context in which the behaviour is (or could be) performed. Interventions across all behaviour areas that reported use of this function were associated with significantly larger effects compared to interventions that did not report its use (regression coefficient 0.11, 95% CI 0.01 to 0.21; p=0.031).

An additional overall multivariate analysis was conducted to identify individual BCTs associated with intervention effectiveness across the five behaviour areas. The final model included seven BCTs and one intervention function. This analysis revealed that two BCTs were significantly associated with intervention effectiveness when controlling for the presence of other BCTs, intervention functions and theory use:

- BCT 4 Pharmacological support – Interventions that reported providing or encouraging the use of or adherence to drugs to facilitate behaviour change were associated with significantly larger effects on behaviour change compared to interventions that did not report use of this technique (regression coefficient 0.13, 95% CI 0.03 to 0.22; p=0.013).

- BCT 29 Graded tasks – interventions that reported setting easy-to-perform task and making them increasingly difficult, but achievable, until behaviour is performed were associated with significantly larger effects compared to interventions that did not report use of this technique (regression coefficient 0.24, 95% CI 0.08 to 0.40; p=0.004).

Table iii: Comparison of effects (regression coefficients and 95% CI) associated with intervention functions and BCT clusters across behaviour areas in primary multivariate analysis

	Overall	Sexual health	Alcohol	Smoking	Diet	Physical activity
Intervention functions						
IF 2 Persuasion		No multivariate analysis	**-0.09 (-0.17 to -0.004)**			
IF 5 Training					-0.14 (-0.33 to 0.05)	
IF 7 Environmental restructuring	**0.11 (0.01 to 0.21)**			0.06 (-0.10 to 0.21)		**0.16 (0.02 to 0.30)**
BCT clusters						
BCT-C 1 Social support		No multivariate analysis		0.11 (-0.03 to 0.26)		-0.13 (-0.27 to 0.09)
BCT-C 2 Regulation	0.07 (-0.01 to 0.16)			0.09 (-0.04 to 0.22)		
BCT-C 3 Feedback and monitoring			**0.12 (0.04 to 0.21)**			-0.09 (-0.21 to 0.03)
BCT-C 5 Repetition and substitution	0.07 (-0.01 to 0.15)					**0.18 (0.05 to 0.31)**
BCT-C 11 Goals and planning				**-0.14 (-0.27 to -0.004)**		
BCT-C 12 Comparison of outcomes					0.24 (-0.01 to 0.49)	0.12 (-0.03 to 0.27)

A sensitivity multivariate analysis that considered only those trials with more than six months post-intervention follow-up resulted in a general augmentation of the overall results, although the significance of the effect was not consistent between the two analyses. Table iv provides a comparison of long term effects (significant and non-significant) from the sensitivity analyses.

Sexual health

No variables were available for a long term multivariate model.

Alcohol

One variable was significantly associated with the long term effectiveness of alcohol interventions:

- BCT cluster 3 Feedback and monitoring – interventions that reported use of techniques that record behaviour or its outcomes, and/or provide feedback on a behaviour or its outcomes were associated with significantly larger long term effects compared to interventions that did not report use of this cluster (regression coefficient 0.11, 95% CI 0.01 to 0.20; p=0.028).

Smoking

No BCT clusters, intervention functions or use of theory were significantly associated with long term effectiveness among smoking interventions when controlling for the other variables.

Diet

No BCT clusters, intervention functions or use of theory were significantly associated with long term effectiveness among dietary interventions when controlling for the other variables.

Physical activity

Four variables were associated with long term effectiveness among physical activity interventions:

- BCT cluster 3 Feedback and monitoring – interventions that reported use of techniques that record behaviour or its outcomes, and/or provide feedback on a behaviour or its outcomes were associated with significantly smaller long term effects compared to interventions that did not report use of this cluster (regression coefficient -0.24, 95% CI -0.40 to -0.07; p=0.009).
- BCT cluster 5 Repetition and substitution – interventions that reported use of techniques targeting the practice, rehearsal or repetition of a behaviour, or directly replacing a new wanted behaviour for an existing unwanted behaviour were associated with significantly larger long term effects than interventions not reporting this cluster (regression coefficient 0.32, 95% CI 0.15 to 0.48; p=0.001).
- BCT cluster 12 Comparison of outcomes – interventions that reported use of techniques that involve considering the relative pros and cons of outcomes of various behaviours were associated with significantly larger long term effects than interventions not reporting this cluster (regression coefficient 0.34, 95% CI 0.07 to 0.61; p=0.017).
- Intervention function 7 Environmental restructuring – interventions with a core function aimed at changing the physical or social context in which the behaviour is (or could be) performed were associated with significantly larger effects compared to interventions that did not report serving this function (regression coefficient 0.27, 95% CI 0.10 to 0.44; p=0.005).

<u>Overall analysis</u>

In long term sensitivity analysis, one variable was significantly associated with intervention effectiveness when controlling for the other variables:

- Intervention function 7 Environmental restructuring – this function is coded for interventions that change the physical or social context in which the behaviour is (or could be) performed. Interventions across all behaviour areas that reported use of this function were associated with significantly larger effects compared to interventions that did not report its use (regression coefficient 0.11, 95% CI 0.01 to 0.21; p=0.031)

A multivariate sensitivity analysis to identify which, if any, individual BCTs are associated with long term intervention effectiveness across the five behaviour areas revealed two significant associations:

- BCT 4 Pharmacological support – interventions that provide, or encourage the use of or adherence to drugs to facilitate behaviour change were associated with significantly larger long term effects compared to interventions that did not report use of this technique (regression coefficient 0.13, 95% CI 0.03 to 0.22; p=0.013)
- BCT 63 Goal setting (outcome) – interventions that reported setting or agreeing to a goal defined in terms of a positive outcome of the desired behaviour were associated with significantly larger effects compared to interventions that did not report use of this technique (regression coefficient 0.17, 95% CI 0.01 to 0.32; p=0.037)

Table iv: Comparison of effects (regression coefficients and 95% CI) associated with intervention functions and BCT clusters across behaviour areas in long term (>6 months) sensitivity analysis

	Overall	Sexual health	Alcohol	Smoking	Diet	Physical activity
Intervention functions						
IF 2 Persuasion		No multivariate sensitivity analysis	-0.09 (-0.19 to 0.003)			
IF 5 Training					-0.19 (-0.41 to 0.04)	
IF 7 Environmental restructuring	**0.22 (0.09 to 0.36)**			0.13 (-0.11 to 0.38)		**0.27 (0.10 to 0.44)**
BCT clusters						
BCT-C 1 Social support		No multivariate sensitivity analysis		0.13 (-0.51 to 0.25)		-0.17 (-0.40 to 0.05)
BCT-C 2 Regulation	0.11 (-0.0003 to 0.22)			0.10 (-0.14 to 0.35)		
BCT-C 3 Feedback and monitoring			**0.11 (0.01 to 0.20)**			**-0.24 (-0.40 to -0.07)**
BCT-C 5 Repetition and substitution	0.07 (-0.06 to 0.20)					**0.32 (0.15 to 0.48)**
BCT-C 11 Goals and planning				-0.23 (-0.47 to 0.01)		
BCT-C12 Comparison of outcomes					No long term studies reported use	**0.34 (0.07 to 0.61)**

Each multivariate model also included use of theory as a covariate, and each analysis found that theory use was not significantly associated with intervention effectiveness, regardless of behaviour area or follow-up period.

Table v: Comparison of effects (regression coefficients and 95% CI) associated with theory use across behaviour areas in primary and sensitivity multivariate analyses

Topic	Effectiveness		Long term effectiveness	
	Regression coefficient (95% CI)	p-value	Regression coefficient (95% CI)	p-value
Sexual health	No multivariate model		No multivariate model	
Alcohol	0.03 (-0.12 to 0.18)	0.684	0.09 (-0.10 to 0.28)	0.342
Smoking	-0.07 (-0.22 to 0.08)	0.364	-0.22 (-0.59 to 0.16)	0.242
Diet	-0.03 (-0.22 to 0.16)	0.739	-0.11 (-0.50 to 0.28)	0.513
Physical activity	-0.03 (-0.16 to 0.09)	0.594	-0.12 (-0.33 to 0.08)	0.201
Overall	-0.04 (-0.12 to 0.03)	0.273	-0.04 (-0.18 to 0.09)	0.520

1.5 Evidence Statements

A selection of evidence statements are provided in this section. These statements concern the meta-analysis and meta-regression evidence for each of the five behaviour areas, as wells as the overall results across the five areas.

The strongest evidence statements for interventions targeting sexual health, alcohol, smoking, diet and physical activity behaviours among specific populations are provided as well. Statements supported by limited or inconsistent evidence are not summarised in this section. For a complete list of topic specific evidence statements, and for further information on the behaviour change techniques reported in the interventions, see Sections 4.2.9 (sexual health), 4.3.9 (alcohol), 4.4.9 (smoking), 4.5.9 (diet) and 4.6.9 (physical activity.

<u>Sexual Health</u>

Evidence statement 1.1 – Overall effectiveness of sexual health behaviour change interventions, BCT clusters and intervention functions

There is moderate evidence from the meta-analysis of 15 interventions described in 13 RCTs (Cortes-Bordoy 2010 [+], Crosby 2009 [+], Dermen_ALC 2011 [+], Dermen_HIV 2011 [+], Dermen_H&A 2011* [+], Gilbert 2008* [++], Golin 2012 [+], Ingersoll 2005* [+], Koblin 2012 [++], Langston 2010 [++], Mansergh 2010 [+], Petersen 2007 [++], Schunmann 2006 [++], Tross 2008 [+], Wolitski 2005 [+]) to suggest that individual level behaviour change interventions can have a very small positive effect on sexual health behaviour (SMD 0.14, 95% CI 0.05 to 0.24), but with moderate heterogeneity (I^2=45.9%, 95% CI 0% to 69.1%). The meta-regression of the results of these studies suggested that BCT clusters and intervention functions did not explain the variance between studies, but there may not have been enough power in the analyses to detect effects.

Evidence Statement 1.5 – Sexual health behaviour change interventions for men who have sex with men

Moderate evidence was identified from three trials (Wolitski 2005 [+], Koblin 2012 [++], Mansergh 2010 [+]) that multi-session interventions delivered face to face in a group setting are no more effective than comparators at changing protected sexual behaviours or condom use among men who have sex with men. The non-significant effect was seen across participant characteristics and comparators, including in HIV positive MSM compared to usual care (Wolitski 2005 [+]), out of treatment substance using MSM compared to an attention control arm (Mansergh 2010 [+]) and black men of mixed serostatus compared to no intervention (Koblin 2012 [++]).

All of the interventions reported use of BCTs 3 Social support (unspecified). Two of the interventions (Wolitski 2005 [+], Mansergh 2010 [+]) reported use of BCTs 37 Information about antecedents, and 61 Problem solving. These three techniques were reported in sexual health trials with inconsistent effects, both terms of direction and significance.

Alcohol

Evidence Statement 2.1 – Overall Effectiveness of alcohol behaviour change interventions, BCT clusters and intervention functions

There is strong evidence from 32 trials describing 50 interventions (Burke 2008* [+], Carey_BMI 2006 [+], Carey_BMI+TLFB 2006 [+], Carey_EBMI 2006 [+], Carey_EBMI+TLFB 2006 [+], Carey_TLFB 2006 [+], Chang 2011 [++], Curry 2003 [+], Daeppen 2007 [+], Dent_BI 2008 [++], Dent_MI 2008 [++], Dermen_ALC 2011 [+], Dermen_H&A 2011* [+], Emmen 2005 [++], Feldman 2011 [++], Field_BP 2009 [+], Field_HP 2009 [+], Field_WP 2009 [+], Fleming 2008 [++], Fleming 2010 [++], Gilbert 2008* [++]), Holloway_SEE 2007 [+], Holloway_SHB 2007 [+], Ingersoll 2005* [+], Juarez _MI 2006 [+], Juarez_MF 2006 [+], Juarez_MI+F 2006 [+], Juarez_MI+MF 2006 [+], Koelewijn-van Loon 2010* [+], Kulesza_10M 2010 [+], Kulesza_50M 2010 [+], Lane 2008 [+], Lau Barraco_EDU 2008 [+], Lau Barraco_EEC 2008 [+], Lewis_GNSF 2007 [+], Lewis_GSF 2007 [+], Lock 2006 [++], Mastroleo_CPA 2010 [+], Mastroleo_EEA 2010 [+], Mello 2008 [++], Moore 2010 [+], Neighbors 2006 [+], Neumann 2006 [++], O'Connor 2007 [+], Ockene 2009 [++], Smeulders 2009* [+], Walters_MI 2009 [++], Walters_MI+F 2009 [++], Walters_WEB 2009 [++], Woodall 2007 [+]) that individual level behaviour change interventions can have a small effect on alcohol consumption behaviour, with an effect size of 0.11 (95% CI 0.06 to 0.16).

Meta-regression of data from these RCTs suggested that use of BCT cluster 3 – Feedback and monitoring is associated with increased effectiveness of interventions (regression coefficient 0.12, 95% CI 0.04 to 0.21; p=0.006), while intervention function 2 – Persuasion is associated with reduced effectiveness of interventions (regression coefficient -0.09, 95% CI -0.17 to -0.004; p=0.040) These two variables account for 100% of between study variance, and the effects are maintained in the long term.

Evidence Statement 2.5 – Alcohol behaviour change interventions among hospital and Emergency Department patients

Strong evidence from ten interventions described in six trials (Dent_BI 2008 [++], Field_BP 2009 [+], Field_HP 2009 [+], Field_WP 2009 [+], Daeppen 2007 [+], Holloway_SEE 2007 [+], Holloway_SHB 2007 [+], Neumann 2006 [+], Dent_MI 2008 [++], Mello 2008 [++]) suggests that alcohol interventions delivered to Emergency Department or hospital patients are no more effective than usual care at altering alcohol consumption.

This non-significant effect was across intervention type, mode of delivery, and patient characteristics. Interventions resulted in no significant difference in consumption behaviours among ED patients (Dent_BI 2008 [++]); injured ED patients (Daeppen 2007 [+], Neumann 2006 [+], Dent_MI 2008 [++], Mello 2008 [++]) or hospitalised patients (Holloway_SEE 2007 [+], Holloway_SHB 2007 [+]). The effect was also consistent (in terms of significance) across ethnic groups among trauma centre patients admitted for intentional or unintentional injuries (black patients: Field_BP 2009 [+], Hispanic patients: Field_HP 2009 [+], white patients: Field_WP 2009 [+]).

The only BCT common to all these interventions is 3 Social support (unspecified); this technique is also reported in the comparator arm of several of the trials (Field_BP 2009 [+], Field_HP 2009 [+], Field_WP 2009 [+], Neumann 2006 [+]). No other BCTs were reported in the majority of interventions among this population.

Evidence Statement 2.6 – Brief alcohol interventions among university students

Moderate evidence from six trials assessing eleven interventions suggests that brief alcohol interventions delivered either face to face, one on one (Carey_BMI 2006 [+], Carey_TLFB 2006 [+], Carey_BMI+TLFB 2006 [+], Carey_EBMI 2006 [+], Carey_EBMI+TLFB 2006 [+], Kulesza_10M 2010 [+]) or remotely (Juarez_MF 2006 [+], Walters_WEB 2009 [++], Neighbors 2006 [+], Lewis_GNSF 2007 [+], Lewis_GSF 2007 [+]) are no more effective than comparators at changing the drinking behaviours of university students. Among interventions delivered face to face and one on one, no significant

differences in alcohol consumption were seen (SMD range: -0.12 to 0.55; all non-significant versus a no intervention comparator).

Four of the five remotely delivered interventions resulted in no significant difference in alcohol consumption (Juarez_MF 2006 [+], Neighbors 2006 [+], Lewis_GNSF 2007 [+], Walters_WEB 2009 [++]). The fifth intervention, which supplied feedback on drinking behaviours tailored to the gender of the participant, resulted in a significant difference in weekly alcohol consumption (Lewis_GSF 2007 [+]).

No BCTs were reported in the significant intervention (Lewis_GSF 2007 [+]) that weren't all reported in other, non-significant interventions in this population. Among the non-significant interventions, all reported use of BCT 80 Information about social and environmental consequences; this BCT was not reported in Lewis_GSF 2007 [+]).

Evidence Statement 2.7 – Extended alcohol interventions among university students

Strong evidence was identified from ten interventions described in six studies that extended face to face interventions delivered one on one (Walters_MI 2009 [++], Walters_MI+F 2009 [++], Juarez _MI 2006 [+], Juarez _MI+F 2006 [+], Kulesza_50M 2010 [+], Ingersoll 2005* [+], Mastroleo_EEA 2010 [+], Mastroleo_CPA 2010 [+]) or to groups (Lau Barraco_EEC 2008 [+], Lau Barraco_EDU 2008 [+]) are no more effective than comparators at altering the drinking behaviour of university students (SMD range -0.23 to 0.51; all non-significant).

All of the interventions reported use of BCT 3 Social support (unspecified), and seven (Walters_MI+F 2009 [++], Juarez _MI 2006 [+], Juarez _MI+F 2006 [+], Kulesza_50M 2010 [+], Ingersoll 2005* [+], Mastroleo_EEA 2010 [+], Mastroleo_CPA 2010 [+]) reported use of BCT 8 Feedback on behaviour. Half of the interventions (Walters_MI+F 2009 [++], Juarez _MI 2006 [+], Juarez _MI+F 2006 [+], Kulesza_50M 2010 [+], Ingersoll 2005* [+]) reported use of BCT 80 Information about social and environmental consequences.

Evidence Statement 2.8 – Multi-session alcohol interventions delivered face to face and one on one among university students

Moderate evidence from three trials describing four alcohol behaviour change interventions (Dermen_ALC 2011 [+], Dermen_H&A 2011* [+], Juarez_MI+MF 2006 [+], Fleming 2010 [++]) suggests that that multi-session alcohol interventions are no more effective than comparators at altering drinking behaviour among university students.

Multi-session face to face interventions among university students with both risky alcohol consumption and sexual health behaviours resulted in non-significant effects. One intervention targeted alcohol consumption only (Dermen_ALC 2011 [+]). The other intervention targeted both risky drinking and risky sexual behaviour (Dermen_H&A 2011* [+]).

The inclusion of a remote follow-up component did not alter the effectiveness of face to face interventions. No significant effect was seen the trials that incorporated either a mailed feedback component (Juarez_MI+MF 2006 [+]) or a telephone/e-mail follow-up component (Fleming 2010 [++]).

All four interventions reported use of BCTs 3 Social support unspecified, and 80 Information about environmental consequences. Three of the four interventions (Dermen_ALC 2011 [+], Juarez_MI+MF 2006 [+], Fleming 2010 [++]) reported use of BCT 85 Social comparison.

Evidence Statement 2.9 – Multi-session alcohol interventions among patients with or at risk for a cardiovascular condition

Moderate evidence from three trials (Koelewijn-van Loon 2010* [+], Smeulders 2009* [+], Burke 2008* [+]) suggests that multi-session, face to face interventions that target multiple risk behaviours no more effective than usual care at reducing alcohol consumption among individuals with or at risk for cardiovascular conditions.

This was seen in a one on one intervention with remote follow-up among individuals deemed eligible for cardiovascular risk management (Koelewijn-

van Loon 2010* [+]), as well as multi-session group interventions among individuals with congestive heart failure (Smeulders 2009* [+]) and overweight, hypertensive patients at risk for cardiovascular conditions (Burke 2008* [+]).

All three interventions reported use of BCT 3 Social support (unspecified), and 62 Goal setting (behaviour). Two of the trials (Koelewijn-van Loon 2010* [+], Burke 2008* [+]) reported using BCT 63 Goal setting (outcome), and two (Smeulders 2009* [+], Burke 2008* [+]) reported use of BCT 64 Action planning.

Evidence Statement 2.11 – Alcohol interventions among individuals recruited in non-primary care settings

Moderate evidence from five trials suggests that brief interventions (Chang 2011 [++], Lane 2008 [+], Feldman 2011 [++]) and multi-session interventions (Emmen 2005 [++], Gilbert 2008* [++]) are no more effective than comparators at changing alcohol consumption among risky drinkers in non-primary care settings.

This was seen among a diverse group of patients, including female risky drinkers recruited from a hospital outpatient clinic (Chang 2011 [++]), risky drinkers presenting at a sexual health clinic (Lane 2008 [+]) individuals being treated for opioid or cocaine dependence (Feldman 2011 [++]), and HIV positive adults (Emmen 2005 [++]; Gilbert 2008* [++]).

All five interventions reported use of BCT 3 Social support unspecified. Four of the five (Chang 2011 [++], Lane 2008 [+], Feldman 2011 [++], Emmen 2005 [++]) reported BCT 8 Feedback on behaviour, and three reported use of BCTs 62 Goal setting (behaviour), 78 Information about health consequences, and 80 Information about social and environmental consequences.

<u>Smoking</u>

Evidence statement 3.6 – Multi-session smoking behaviour change interventions delivered face to face at both an individual and group level to patients with cardiovascular conditions or obstructed airways

There is strong evidence from four trials (Wood 2008* [++], Vestfold Heartcare Study Group [VHSG] 2003* [++], Anthonisen 2005 [+], Mohiuddin 2007 [+]) that multiple session smoking cessation interventions delivered at both an individual and group level are effective at increasing smoking abstinence among patients with cardiovascular conditions or previously undetected mild to moderate airway obstruction. The effect was significant on point abstinence (Wood 2008* [+], VHSG 2003* [++]). The effect on abstinence sustained overtime was especially pronounced, with large effect sizes seen in cessation sustained for several years (Anthonisen 2005 [+]) and for three months (Mohiuddin 2007 [+]).

No BCTs were common across all four interventions.

Evidence statement 3.7 – Smoking behaviour change interventions delivered remotely or with remote follow-up for individuals with cardiovascular conditions

Strong evidence from 13 interventions in 11 studies suggests that multi-session smoking interventions delivered remotely (Vale 2003* [++]) or face to face with remote follow-up (Harting 2006* [+], Joseph 2008 [+], Hyman_Sic 2007* [++], Hyman_Sec 2007* [++], Bock 2008 [+], Hilberink 2011 [+], Kotz_CC+Nort 2009 [++], Kotz_HE+Nort 2009 [++], Chouinard_IC+FU 2005 [++], Koelewijn-van Loon 2010* [+], Groenveld 2011* [+], Sivarajan Froelicher 2004 [+]) are no more effective than usual care at encouraging smokers with cardiovascular conditions or COPD to quit.

The remotely delivered intervention (Vale 2003* [++]) was found to be no more effective than usual in terms of improving abstinence among patients hospitalised for CVD.

Eleven of the face to face interventions with remote follow-up resulted in no significant difference in smoking behaviour between the intervention and usual care arms at follow up (Joseph 2008 [+], Groenveld 2011* [+], Hyman_Sic 2007* [++], Hyman_Sec 2007* [++], Bock 2008 [+], Hilberink 2011 [+], Kotz_CC+Nort 2009 [++], Kotz_HE+Nort 2009 [++], Chouinard_IC+FU 2005 [++], Koelewijn-van Loon 2010* [+], Sivarajan Froelicher 2004 [+]), SMD range: -0.63 to 0.46; all non-significant.

Only one trial (Harting 2006* [+]) resulted in a significant intervention effect. All of the BCTs reported in Harting 2006* [+] were also reported in other trials in this subgroup that found non-significant intervention effects.

The intervention resulting in significant effects on the smoking behaviour did not report any BCTs which didn't also appear in at least three of the interventions reporting non-significant effects, and also did not report use of any BCTs consistently found in smoking interventions with positive effects.

Evidence statement 3.8 – Smoking interventions for ED or hospitalised patients

Strong evidence from nine interventions described in eight trials suggests that brief (Molyneux_Cou 2003 [+], Molyneux_Cou+NRT 2003 [+], Lacasse 2008 [+]), extended (Thomsen 2010 [+]) and multi-session (Sadr Azodi 2009 [++], Bernstein 2011 [++], Neuner 2009 [+], Ratner 2004 [++], Glasgow 2009 [+]) interventions are no more effective than usual care at encouraging cessation among ED or hospitalised patients. This non-significant effect was seen across intervention types, modes of delivery, and patient groups.

Emergency Department patients

Multi-session face to face interventions with remote follow-up appointments were not effective at altering the smoking behaviour of patients presenting in the Emergency Department (Bernstein 2011 [++], Neuner 2009 [+]).

Hospitalised Medical or Surgical patients

No significant effects on smoking cessation were seen across the interventions delivered to hospitalised patients, regardless of intervention types and mode of delivery, and reason for hospitalisation. Among patients hospitalised for non-surgical reasons, the size and direction of effect varied, although all effects remained non-significant compared to usual care (Molyneux_Cou 2003 [+], Molyneux_Cou+NRT 2003 [+], Lacasse 2008 [+])

This variation in size and direction of effect was seen among surgical patients as well (Sadr Azodi 2009 [++], Ratner 2004 [++], Thomsen 2010 [+], Glasgow 2009 [+]).

The only technique common to all nine interventions is BCT 3 Social support (unspecified). Seven interventions (Molyneux_Cou+NRT 2003 [+], Lacasse 2008 [+]), Thomsen 2010 [+], Sadr Azodi 2009 [++], Bernstein 2011 [++], Neuner 2009 [+], Ratner 2004 [++]) also reported use of BCT 4 Pharmacological support.

Evidence statement 3.9 – Single session smoking interventions for pregnant smokers

Moderate evidence from four interventions described in two trials suggests that brief (Ondersma_CM-Lite 2012 [++], Ondersma_CD-5As+CM-Lite 2012 [++], Ondersma_CD-5As 2012 [++]) and extended (Stotts_USF 2009 [+]) smoking interventions are no more effective than usual care at aiding pregnant smokers to quit.

There was an inconsistent direction of and size of effect across the three brief remotely delivered interventions, however, all effects were non-significant (Ondersma_CM-Lite 2012 [++], Ondersma_CD-5As+CM-Lite 2012 [++], Ondersma_CD-5As 2012 [++]).

An extended smoking intervention delivered face to face and one on one (Stotts_USF 2009 [+]) was no more effective than usual care at aiding smokers in quitting during pregnancy.

These interventions reported no common BCTs, and no use of BCTs consistently reported in interventions with positive effects.

Evidence statement 3.11 – Multi-session smoking interventions with remote components for pregnant women

Strong evidence from seven interventions suggests that multi-session remotely delivered interventions (Rigotti 2006 [+]) and face to face interventions with remote follow-up (McBride_WOI 2004 [++], McBride_PAI 2004 [++], Stotts_MI+USF 2009 [+], Dornelas 2006 [+], Lawrence_SHM 2003 [+], Lawrence_SHM+ICI 2003 [+]) are no more effective than usual care at getting women to quit smoking during their pregnancy.

The six face to face trials with a remote component resulted in small to medium, non-significant effects (McBride_WOI 2004 [++], McBride_PAI 2004, Stotts_MI+USF 2009 [+],Dornelas 2006 [+], Lawrence_SHM+ICI 2003 [+], Lawrence_SHM 2003 [+]). The multi-session remotely delivered intervention (Rigotti 2006 [+]) resulted in a small, non-significant effect on postpartum smoking.

The majority of these trials reported use of BCT 3 Social support (unspecified), which was also reported in the comparator arm of two of the interventions. BCT 61 Problem solving was reported in three of the seven interventions.

Evidence statement 3.12 – Brief interventions for smokers who intend to quit

Moderate evidence from three trials (Willemsen 2006 [+], Sutton 2007 [+], Toll 2010 [++]) suggests that brief, remotely delivered interventions are no more effective than the comparator in terms smoking abstinence among individuals who are motivated to quit. All three trials resulted in very small, non-significant effects; two of these trials (Sutton 2007 [+], Toll 2010 [++]) offered adjunct or alternative quitline counselling, and had a direction of effect in favour of the intervention arm (Sutton 2007 [+], Toll 2010 [++]), which suggests that the

addition of brief interventions to established quitline counselling offers no significant benefit. The remaining trial (Willemsen 2006 [+]) resulted in a very small, negative, non-significant effect.

The only BCT common across all three interventions is BCT 3 Social support (unspecified). Two trials (Willemsen 2006 [+], Toll 2010 [++]) also reported use of BCTs 4 Pharmacological support and 34 Adding objects to the environment; these two BCTs also were sued in the comparator arm of Toll 2010 [++].

Evidence statement 3.13 – Multi-session smoking intervention for smokers who intend to quit

Strong evidence from seven trials (Rodriguez-Aralejo 2003 [++], Nollen 2007 [++], Joseph 2011 [++], Rabius 2004 [+], Free 2011 [++], Swartz 2006 [+], An 2006 [+]) suggests that multi-session smoking interventions can be effective at aiding cessation attempts among smokers who are motivated to quit or report intending to quit within six months. One trial (Rodriguez-Aralejo 2003 [++]) of a workplace based intervention, delivered face to face and one on one, resulted in a medium effect sustained abstinence among smokers motivated to quit (Nollen 2007 [++]), while a multi-session intervention with face to face and remote components was no more effective than usual care among African American males who wanted to quit smoking ().

Five interventions used a remote delivery; all resulted in significant effects. Medium effect sizes were seen in both an internet based intervention (Swartz 2006 [+]) and a multiple text message programme (Free 2011 [++]). Telephone counselling resulted in small to medium effect sizes across three trials (Joseph 2011 [++], Rabius 2004 [+], An 2006 [+]).

The majority of these interventions reported use of BCT 4 Pharmacological support; this technique was also reported in both the intervention and control arms of the single non-significant intervention (Nollen 2007 [++]).

Evidence statement 3.14 – Smoking behaviour change interventions among smokers identified in primary care

Strong evidence from four trials describing five interventions suggests brief (Unrod 2007 [+]) and multi-session (Borrelli 2005 [+], Pisinger_GC 2010 [+]) and remotely delivered (Pisinger_IC 2010 [+], Katz 2004 [+]) interventions are no more effective than usual care at improving abstinence among smokers identified in primary care settings.

A brief intervention (Unrod 2007 [+]) delivered face to face and one on one during primary care appointments is no more effective than usual care at improving abstinence. Multi-session interventions were no more effective than usual care across several delivery mechanisms, including those delivered face to face one on one (Borrelli 2005 [+]), within a group (Pisinger_GC 2010 [+]) or remotely (Pisinger_IC 2010 [+]; Katz 2004 [+]).

No BCTs occurred in all five interventions; BCTs 70 Persuasive source and 78 Information about health consequences were reported in three interventions.

<u>Diet</u>

Evidence Statement 4.1 – Overall Effectiveness of diet behaviour change interventions, BCT clusters and intervention functions

There is strong evidence from 27 interventions (Giannuzzi 2008* [+], Wood_CP 2008* [++], White_TB 2012* [+], Osborn 2010* [+], Keogh 2011* [+], Clark 2004* [+], Glasgow 2006 [+], Thoolen 2009* [+], Toobert 2010* [+], Eakin 2010* [+], Burke 2008* [+], Hardcastle 2008* [+], Groenveld 2011* [+], Koelewijn-van Loon 2003* [++], Ellingsen 2005* [+], Wright_NE 2011 [+], Wright_TDF 2011 [+], Wood_HR 2008* [++], Lindahl 2009* [+], Stolley 2009* [+], van Wier_I 2009* [+], van Wier_T 2009* [+], Morey 2009* [++], Patrick 2011* [+],Eakin 2007* [+], Guelinckx_B+LI 2010* [+], Sallit 2009* [+]) to suggest that individual level behaviour change interventions can have a small effect on dietary behaviour (SMD 0.33, 95% CI 0.24 to 0.42).

Meta-regression of the results of these RCTs suggested that following variables explain 18% of between study variance:

- BCT cluster 12 Comparison of outcomes (regression coefficient 0.24, 95% CI -0.01 to 0.49, p=0.061)
- Intervention function 5 'Training' (regression coefficient -0.14, 95% CI -0.33 to 0.05; p=0.142)

Use of the BCT cluster 12 'Comparison of outcomes' is associated with increased intervention effectiveness, while intervention function 5 'Training' may be associated with reduced effectiveness of interventions. The evidence about the long term effects of these variables is not conclusive.

Evidence statement 4.4 – Multi-session, face to face dietary interventions for individuals with cardiovascular conditions

Moderate evidence from three interventions (Giannuzzi 2008* [+], Wood_CP 2008* [++], White_TB 2012* [+]) suggests that multi-session dietary interventions that also address physical activity have a small, significant impact on eating habits among individuals with cardiovascular conditions. This effect was seen across several face to face delivery methods (individual: Giannuzzi 2008* [+] SMD 0.22, 95% CI 0.15 to 0.29; group: White_TB 2012* [+] SMD 0.46, 95% CI 0.05 to 0.88; combined: Wood_CP 2008* [++] SMD 0.44, 95% CI 0.29 to 0.60). All of the interventions reported use of BCTs 3 Social support (unspecified), 62 Goal setting (behaviour), and 64 Action planning. Two of the interventions (White_TB 2012* [+], Wood_CP 2008* [++]) also reported use of BCT 61 Problem solving.

<u>Physical Activity</u>

Evidence Statement 5.1 – Overall Effectiveness of physical activity behaviour change interventions, BCT clusters and intervention functions

There is strong evidence from 63 interventions (Grandes 2009 [++], Armit_ES 2009 [++], McMurdo_BCI+P 2010* [+], Armit_ES+P 2009 [++], McMurdo_BCI 2010* [+], Lawton 2008 [++], Elley 2003 [++], Hertogh 2010 [+], Nies 2003 [+], Marcus_TB 2007 [+], Kolt 2007 [+], Marcus_PB 2007 [+], Muniz 2010* [+], Giannuzzi 2008* [+], Wood_HR 2008* [++], Wood_CR 2008* [++], VHSG 2003* [++], Smeulders 2009* [+], Tingstrom 2006 [+], White 2012* [+], Moore 2006 [+], Vale 2003* [++], Reid 2012 [++], ter Bogt 2011* [+], Hardcastle 2008* [+], Hyman_SiC 2007* [++], Hyman_SeC 2007* [++], van Sluijs 2005 [++], Koelewijn-van Loon 2003* [+], Groeneveld 2011* [+], Horden 2009* [+], Harting 2006* [+], Eriksson 2009* [++], Burke 2008* [+], Eakin 2010* [+], Lorig 2006* [++], Eakin 2007* [+], Luoto 2011* [+], Toobert 2010* [+], Thoolen 2009* [+], Kirk_PA-P 2009 [+], Debussche 2012* [+], Clark 2004* [+], Di Loreto 2003 [+], Toobert 2011* [+], Keogh 2011* [+], Lorig_SM+MR 2010* [++], Lorig_SM 2010* [++], Kirk_PA-W 2009 [+], Lindahl 2009* [+], Vermunt 2011* [+], Penn 2009* [+], Prestwich_II 2009 [+], Prestwich_II+SMS 2009 [+], Prestwich_SMS 2009 [+], Guelinckx 2010* [+], Kuller 2012* [+], Nijamkin 2012* [++], van Wier_I 2009* [+], Pinto 2011 [++], Morey 2009* [++], Patrick 2011* [+], van Wier_T 2009* [+]) to suggest that individual level behaviour change interventions can have a small effect on physical activity behaviour, with an effect size of 0.22 (95% CI 0.15 to 0.29).

Meta-regression of the results of these RCTs found that the following variables explained 29.7% of between study variance:

- BCT cluster 5 ‘Repetition and substitution’ (regression coefficient 0.18, 95% CI 0.05 to 0.31; p=0.006)
- Intervention function 7 ‘Environmental restructuring’ (regression coefficient 0.16, 95% CI 0.02 to 0.30; p=0.030)
- BCT cluster 3 ‘Feedback and monitoring’ (regression coefficient -0.09, 95% CI -0.21 to 0.03; p=0.131)
- BCT cluster 12 ‘Comparison of Outcomes’ (regression coefficient 0.12, 95% CI -0.03 to 0.27; p=0.103)

- BCT cluster 1 ‘Social support’ (regression coefficient -0.13, 95% CI -0.27 to 0.09; p=0.060)

BCT cluster 5 ‘Repetition and substitution’ and Intervention function 7 ‘Environmental restructuring’ were associated with significantly increased effectiveness of the intervention, while BCT cluster 12 ‘Comparison of Outcomes’ was associated with a non-significant increase. BCT cluster 3 ‘Feedback and monitoring’ and BCT cluster 1 ‘Social support’ were associated with non-significant decreases in intervention effectiveness.

These effects remain in the long term, with the effects of BCT clusters 5, 3 and 12 and Intervention function 7 increasing in magnitude, and all being statistically significant.

Evidence statement 5.5 – Multi-session physical activity interventions delivered face to face and one on one or combined one on one and group level to patients with cardiovascular conditions

Strong evidence from four interventions (Muniz 2010* [+], Giannuzzi 2008* [+], Vestfold Heartcare Study Group [VHSG] 2003* [++], Wood_CR 2008* [++]) suggests that physical activity interventions (with an additional dietary component) delivered over multiple sessions at either one on one or combined one on one and group level are effective at physical activity among cardiovascular patients compared to usual care (Muniz 2010* [+] SMD 0.14, 95% CI 0.01to 0.27; Giannuzzi 2008* [+] SMD 0.18, 95% CI 0.11 to 0.25; VHSG 2003* [++] SMD 0.48, 95% CI 0.16 to 0.80; Wood_CR 2008* [++] SMD 0.86, 95% CI 0.75 to 0.98).

All four interventions included use of BCT 3 Social support (unspecified) [C2]. Three of the four (Muniz 2010* [+], Giannuzzi 2008* [+], Wood_CR 2008* [++]) reported use of BCT 34 Adding objects to the environment[C2]. The two interventions delivered one on one to cardiac patients reported use of BCTs 68 Commitment[A2] and 70 Persuasive source[A2]. The two combined delivery

interventions (VHSG 2003* [++], Wood_CR 2008* [++]) reported use of BCT 61 Problem solving[C2].

Evidence statement 5.6– Multi-session physical activity interventions delivered face to face on a group level to patients with cardiovascular conditions

Strong evidence from four interventions (Smeulders 2009* [+], Tingstrom 2006 [+], White 2012* [+], Moore 2006 [+]) suggests that multi-session group interventions are no more effective than comparators at improving physical activity among patients with cardiovascular conditions. All four interventions resulted in very small to small, non-significant effects (Smeulders 2009* [+] SMD 0.10, 95% CI -0.12 to 0.33; Tingstrom 2006 [+] SMD 0.00, 95% CI -0.30 to 0.30; White 2012* [+] SMD 0.22, 95 % CI -0.20 to 0.64; Moore 2006 [+] SMD 0.07, 95% CI -0.18 to 0.32). All four interventions reported use of BCTs 3 Social support (unspecified)[C2], and 62 Goal setting (behaviour)[C2].

Evidence statement 5.11 – Remotely delivered (or with remote components) physical activity interventions for individuals at elevated cardiovascular risk

Strong evidence from six interventions suggests that multi-session interventions targeting more than one behaviour and delivered either face to face with a remote component (Koelewijn-van Loon 2003* [+], Groeneveld 2011* [+], Hyman_SiC 2007* [++], Hyman_SeC 2007* [++], van Sluijs 2005 [++]) or remotely (Eakin 2010* [+]) are no more effective than usual care at altering the physical activity behaviour of individuals with elevated CV risk.

Among the face to face interventions with either remote follow-up or a remotely delivered component, several different population groups were involved, including individuals deemed eligible for cardiovascular risk management (Koelewijn-van Loon 2003* [+] SMD 0.03, 95% CI -0.22 to 0.28), male construction workers (Groeneveld 2011* [+] SMD 0.03, 95% CI -0.16 to 0.22), black men with hypertension (Hyman_SiC 2007* [++] SMD 0.02, 95% CI -0.33 to 0.37; Hyman_SeC 2007* [++] SMD 0.03, 95% CI -0.32 to 0.39),

inactive individuals with hypertension, high cholesterol, T2DM or a combination of the three (van Sluijs 2005 [++] SMD -0.01, 95% CI -0.26 to 0.25).

A remotely delivered intervention addressing both physical activity and diet was no more effective than usual care at improving the amount of moderate intensity physical activity undertaken by individuals with hypertension or T2DM (Eakin 2010* [+] SMD -0.06, 95% CI -0.25 to 0.13).

The only technique reported in all five interventions was BCT 3 Social support (unspecified).

Overall

Evidence statement 6.1 – Effectiveness of behaviour change techniques, clusters, intervention function and theory across sexual health, alcohol, smoking, diet and physical activity trials

Evidence from 197 comparisons suggests that the following BCTs and intervention function may be associated with increased intervention effectiveness when analysed across behaviours (sexual health, alcohol, smoking, diet, and physical activity):

- IF 7 Environmental restructuring (regression coefficient [β]=0.08, 95% CI -0.02 to 0.18; p=0.134)
- BCT 4 Pharmacological support (β=0.13, 95% CI 0.03 to 0.22; p=0.013)
- BCT 29 Graded tasks (β=0.24, 95% CI 0.08 to 0.40; p=0.004)
- BCT 65 Review behaviour goal(s) (β=0.09, 95% CI -0.02 to 0.20; p=0.115)
- BCT 31 Restructuring the social environment (β=0.15, 95% CI -0.11 to 0.41; p=0.254)
- BCT 63 Goal setting (outcome) (β=0.07, 95% CI -0.02 to 0.16; p=0.133)

The associations reached statistical significance for BCTs 4 and 29.

These comparisons also provided evidence that the following BCTs may be associated with reduced intervention effectiveness:

- BCT 80 Information about social and environmental consequences (β=-0.07, 95% CI -0.16 to 0.02; p=0.130)
- BCT 14 Biofeedback (β=-0.15, 95% CI -0.42 to 0.11; p=0.257)

Sensitivity analysis of studies with 6 months of follow up or longer (71 comparisons) suggested that the BCTs retain the same direction effects in the long term. In the longer term BCT 63 Goal setting (outcome) was associated with a larger positive effect than in the overall analysis and the association became significant (β=0.17, 95% CI 0.01 to 0.32; p=0.037). The positive effect associated with intervention function 7 Environmental restructuring also increased in size and became statistically significant (β=0.16, 95% CI 0.008 to 0.31; p=0.039).

Meta-regression at the level of the BCT clusters supports a positive effect for BCT cluster 2 Regulation and BCT cluster 5 Repetition and substitution, which contains the two BCTs in the BCT level meta-regression with significant associations with intervention effectiveness (BCT 4 Pharmacological support in Cluster 2, and BCT 29 Graded tasks in Cluster 5).

1.6 Summary and Discussion

A major focus of this review was on analysing the effectiveness of behaviour change techniques (BCTs) in altering sexual health, alcohol consumption, smoking, dietary and physical activity behaviour. The approach taken relied on categorising the components of interventions using BCT taxonomy. This approach has several limitations that should be considered when interpreting results:

- The sensitivity of the BCT taxonomy is reliant upon accurate and detailed reporting of the interventions; poorly described interventions may lead to an under detection of BCTs
- Analysis of the effectiveness of BCTs relies on which BCTs have been adopted in previous interventions. Of the 89 individual techniques in the BCT taxonomy used, 29 were not detected during this review; it is not

possible to evaluate the effectiveness of these techniques to guide their use or non-use in future interventions

- The BCT coding approach taken is reductionist, and decontextualizes these intervention components. The effectiveness of these techniques as well as the interventions as a whole may depend on additional factors

Despite these limitations, the BCT taxonomy approach offers a technological advance on previous methods for understanding behaviour change interventions, by providing a standardised nomenclature for the description of intervention components.

Which behaviour change techniques are effective for changing and/or sustaining change in specific behaviours only, such as alcohol or smoking, and which are more generalisable (i.e. effective across a range of behaviours)?

Individual behaviour change techniques (BCTs) were considered across all five topic areas combined, while BCT clusters were considered at the level of individual behaviour areas.

The overall multivariate analysis (across all five topics combined) suggests that the following BCTs/intervention functions may be effective at supporting behaviour change:

- BCT 4 Pharmacological support, which involves providing or encouraging the use of or adherence to drugs in order to facilitate behaviour change
- BCT 29 Graded tasks, which involves setting easy-to-perform, achievable tasks, and making them increasingly difficult until desired behaviour is performed
- BCT 65 Review behaviour goal(s), which involves jointly reviewing behavioural goals with the individual, *and* consideration of modifying the goal or behaviour change strategy in light of achievement (this may involve re-setting the same goal, making a small change in that goal, or setting a new goal instead of/ in addition to the previous goal)

- BCT 31 Restructuring the social environment, which involves changing, or advising the individual to change, the social environment in order to facilitate performance of the wanted behaviour, or creating barriers to the unwanted behaviour
- BCT 63 Goal setting (outcome), which involves setting or agreeing to a goal defined in terms of a positive outcome of the desired behaviour
- Intervention function 7 Environmental restructuring had a positive effect. This function is seen in interventions that report changing the physical or social context in which the behaviour is or could be performed.

Examination of the multivariate analyses results across the five topics combined compared to the results from each individual topic area suggests that the following techniques and functions may have more generalisable effects:

- BCT-Cluster 12 Comparison of outcomes – this BCT cluster shows an effect in diet and physical activity, but not an overall effect. Commonly reported techniques in this cluster include:
  - BCT 70 Persuasive source, which occurs when a credible figure, such as a health professional, provides information in favour of or against a given behaviour. Within this cluster, only BCT 70 showed an effect in the overall analyses: it had an effect in the univariate analysis but was not retained in the final multivariate model
  - BCT 71 Pros and cons, which involves advising the individual to identify and compare reasons for wanting and not wanting to change their behaviour

- Intervention function 7 Environmental restructuring (and by extension possibly the linked BCTs 31 Restructuring the social environment and 34 Adding objects to the environment) seem to have an effect in physical activity, smoking, as well as an overall effect

BCTs, clusters and functions with effects in specific behaviour areas only may include:

- BCT 1 Social support (practical), which involves advising on, arranging or providing practical help for the performance of the behaviour. This technique is associated with a positive effect in smoking, but a negative effect in physical activity
- BCT 4 Pharmacological support, which does have an overall effect, but this is likely to be largely due to its effect in smoking, where it generally indicates recommendation or provision of nicotine replacement therapy
- BCT 29 Graded tasks, which is associated with an overall effect, this may relate to the effect of its cluster (BCT-C 5 Repetition and substitution) in physical activity. BCT 29 may be less relevant/applicable in certain areas e.g. sexual health where graded tasks are less likely to be used to encourage changes in sexual behaviour or practices
- BCTs 63 Review behaviour goal(s) and 65 Goal setting (outcome) have a positive effect in the overall analysis, but their cluster (BCT-Cluster 11 Goals and planning) has a negative effect in smoking and no identified effect in other behaviours. This may indicate that in the non-smoking areas these BCTs are associated with a positive effect that is not large enough to be detected individually
- BCT cluster 3 Feedback and monitoring is associated with a positive effect in alcohol, but a negative effect in physical activity
- Intervention function 5 Training, which involves imparting skills to aid in the performance of the desired behaviour, was associated with a negative effect in diet but not in other areas
- Intervention function 2 Persuasion, which involves using communication to induce positive or negative feelings, or to stimulate action, was associated with a negative effect in alcohol but not in other areas

Which specific behaviour change techniques and combinations of behaviour change techniques are effective at changing behaviour in the long term (over 6 months) and/or sustaining behaviour change in individual-level interventions?

The overall sensitive analysis of studies with long term (>6 months) post-intervention follow-up assessed the effectiveness of BCTs across the five topic areas combined. This analysis suggests that the following variables were significantly associated with effective interventions:

- BCT 4 Pharmacological support
- BCT 63 Goal setting (outcome)
- IF 7 Environmental restructuring

Sensitivity analysis of studies with long term follow-up within each individual behaviour area was also carried out. This reduced the number of studies available for analysis (71 in total), and fewer variables were found to be significantly associated with intervention effects. The analysis suggests that the following BCT clusters and intervention functions were significantly associated with effectiveness:

- Alcohol
  - BCT cluster 3 Feedback and monitoring (significant positive effect)
- Smoking
  - No variables associated with significant long term effectiveness
- Diet
  - No variables associated with significant long term effectiveness
- Physical activity
  - BCT-Cluster 5 Repetition and substitution (significant positive effect)
  - BCT-Cluster 12 Comparison of outcomes (significant positive effect)
  - IF 7 Environmental Restructuring (significant positive effect)
  - BCT-Cluster 3 Feedback and monitoring (significant negative effect)

No sensitivity analysis was carried out for sexual health as none of the factors were found to account for between any of the between study variance in primary univariate analysis.

Which interventions are effective at changing behaviour and/or sustaining behaviour change in individual-level interventions?

In addition to the quantitative analysis of behaviour change techniques, clusters and functions, interventions were narratively reviewed according to two variables: type (brief, extended or multi-session) and delivery method (face to face, remote, one on one and/or group).

The majority of interventions were provided over multiple sessions. Intervention type tended to vary according to the population receiving the intervention – for example, brief interventions were more common among individuals identified on the basis of behaviour alone (e.g. smoking) rather than health status and behaviour (e.g. smokers with CVD).

Intervention Type

Overall, studies found that brief interventions (single sessions lasting less than thirty minutes) were no more effective than comparators at altering behaviour. Many of these studies targeted alcohol consumption among university students in the United States or heavy/at risk drinkers presenting in the Emergency Department or primary care. The lack of observed effectiveness may be due to particular difficulties altering drinking behaviour in these populations (other intervention types also largely resulted in no significant differences in alcohol consumption in these populations/settings.

Few studies assessed extended interventions. These were mainly provided to heavy/risky drinking university students with the aim of reducing alcohol consumption. The lack of effectiveness seen among these interventions may be due to difficulties in addressing alcohol consumption in this group, rather than due to the intervention type itself.

Across the five topic areas, multi-session interventions were more likely to be used and more likely to be effective than the other types of intervention. This effectiveness varied across population groups and delivery method, however. Interventions provided to individuals with clinical disease (CVD, T2DM) were most likely to be provided over multiple sessions, and most likely to address multiple behaviours. The effectiveness of these interventions may be due to a combination of intervention intensity, content, context and population characteristics.

While the categorisation of intervention type used in this review provides a proxy measure of intensity (with brief interventions being less intense and multiple sessions more intense), it does not capture all aspects of it, and further assessment is necessary to clarify which aspects of these multi-session interventions are effective at encouraging behaviour change.

Delivery method

Frequency of use and effectiveness of each delivery method varied across the topic areas and population groups. Face to face, one on one interventions were most common in the sexual health, alcohol and smoking topics, and among interventions delivered in clinical settings such as primary care or Emergency Departments. Remotely delivered interventions (alone or as a follow-up to face to face interventions) were used most frequently in the smoking and physical activity topics. However, no clear trends in effectiveness among different delivery methods were observed.

How do the effects of individual interventions vary across different population groups?

Trials in each behaviour area were grouped according to key participant characteristics. These characteristics broadly mirrored the individual level criteria used to assess eligibility for inclusion in the review, that is, existing behavioural or health-status factors that indicate the need for or appropriateness of a behaviour change intervention. Some of these population groups were specific to the individual areas of interest (e.g.

individuals with HIV or other STI in the sexual health section), while others applied to several behavioural areas (e.g. individuals with or at risk for CVD in the alcohol, smoking, diet and physical activity sections).

There was considerable heterogeneity in both participant and intervention characteristics within each population group. Such heterogeneity may account for variation in intervention effectiveness, but was not assessed in this review. A summary and discussion of the effectiveness of behaviour change interventions within the main population groups is provided for each behaviour area.

Sexual Health

There was a limited number of sexual health studies included in the review. Further dividing these studies results in most populations being represented by only 3 to four trials; this limits the conclusions that can be drawn regarding the effectiveness of sexual health interventions among any given population.

Overall, interventions had no significant effect on the sexual health behaviours of:

- Men who have sex with men

Interventions had inconsistent effects on the sexual health behaviours of:

- Women at risk of unintended pregnancy
- Individuals at risk of acquiring HIV or other STIs
- Individuals with HIV or other STIs

Alcohol

A large proportion of alcohol behaviour change trials recruited participants with clinical illness (e.g. cardiovascular disease) or from clinical settings (e.g. surgical wards or primary care practices). These interventions were generally compared to usual care, which may provide unreported or under reported strategies to reduce alcohol consumption among these populations. It is

unclear in the majority of these trials whether the observed lack of effectiveness is due to overall difficulties in altering the behaviour of these populations, factors relating to the interventions themselves, or fairly robust yet poorly described usual care strategies targeting alcohol consumption.

Overall, interventions had no significant effect on the alcohol consumption behaviours of:

- Individuals with or at risk for cardiovascular conditions
- Emergency Department or hospitalised patients
- Primary care patients
- University students

Interventions may be effective at changing the alcohol consumption behaviour of:

- Pregnant and postpartum women. However this evidence was limited to two interventions; this may be an area of interest for future research

Smoking

The effectiveness of smoking interventions varies considerably across different population groups. As with interventions in other behaviour areas, considerable variation was seen in participant characteristics within each subpopulation. Additionally, usual care generally served as the comparator in trials recruiting smokers with clinical illness (e.g. CVD or COPD) and in those recruiting from clinical settings (e.g. Emergency Departments, primary or antenatal care settings). Similar to alcohol interventions using usual care as the comparator, in these cases it is especially unclear whether any observed lack of effect is due the populations, the interventions, or fairly robust yet poorly described usual care smoking cessation strategies.

Overall, interventions may be effective at changing the smoking behaviours of:

- Smokers who are motivated or interested in quitting

Interventions had inconsistent effects on the smoking behaviours of:

- Individuals with or at risk for cardiovascular or respiratory conditions
- Pregnant and postpartum women

Overall, interventions had no significant effect on the smoking behaviours of:

- Emergency Department or hospitalised patients (e.g. surgical patients)
- Primary care patients
- Individuals with or at risk for cardiovascular conditions

Diet

The subpopulations in this topic area were represented by only a handful of studies, which limits the conclusions that can be drawn within or across the groups.

Overall, interventions that address both diet and physical activity may be effective at changing the dietary behaviours of:

- Individuals with cardiovascular conditions

Interventions had inconsistent effects on the smoking behaviours of:

- Individuals with Type 2 Diabetes
- Individuals at risk for cardiovascular conditions
- Overweight or obese individuals

Physical activity

As with the sexual health and diet areas, subpopulations in the physical activity review were represented by only a handful of studies, which limits the conclusions that can be drawn within or across the groups.

Interventions had inconsistent effects on the smoking behaviours of:

- Individuals with or at risk for cardiovascular conditions
- Individuals with or at risk for Type 2 Diabetes
- Inactive or underactive individuals

Interventions that address both physical activity and diet may be effective at changing the activity behaviours of:

- Overweight or obese individuals

Social Inequalities

The majority of included studies did not target low SES or BME groups, nor specify the socioeconomic or ethnic characteristics of their participants. This limits the number of studies available for synthesis in this section, and thus the conclusions that can be drawn regarding the effectiveness of behaviour change interventions in these populations.

Overall, there were a limited number of studies that reported participant characteristics in a manner suitable for assessing the effect of these behaviour change interventions among economically disadvantaged individuals, or individuals in minority ethnic groups. While these studies suggest that behaviour change interventions can be effective among these populations, given the limitations of this synthesis, it is unclear whether the variation in effectiveness seen is related to target behaviours, intervention content and design, participant SES, ethnicity, or other characteristics.

Which theories explain when, why and how behaviour change is maintained?

Theory was included as a variable in all meta-regression analyses (both the overall analysis as well as those carried out in individual behaviour areas). Theories were used in a minority of interventions, and the absence of positive effects of theory use in the meta-regression analyses suggests there was no

clear advantage to using theory to inform interventions. This conclusion is qualified, however, by a key limitation of our coding of theory use.

Preliminary attempts were made to apply a robust 19-item theory coding frame. Due to insufficient descriptions of theory in the included trials, however, many of these items could not be coded. Therefore, a single-item assessment of theory use was adopted. While theory can be used in multiple ways to inform the basis of an intervention, the coding approach taken in the current review is not able to distinguish between instances in which theory is mentioned in the intervention description but not used to inform content, and those instances in which theory is integrated into all parts of the intervention (development, implementation, evaluation).

2 Introduction

The National Institute for Health and Clinical Excellence (NICE) is undertaking a partial update of public health guidance 6 (PH6, Behaviour change at population, community and individual levels) in order to provide guidance on behaviour change at the individual level, and interventions based on choice architecture at individual, community and population level.

This evidence review supports the partial update of PH6 by assessing the evidence base of individual level behaviour change interventions, with a particular focus on the behaviour change techniques used in these interventions, including health promotion and disease prevention interventions aimed at changing an individual's behaviour. This differs from the wider remit of the original PH6, which also included population and community behaviour change interventions. For the current guidance, an intervention is considered to operate at the individual level if a person is selected of the basis of an existing health status or behaviour. For example, vouchers for healthier food options offered to anyone with a specific biomarker (for example, a specific body mass index) or health status (for example, obesity), would be an individual-level intervention. Offering vouchers to everyone in the country or a specific city would not be an individual level intervention.

Individual behaviours can have a substantial impact on people's health, and play a role in the development of non-communicable diseases (NCDs), and communicable diseases in the case of sexual health. The NCD conditions, which include cardiovascular disease, type 2 diabetes, cancers and respiratory diseases, are now the leading cause of death both in the UK and worldwide (ONS 2102, WHO 2010). The World Health Organisation (WHO) reports that smoking, harmful alcohol use, lack of physical activity and an unhealthy diet are considered to be the four main behavioural risk factors for NCDs (WHO 2010). Interventions that can effectively alter these individual behaviours may have a substantial impact on the burden of disease throughout the UK.

Theoretical and methodological perspectives

Developing and implementing effective behaviour change interventions depends on understanding the determinants of change. Health behaviour theories, drawn from psychology and other disciplines, offer summaries of hypothesised causal processes that precede behaviour, and so offer a framework for developing and evaluating behaviour change interventions. These theories can be categorised into two main types. *Predictive theories* seek to describe the psychological constructs that determine engagement in health-related behaviours; these can be further categorised into motivational theories, which focus on the thoughts and beliefs that determine an individual's intention to engage in a behaviour (e.g. the Theory of Planned Behaviour [Ajzen 1991], Protection Motivation Theory [Rogers 1983]); and volitional or self-regulation theories, which explore the determinants of translating intention into action (e.g. Control Theory [Carver & Scheier, 1982]). *Stage-based theories* propose that the behaviour change process comprises qualitatively different stages (such as initiation and maintenance), each of which is characterised by different psychological constructs (e.g. the Transtheoretical Model, also known as the 'Stages of Change' Model; Prochaska & DiClemente 1983). Health behaviour theories propose that psychological constructs are the closest determinant of behaviour, and that changing these constructs should lead to changes in behaviour. Identifying the theoretical basis of behaviour change interventions as part of evidence synthesis can help to identify the social, cultural and psychological variables associated with behaviour change.

Substantial advances have been made in behaviour change technology since the publication of NICE's 2007 public health guidance in behaviour change. Health behaviour theories focus on predictors of behaviour change, but rarely specify which techniques bring about changes in behaviour. Extensive lists, or 'taxonomies', that specify and define discrete behaviour change techniques (BCTs) have been proposed (Abraham & Michie 2008; Michie et al 2013). These offer the opportunity to identify the 'active ingredients' of previously published behaviour change interventions (Michie 2009). A state-of-the-art

generic taxonomy is available which identifies and categorises 89 BCTs into sixteen theoretical clusters (Michie 2013). Combining BCT coding with meta-regression analysis within evidence synthesis can help to identify the discrete BCTs, or theoretical clusters, most closely associated with behaviour change (Michie 2009). Additionally, a systematic framework (the 'Behaviour Change Wheel'; Michie 2011b) has been developed for the categorisation of behaviour change interventions according to their intended function (e.g. education, persuasion, training, etc.). This framework can be used to identify the types of interventions that are most effective in engineering change in particular behaviour domains.

Our review uses a combination of these tools to categorise and evaluate components of interventions. We coded descriptions of eligible behaviour change interventions for theory use (i.e. whether and which behaviour change theories were used to inform the intervention), the presence of BCTs, BCT clusters, and intervention function. Meta-regression analyses were used to identify which of the intervention components were most associated with behaviour change.

Equality and equity issues

Health behaviours and outcomes vary across socioeconomic and ethnic groups (Michie 2008)(Wilkinson 2011). In the UK, socioeconomic status (SES) has been reported to be associated with smoking, dietary, and physical activity behaviours: individuals in routine and manual occupational groups are more likely to smoke, less likely to eat five portions of fruit and vegetable each day, and less likely to take regular exercise than individuals in managerial and professional groups (Michie 2008). Chronic disease mortality rates are also higher among those in lower SES groups (Michie 2008). While there is a less clear pattern across ethnicities, inequalities have been reported in black and minority ethnic (BME) groups in terms of both health behaviours and outcomes, with heath and mortality inequities among BME groups being "particularly pronounced alongside higher prevalence of some health-risk behaviours" (Wilkinson 2011). Whether the effectiveness of a behaviour

change intervention varies across different population groups of interest, as changes in behaviour in these groups could have an impact on reducing health inequalities.

This is the second of three external evidence reviews commissioned by NICE to update the current public health guidance on behaviour change (PH6). This is a review of the evidence of effectiveness of interventions and behaviour change techniques in individual-level interventions for smoking, alcohol, diet, physical activity and sexual health. Interventions at a community or population level are not considered in this review.

The four questions that this review (Review 2) aims to contribute to are:

1. a. Which interventions are effective at changing behaviour and/or sustaining behaviour change in individual-level interventions?

   b. Which specific behaviour change techniques and combinations of behaviour change techniques are effective at changing behaviour in the long term (over 6 months) and/or sustaining behaviour change in individual-level interventions?

2. Which behaviour change techniques are effective for changing and/or sustaining change in specific behaviours only, such as alcohol or smoking, and which are more generalisable (i.e. effective across a range of behaviours)?

3. How do the effects of individual interventions vary across different population groups?

4. Which theories explain when, why and how behaviour change is maintained?

The accompanying reviews are Reviews 1 and 3. Review 1 summarises the existing state of knowledge and guidance on behaviour change as described in current NICE public health guidance. Review 3 is a qualitative review that addresses one further question regarding the competencies required to

deliver effective interventions and techniques as well as patient views. Review 2 should be interpreted alongside the findings of the other two reviews, as well as existing NICE guidance.

3 Methods

Briefly, the steps in this review were:

- Identifying relevant studies by systematic searches of electronic literature databases
- Selecting relevant studies relating to individual-level behaviour change interventions that meet inclusion criteria
- Assessing the quality of the included studies
- Extracting data from the best quality included studies, including coding behaviour change techniques (BCTs), intervention function, and the use of theory in the interventions
- Carrying out meta-regression to identify which BCTs are associated with effectiveness
- Summarising findings and drafting evidence statements relating to BCTs, intervention function, and theory use that address the questions for the review

Further details are described in the Sections 3.1 to 3.3.

3.1 Scope of the review

The scope of the review is reported in Appendix A.

The wide remit of the current evidence review (addressing any of a potentially wide range of individual behaviour change interventions across five different areas) suggested that without including a study design constraint, a very large volume of studies could potentially be relevant. Therefore initial searches for this review were limited to detect only systematic reviews and RCTs. If any areas were found to have limited numbers of systematic reviews and RCTs, searches would have been expanded to include other study designs.

However, this was not required as a large volume of very good/good quality studies was retrieved in the systematic review and RCT search.

3.2 Systematic searches

The evidence review for previous NICE Behaviour Change guidance (PH6) covered systematic reviews published up to February 2006. To cover the lag between RCTs being published and included in systematic reviews, for the current review systematic searches were for papers published in English from 2003 onwards. The following databases were searched:

- Cochrane Database of Systematic Reviews (Cochrane Library)
- Database of Abstracts of Reviews of Effects (Centre for Reviews and Dissemination)
- MEDLINE In Process (OvidSP)
- EMBASE (OvidSP)
- PsycINFO (OvidSP)
- ERIC Free (Education Resources Information Center)
- CinAHL (EBSCOhost)
- Cochrane Central Register of Controlled Trials (Cochrane Library)
- Applied Social Science Index and Abstracts (Proquest, supplied by NICE)
- HMIC (OvidSP)
- Social Policy & Practice (Ovid, supplied by NICE)

Searches and filters used were adapted to suit the content and indexing of each database, searches strategies can be found in Appendix B.

The main search strategy was developed, working closely with the team at CPHE at NICE, in MEDLINE through testing to identify the optimal search (best balance between sensitivity and specificity) that was fit for purpose. Modified SIGN filters for retrieving RCTs and systematic reviews were used. The main search strategy has facets for the five behaviours linked by OR, which together are paired via AND with a behaviour change intervention facet. After this section of the search we included two lines to identify those articles

that study behaviour change across a range of behaviours, and hence may not be picked up by the original combination that concentrated on articles focused on particular behaviours. The development of the search was tested against a group of 21 independently retrieved RCTs and SRs. Two were initially missed, but with the addition of “brief intervention” into the search both the articles were retrieved.

Search results were uploaded and managed in Reference Manager 12.

3.3 Selecting studies for inclusion

3.3.1 First pass appraisal

Evidence identified in the search was filtered at the title/abstract level by an Information Specialist to remove any clearly non-relevant material. Studies were excluded on the basis of the following:

- Clearly non-relevant question
- Clearly non-relevant study design (e.g. letters, animal studies, uncontrolled studies, non-systematic reviews)
- Non-relevant intervention area (i.e. not alcohol, smoking, diet, physical activity, sexual health)
- Clearly a non-individual level intervention
- Not a behaviour change intervention (e.g. abstract does not describe inclusion of a behavioural outcome; studies assessing the effect of a drug only)
- Wrong population group (i.e. in children aged <16 years)

Any uncertainties regarding inclusion/exclusion were resolved by discussion with a second information specialist. This stage of screening acted as a “coarse filter” and erred on the side of inclusion, to avoid exclusion of studies that might be relevant. The filtered references were tagged in a Reference Manager database and passed on to a Research Analyst for second pass appraisal.

3.3.2 Second pass appraisal

Detailed inclusion/exclusion criteria were developed based on the scope to assist with second pass and full text appraisals. These are summarised in Appendix C.

Due to the large number of studies retrieved, additional exclusion criteria were agreed with NICE, including the exclusion of studies undertaken in developing world countries, feasibility/exploratory studies, studies with fewer than 100 participants, dissertations and conference abstracts.

A 10% sample of titles and abstracts was double screened for eligibility, resulting in 86% agreement (kappa 0.68). Disagreements were resolved by discussion, with recourse to a third analyst if needed. Information on reasons for exclusion was recorded in Reference Manager, and possible reasons for exclusion are reported in Appendix C. If it was unclear whether a study met inclusion/exclusion criteria the full text was obtained.

3.3.3 Full text appraisal

The full text papers were appraised by a Research Analyst, using the detailed criteria described in Appendix C. Information on reason for exclusion were recorded. A 10% sample of full texts was double screened at this stage as agreed with the NICE team. There was a 96.3% overall agreement (kappa 0.93). Disagreements regarding inclusion/exclusion were resolved by discussion, with recourse to a third analyst if needed.

3.3.4 Quality appraisal

Quality appraisal was carried out using NICE quantitative study quality checklists. The ratings are as follows:

[++] All or most of the NICE checklist criteria have been fulfilled; where they have not been fulfilled the conclusions are very unlikely to alter.

[+] Some of the checklist criteria have been fulfilled, where they have not been fulfilled, or not adequately described, the conclusions are unlikely to alter.

[-] Few or no checklist criteria have been fulfilled and the conclusions are likely or very likely to alter.

Studies with a [-] internal validity score were double appraised, and if there was agreement that the internal validity score was [-] they were excluded. A 10% sample of the remaining studies underwent double screening, with 82% agreement (kappa 0.65). Disagreements were resolved by discussion, with recourse to a third analyst if needed.

3.3.5 Grouping of interventions

The following definitions have been adopted for grouping the individual level interventions, their types and modes of delivery in the population subgroups of interest.

- Brief interventions: Single session interventions, usually opportunistic, and lasting less than 30 minutes.
- Extended interventions: Single session interventions, lasting more than 30 minutes
- Multi-session intervention: Interventions that are not “brief” but delivered over several sessions, these may include sessions delivered on referral from another provider (i.e. following a brief intervention).
- Face to face, one to one interventions: Interventions delivered in settings and situations that allow eye contact, and delivered by one to one professional contacts, counselling or other contact between a single person and a single professional.
- Face to face, group interventions: Interventions delivered in settings and situations that allow eye contact, and delivered to a group of individuals e.g. group counselling, group education.
- Remotely delivered interventions: Includes interventions delivered by telephone proactively or reactively (quitlines); SMS or text message; web/internet; and video without face to face contact.

3.3.6 Coding behaviour change techniques, intervention function, and theory use

BCT coding was based on an 89-item BCT taxonomy (Michie et al. 2011a)(Michie et al. 2012). This taxonomy contains explicit definitions of individual BCTs, which are defined as “replicable components of an intervention designed to alter or redirect causal processes that regulate behaviour; that is, a technique is proposed to be an ‘active ingredient” (Michie et al. 2011a). Each technique is classified into one of 16 theoretical clusters (e.g. BCT Cluster 1 “Social Support”).

The 89-item BCT taxonomy 'BCT taxonomy v1.0’ (May 2012) has subsequently been expanded into a 93-item taxonomy “BCT taxonomy v1.1” (August 2012) in which one BCT from the 89-item version (BCT 60 “Incentive”) has been broken down into five discrete BCTs (i.e. material incentive for behaviour, material incentive for outcome, social incentives, non-specific incentives, self-incentives). The 93-item taxonomy v1 was not used in this review (Review 2) as it was not available at the time this review was initiated, but it has been used for a separate cost effectiveness review of behaviour change interventions for NICE (Shahab et al. unpublished document [link will be added to final version on NICE website]).

In the text individual BCTs are referred to by their number and brief title for brevity. When interpreting the content of each BCT, it is important to read the full details of what each BCT comprises (see Appendix D).

Interventions were also categorised according to which one or more of nine functions they served (education; persuasion; incentivisation; coercion; training; restriction; environmental restructuring; modelling; enablement), as taken from the ‘Behaviour Change Wheel’ (Michie et al. 2011b).

The extent to which interventions are based on theory was coded using a single item coding frame. Initially it was planned to use more items in a modified version of Michie and Prestwich’s 19-item coding frame, which assesses the use of theory in justifying or developing an intervention, or

selecting intervention techniques or recipients (Michie and Prestwich 2010). This coding frame was intended to be used in this review, but early applications to published interventions showed that interventions were insufficiently described for many of the items to be coded. Therefore a single-item assessment of theory use was used to reflect the degree to which any theory applied to an intervention's development or use can affect outcomes. The term 'theory use' throughout this review refers to this single-item coding.

See Appendix D for descriptions of the BCT taxonomy, BCT clusters, intervention functions and theory use coding frames used in this report. The number of items in each of the coding frames is given below and indicates the level of specificity in each of the coding structures.

- BCT taxonomy (89 items)
- BCT clusters (16 clusters; a cluster was coded as present when at least one of the individual BCTs in the cluster was present)
- Intervention function (9 items)
- Theory use (1 item)

Where insufficient evidence on the interventions was available in the published reports to allow BCT coding, additional information was sought on the intervention using links or references in the published study. Time constraints meant that it was not feasible to contact authors for additional information regarding the methods used in the interventions.

Based on expert advice, where a single intervention targeted more than one of the five behavioural areas of interest, all BCT codes used to target these areas were ascribed to the intervention, rather than separately coding the BCTs targeting each individual behavioural area of interest. This was because when delivered together, BCTs targeting different behavioural areas may influence other behaviours as well as those directly targeted.

BCTs, intervention functions, and theory use were coded for both intervention and comparator arms.

3.3.7 Results extraction and summary

Results data were extracted from the included studies. As studies often used multiple outcomes within an individual behaviour area, an outcome hierarchy was used to select one outcome for each behaviour area assessed in each study for inclusion. This outcome hierarchy was based on a judgement of the relative importance and reliability of outcomes (e.g. sustained biochemically confirmed quitting being judged to be the most important smoking outcome). The outcome hierarchy is described in more detail in Appendix E. For the overall meta-regression, one effect size per intervention was entered into each model. Where a single intervention targeted multiple behaviour areas, the calculated effect sizes for each of these areas was averaged to avoid a unit of analysis error.

Where a study compared multiple interventions to a single control, the control group sample size was divided by the number of interventions when calculating the effect size and associated standard error (thus avoiding a unit of analysis error).

Studies were only included in the review if they provided data which could be converted into standardised mean differences (SMDs) for comparison across studies and use in the meta-analysis and meta-regression. The SMDs were standardised so that a positive SMD represented a benefit with the intervention (favoured intervention), and a negative SMD represented a benefit with the comparator (favoured comparator).

The following guidelines were used when interpreting effect sizes:

- very small effect size: SMD <0.2
- small effect size: SMD ≥0.2 but <0.5
- a medium effect size: SMD ≥0.5 but <0.8
- large effect size: SMD ≥0.8

The same guidelines apply regardless of the direction of effect, for example, an effect side of 0.3 is considered small, as is an effect size of -0.3.

A graphical approach was taken to summarising the frequency of use of individual BCTs and effectiveness in the individual areas. The graphs also indicate the direction of effect of the trials including the BCTs (favouring intervention or control), and the significance of the effect. These graphs were used to give a general picture of effectiveness of interventions containing the individual BCTs. However, caution should be taken in inferring the effectiveness of individual BCTs on the basis of these graphs, as they do not indicate effect sizes or size of the individual trials.

In order to consider the BCTs used in different populations in the wider context of all trials in each specific behaviour area, a coding system was developed to annotate each BCT. The alphanumeric codes are outlined in Table 1.

Table 1: BCT annotation based on direction and significance of effect

Direction of effect across all interventions in the specified behaviour area	
A	BCT found in interventions with a positive direction of effect only (i.e. effect favours intervention)
B	BCT found in interventions with a negative direction of effect only (i.e. effect favours control)
C	BCT found in interventions with positive and negative directions of effect (i.e. inconsistent direction of effect – some favouring intervention, some favouring control)
Significance of effect across all interventions in the specified behaviour area	
1	BCT found in one intervention with a significant positive effect
2	BCT found in more than one intervention with a significant positive effect

For example, a BCT annotated with ‘A1’ is reported only in interventions with a positive direction of effect, at least one of which was found to be statistically significant, while a code of ‘C2’ indicates the BCT was found in trials with inconsistent directions of effect, but with at least two of those effects being significant (and in a positive direction). The absence of a number indicates that the BCT was not associated with a significant intervention effect in any of the trials in the behaviour area being discussed. These codes appear in the study description tables and the evidence statements. The codes do not take into account use of the BCTs in control groups of the trials.

Within each behaviour area, interventions were grouped by population targeted (e.g. based on the presence of or risk for clinical disease, or other relevant characteristics), and tables summarising the intervention type, delivery method, effect size and significance, and use of BCTs were created for each population. These tables and the BCT graphs were used to develop evidence statements regarding intervention effectiveness in the individual behaviour areas and population groups.

3.3.8 Meta-analysis and meta-regression

Meta-analysis and meta-regression models were run using STATA, to explore the extent to which coded items (BCTs, BCT clusters, intervention functions, theory use) could explain between-study heterogeneity in intervention effectiveness, either in isolation (univariate analysis) or when controlling for other items and covariates (multivariate analysis).

Meta-analysis

Random effects meta-analysis was used to pool the results of the relevant comparisons in the included trials in the individual behaviour areas (smoking, sexual health, alcohol, diet, and physical activity). Pooled results were calculated as standardised mean differences (SMDs).

Heterogeneity was assessed using the Cochrane Q and I^2 statistics. Thresholds for the interpretation of I^2 are described in the Cochrane Handbook of Systematic Reviews (Deeks et al. 2011), which gives the following rough guide to interpretation:

- 0% to 40%: heterogeneity may not be important;
- 30% to 60%: may represent moderate heterogeneity;
- 50% to 90%: may represent substantial heterogeneity;
- 75% to 100%: considerable heterogeneity.

A sensitivity analysis was carried out to look at whether the results of individual studies were having a major impact on the results of the meta-regression (called outliers). Outliers were assessed using the metainf

command in STATA. This approach assesses the influence of each individual comparison on the overall meta-analysis summary estimate. To do this each individual comparison is deleted from the meta-analysis in turn, and the results of these analyses compared with the overall meta-analysis. If omitting a comparison results in an effect estimate outside of the confidence interval of the overall meta-analysis, this indicates that the study may be an outlier that is having excessive influence on the overall meta-analysis.

Publication bias refers to the phenomenon where smaller studies with less positive results may not to get published. If this happens, when the results of published studies are pooled, the result may suggest greater effectiveness than would be seen if all existing studies were pooled. Publication bias is assessed by various methods that attempt to detect whether these smaller, less positive trials are systematically missing from the published evidence. For this review publication bias was assessed using funnel plots, Egger's test for small study effects, and a filled funnel plot analysis. The filled funnel plot analysis identifies potentially missing studies from gaps in the funnel plot and estimates (imputes) their results based on the existing studies. These imputed results are included in a meta-analysis with the existing studies to assess whether this changes the effect size, direction, or significance of the meta-analysis. The exclusion of small studies (n<100) from this review may contribute to any observed publication bias. As studies were excluded based on size only, and not results, this should not bias the findings towards more positive findings.

Meta-regression

Meta-regression assesses whether an outcome variable (in this case the effect sizes from the studies) is predicted by one or more explanatory variables (in this case the BCTs, BCT clusters, intervention functions or theory use of the intervention).

In the results of a meta-regression, the regression coefficient (β) describes how the outcome variable (effect size) changes with a unit change in the explanatory variable. So, a regression coefficient of 0.14 associated with a

BCT cluster would mean that the effect size of interventions containing this cluster were on average 0.14 higher than the effect size of interventions not containing this cluster. The confidence intervals for the regression coefficient and P values indicate whether the relationship is statistically significant (i.e. $p<0.05$ and a CI that does not include zero are significant outcomes).

The adjusted R-squared statistic indicates how much of the variance in effect size between the studies is due to the variable being tested. Therefore the explanatory variables that explain the largest amount of between study variance in the univariate analyses are taken forward into the multivariate analyses.

Based on expert meta-regression advice, the 89 individual BCTs were not assessed in the meta-regressions for the individual behaviour areas (smoking, sexual health, alcohol, diet, and physical activity), as the analyses were unlikely to have enough power to detect effects of individual BCTs. The overall meta-regression across all behaviour areas assessed the effects of the individual BCTs, as this analysis was more highly powered.

The meta-regression started with individual univariate meta-regressions for each of the individual behaviour areas (sexual health, alcohol, smoking, diet, and physical activity), looking at whether the following individual variables explained between study variance:

- BCTs at the cluster level (16 clusters). The model was run for a cluster if at least 3 studies used or did not use a particular cluster (i.e. so that there was a spread of studies using and not using the cluster).
- intervention function (9 functions). The model was run for a function if at least 3 studies used or didn’t use a particular function.
- theory use (1 variable). There was no minimum number of studies set for running this model.

The overall meta-regression across all behaviour areas together, included individual univariate meta-regressions looking at whether the following individual variables explained between study variance:

- individual BCTs (89 BCTs). The model was run for a BCT if at least 3 studies used or didn't use that particular BCT.
- BCTs at the cluster level (16 clusters). The model was run for a cluster if at least 3 studies used or didn't use that particular cluster.
- intervention function (9 functions). The model was run for a function if at least 3 studies used or didn't use a particular function.
- theory use (1 variable). There was no minimum number of studies set for running this model.

The meta-regressions adjusted for the presence of each BCT (for the overall meta-regression), BCT cluster, or intervention function in the control (comparator) group. Initially these adjustments were carried out by including a separate second variable indicating the presence of the BCT/BCT cluster/intervention function. However, following comments from the PDG the approach to controlling for use of BCT clusters and intervention functions in the control group in the meta-regression was updated. The presence of BCTs, BCT clusters and intervention functions in intervention and comparator groups was coded as a single variable. Essentially a BCT cluster/intervention function was only coded as present (coded as 1) if it was used in the intervention but not in the comparator arm; if it was present in both the intervention and the comparator arm it was 'cancelled out' (coded as 0). Only in a small number of instances was a BCT cluster/intervention function present in the comparator arm but not in the intervention arm, which could potentially be coded as "-1". Incorporating "-1" values into the meta-regression and interpreting results would be complex, therefore in these cases the BCT cluster/intervention function was coded as not present (coded as 0), rather than excluding the study, which would reduce the power of the analyses.

Forward stepwise multivariate meta-regression was run for each target behaviour area and for the overall analysis, beginning with an empty model,

then adding the variable with the highest adjusted R-squared identified via the univariate analyses adjusted for control group BCTs/BCT clusters/intervention functions. This was followed by adding the variable with the next highest adjusted R-squared and so on until adding the next variable explained no more of the variance.

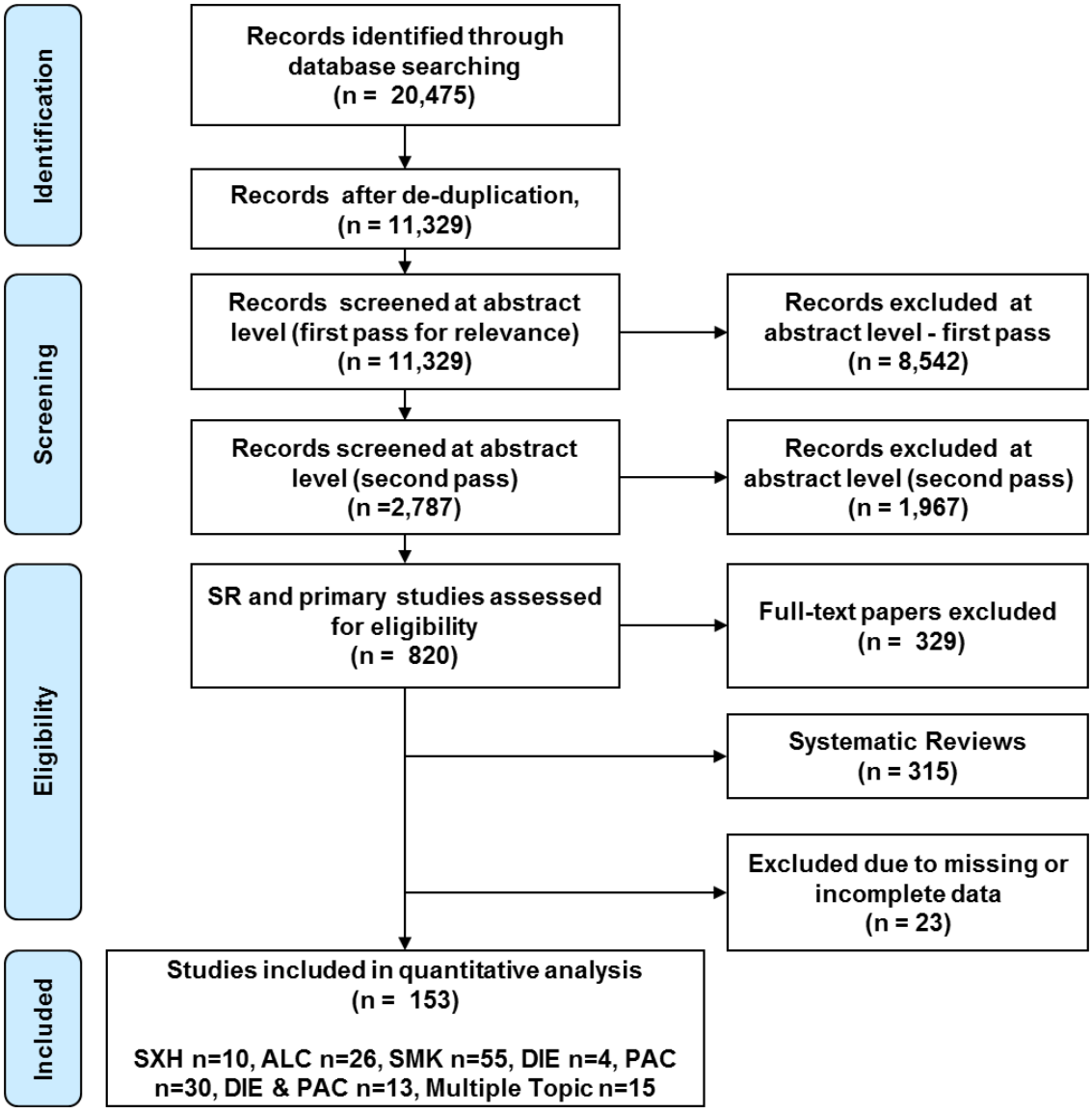
At each step, the regression coefficient for each variable was checked, and variables that were not related to the effect size removed, then the next variable added. The use of BCTs in the control group and theory use were controlled for at each step. Theory use was controlled for by including it as a variable in the multivariate meta-regression (regardless of its adjusted R^2 in the univariate analysis). The fit of the model indicates how well the included variables explain the between study variance.

Sensitivity analysis was carried out to assess whether effects were maintained in the long term, by repeating the multivariate meta-regression including only studies with long term follow-up (>6 months).

4 Summary of findings

The overall flow of studies in the review is shown in Figure 1.

Figure 1: PRISMA diagram



4.1.1 Studies addressing more than one behavioural area

Several of the interventions in the RCTs addressed more than one of the topic areas covered in this review (sexual health, alcohol, smoking, diet or physical activity). These interventions are denoted with an asterisk (*) after the study reference in the evidence statements, other text and tables.

4.1.2 Trials assessing more than one behaviour change intervention

For trials that assessed more than one intervention, each arm is designated by a unique acronym after the AUTHOR DATE combination (i.e. the two arms reported in Chouinard 2005 [++] are designated as Chouinard_IC 2005 [++] and Chouinard_IC+FU 2005 [++] throughout the report). See Appendix F for a glossary of these intervention abbreviations, and Appendix G for a more detailed description of the individual interventions within the trials.

4.2 Sexual health

4.2.1 Included studies

Nineteen RCTs assessing individual level interventions targeting sexual health behaviour outcomes met the population, intervention, and comparator inclusion criteria after full text appraisal. Study characteristics and results for these studies are summarised in the evidence tables in Appendix G.

Of these 19 studies, 13 provided outcome data which could be converted into standardised mean differences (SMDs) for comparison across studies and use in the meta-analysis and meta-regression. The narrative review and analyses below include these 13 studies.

4.2.2 Quality Assessment

Among the 13 studies which provided useable outcome data, five studies had internal validity rated as very good [++], and eight studies as good [+].The

results of the quality appraisals for the individual studies are found in Evidence tables in Appendix G.

4.2.3 BCTs

The individual BCTs that occurred across 15 interventions described in the 13 sexual health trials are summarised in Figure 2, along with the effectiveness of the interventions including each BCT.

The following BCTs were reported only in trials with positive intervention effects, more than one of which was significant (annotated A2 throughout the sexual health sections). The significance of this effect varied across the trials (see Figure 2 for details of frequency of use in significant interventions):

- 9 Feedback on outcome(s) of behaviour

The following BCT was reported only in trials with positive intervention effects, one of which was significant (annotated A1 throughout the sexual health sections). The significance of this effect varied across the trials (see Figure 2 for details of frequency of use in significant interventions):

- 62 Goal setting – behaviour
- 80 Information about social and environmental consequences

The following BCTs were reported only in trials with positive intervention effects, none of which was significant (annotated A throughout the sexual health sections). The significance of this effect varied across the trials (see Figure 2 for details of frequency of use in interventions):

- 1 Social support – practical
- 2 Social support – emotional
- 4 Pharmacological support
- 5 Reduce negative emotions
- 25 Behaviour substitution
- 30 Restructuring the physical environment
- 34 Adding objects to the environment
- 40 Verbal persuasion about capability
- 65 Review behavioural goals

- 69 Discrepancy between current behaviour and goal
- 85 Social comparison
- 89 Vicarious consequences

The following BCTs were reported in trials with positive both and negative directions of effect , more than one of which was a positive, significant effect (annotated C2 throughout the sexual health sections). The significance of this effect varied across the trials (see Figure 2 for details of frequency of use in significant interventions):

- 3 Social support – unspecified

The following BCT was reported in trials with positive both and negative directions of effect , one of which was a positive, significant effect (annotated C1 throughout the sexual health sections). The significance of this effect varied across the trials (see Figure 2 for details of frequency of use in significant interventions):

- 8 Feedback on behaviour
- 23 Behavioural practice/ rehearsal
- 36 Instruction on how to perform a behaviour
- 37 Information about antecedents
- 61 Problem solving
- 71 Pros and cons
- 84 Demonstration of the behaviour

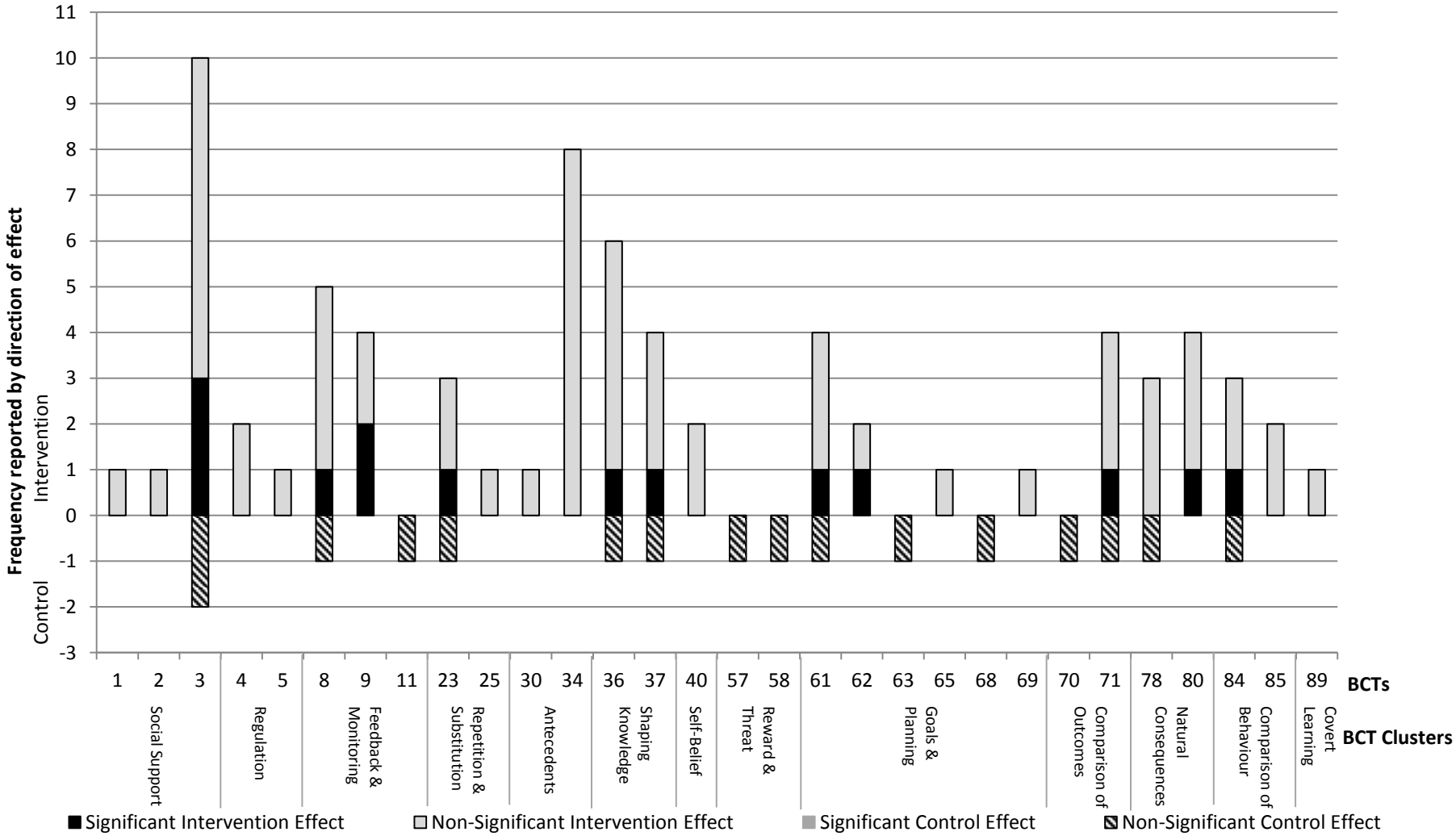
The following BCT was reported in trials with positive both and negative directions of effect , none of which was a positive, significant effect (annotated C throughout the sexual health sections). The significance of this effect varied across the trials (see Figure 2 for details of frequency of use in interventions):

- 78 Information about health consequences

The following BCTs were reported in only in trials with a negative effect (annotated B throughout the sexual health sections). In all cases the BCTs were each only used in a single trial; the effect sizes in all of these trials were very small (SMD range: -0.10 to -0.07) and non-significant:

- 11 Self-monitoring of outcome(s) of behaviour
- 57 Non-specific reward
- 58 Self-reward
- 63 Goal setting - outcome
- 68 Commitment
- 70 Persuasive source

Figure 2: Distribution of behaviour change techniques in sexual health trials; direction and significance of effect



4.2.4 Variation of effects across population groups

Tables 2 to 5 summarise the intervention type, mode of delivery, and effect size and significance for individual level behaviour change interventions for men who have sex with men, women at risk of unintended pregnancy, and individuals at risk for or living with HIV or STIs

Men who have sex with men

Three trials (Wolitski 2005 [+], Koblin 2012 [++] and Mansergh 2010 [+]) examined the effectiveness of individual level behaviour change interventions at improving protected sex/condom use in men who have sex with men (MSM). See Table 2 for a summary of the interventions' effect sizes and 95% confidence intervals, as well as a list of the individual BCTs reported for each trial.

Overall, these multi-session interventions delivered face to face in groups had no significant impact on changing unprotected sexual behaviours among men who have sex with men, regardless of HIV status and the comparator used.

Multi-session face to face group interventions

Wolitski 2005 [+] assessed the effect of a multi-session, face to face group intervention on reducing unprotected sex among HIV positive gay and bisexual men. The trial resulted in reported a very small non-significant effect on protected sex behaviour compared to usual care (SMD 0.14, 95% CI -0.06 to 0.34).

Koblin 2012 [++] enrolled black men, the majority of whom identified as gay or bisexual (although 5.7% of the participants identified as 'other' in regards to sexual orientation). The multi-session face to face group intervention resulted in a very small, negative non-significant effect on unprotected sexual behaviour compared to no intervention (SMD -0.10, 95% CI -0.38 to 0.17).

Mansergh 2010 [+] recruited out of treatment, substance-using men who have sex with men, the majority of whom (51%) were black or Hispanic/Latino. The multi-session, face to face group intervention employed cognitive behavioural techniques and skills building, and resulted in a very small, negative, non-significant effect on unprotected sex compared to an attention control arm (SMD -0.07, 95% CI -0.23 to 0.08).

All three interventions reported use of BCT 3 Social support (unspecified), this was also reported in the usual care arm of Wolitski 2005 [+]. No other BCTs were common across all trial arms.

Table 2: Sexual health interventions for men who have sex with men

Author year	Intervention Type	Primary delivery mode	Outcome	SMD	95% CI lower	95% CI upper	Intervention BCTs Control BCTs
Wolitski 2005 [+]	Multi-session	Face to face, group	Protected sex/Condom use	0.14	-0.06	0.34	3 Social support (unspecified)[C2] 34 Adding objects to the environment[A] 37 Information about antecedents[C1] 61 Problem solving[C1] 78 Information about health consequences[C] 89 Vicarious consequences[A] --- 3 Social support (unspecified)[C2] 70 Persuasive source[B] 78 Information about health consequences[C] 89 Vicarious consequences[A]
Koblin 2012 [++]	Multi-session	Face to face, group	Protected sex/Condom use	-0.10	-0.38	0.17	3 Social support (unspecified)[C2] 11 Self-monitoring of outcome(s) of behaviour[B] 58 Self-reward[B] 63 Goal setting (outcome)[B] 68 Commitment[B] 71 Pros and cons[C1] --- None reported
Mansergh 2010 [+]	Multi-session	Face to face, group	Protected sex/Condom use	-0.07	-0.23	0.08	3 Social support (unspecified)[C2] 8 Feedback on behaviour[C1] 23 Behavioural practice/ rehearsal[C1] 36 Instruction on how to perform a behaviour[C1] 37 Information about antecedents[C1] 57 Non-specific reward[B] 61 Problem solving[C1] 84 Demonstration of the behaviour[C1] --- None reported

A positive SMD represents a benefit with the intervention (i.e. favours the intervention), and a negative SMD represents a benefit with the comparator (favours comparator). A SMD of <0.2 represents a very small effect size, of ≥0.2 to <0.5 represents a small effect size, of ≥0.5 to <0.8 a medium effect size, and of ≥0.8 a large effect size.
* Intervention targeted multiple behaviour topcs

Women at risk of unintended pregnancy

Four trials (Langston 2010 [++], Ingersoll 2005* [+], Schunmann 2006 [++], Petersen 2007 [++]) studied the effectiveness of interventions at changing the use of contraceptives among women at risk of unintended pregnancy.

Overall, limited evidence suggests that an extended intervention (single session, lasting more than 30 minutes) may be effective at improving contraception use among women at risk for alcohol exposed pregnancy. The evidence surrounding the effectiveness of brief and multi-session face to face interventions delivered one on one is also limited, but suggests that these interventions are no more effective than comparators at improving contraception use among women considered to be at risk for unintended pregnancy. Based on this limited evidence, it is unclear whether the variation in intervention effectiveness among this population is due to differences in behaviour change techniques used (BCTs 62 Setting behaviour goal, and 71 Pros and cons were reported in Langston 2010 [++] but no other trial in this subpopulation) intervention type (extended vs. brief or multi-session), study focus (reduce risk of alcohol exposed pregnancy vs. unintended pregnancy alone), or other factors.

Brief, face to face one on one interventions

Langston 2010 [++] included mainly Hispanic women (97.5% of participants were Hispanic) with no desire to become pregnant right away who were seeking a first trimester procedure for a spontaneous or induced abortion. The trial compared a brief, face to face behaviour change intervention delivered face to face and one on one. This trial had a very small, non-significant effect on contraception use (SMD 0.26, 95% CI -0.14 to 0.66).

Extended, face to face one on one intervention

One intervention (Ingersoll 2005* [+]) recruited female university students reporting recent ineffective contraception use while binge drinking or having more than eight drinks per week; this study aimed to reduce the risk of alcohol

exposed pregnancy. The trial used an extended single session intervention delivered face to face and one on one, and resulted in a small, significant intervention effect on correct contraception use (SMD 0.32, 95% CI 0.004 to 0.63).

Multi-session, face to face one on one interventions

Schunmann 2006 [++] assessed the effect of a multi-session intervention delivered face to face and one on one on contraception use among women presenting to the abortion clinic of a hospital. Compared to usual care, the intervention group exhibited a very small, non-significant difference is contraception use (SMD 0.08, 95% CI -0.23 to 0.38).

Petersen 2007 [++] assessed the effect of a multi-session motivational interviewing intervention delivered face to face and one on one among women considered to be at risk of unintended pregnancy (based on not being pregnant, not planning a pregnancy, not using an IUD and neither they nor their partners being sterilized). The trial resulted in a very small, non-significant effect on maintaining a high level of contraceptive use or improving use in the compared to an attention control arm (SMD 0.10, 95% CI -0.07 to 0.26).

Both interventions (Schunmann 2006 [++], Petersen 2007 [++]) reported use of BCT 34 adding objects to the environment; this BCT was also reported in the usual care arm of Schunmann 2006 [++].

Table 3: Sexual health interventions for women at risk of unintended pregnancy

Author year	Intervention Type	Primary delivery mode	Outcome	SMD	95% CI lower	95% CI upper	Intervention BCTs Control BCTs
Langston 2010 [++]	Brief	Face to face, one on one	Contraceptive use	0.26	-0.14	0.66	3 Social support (unspecified)[C2] 4 Pharmacological support[A] 34 Adding objects to the environment[A] 36 Instruction on how to perform a behaviour[C1] 34 Adding objects to the environment[A] 36 Instruction on how to perform a behaviour[C1]
Ingersoll 2005* [+]	Extended	Face to face, one on one	Contraceptive use	0.32	0.004	0.63	3 Social support (unspecified)[C2] 8 Feedback on behaviour[C1] 62 Goal setting (behaviour)[A1] 71 Pros and cons[C1] 80 Information about social and environmental consequences[A1] None reported
Schunmann 2006 [++]	Multi-session	Face to face, one on one	Contraceptive use	0.08	-0.23	0.38	4 Pharmacological support[A] 30 Restructuring the physical environment[A] 34 Adding objects to the environment[A] 4 Pharmacological support[A] 30 Restructuring the physical environment[A] 34 Adding objects to the environment[A]
Petersen 2007 [++]	Multi-session	Face to face, one on one	Contraceptive use	0.10	-0.07	0.26	3 Social support (unspecified)[C2] 8 Feedback on behaviour 34 Adding objects to the environment[A] 36 Instruction on how to perform a behaviour[C1] 37 Information about antecedents[C1] 69 Discrepancy between current behaviour and goal[A] 80 Information about social and environmental consequences[A1] None reported

A positive SMD represents a benefit with the intervention (i.e. favours the intervention), and a negative SMD represents a benefit with the comparator (favours comparator). A SMD of <0.2 represents a very small effect size, of ≥0.2 to <0.5 represents a small effect size, of ≥0.5 to <0.8 a medium effect size, and of ≥0.8 a large effect size.
* Intervention targeted multiple behaviour topcs

Individuals at risk for acquiring sexually transmitted infections, including HIV

Four interventions described in two trials (Dermen_HIV 2011 [+], Dermen_ALC 2011 [+], Dermen_H+A 2011 [+], Tross 2008 [+]) studied the effectiveness of interventions at changing the sexual health behaviour of individuals at risk for contracting sexually transmitted infections (STIs) due to a reported history of engaging in unprotected sex.

Overall, limited evidence suggests that a multi-session face to face intervention delivered one on one is no more effective than no intervention at improving condom use among university students exhibiting both risky drinking and sexual behaviour. A multi-session group intervention among females in drug treatment was effective at improving condom use compared to usual care.

Multi-session face to face one on one interventions

One trial included three interventions (Dermen_ALC 2011 [+], Dermen_HIV 2011 [+], Dermen_H&A 2011* [+]) and recruited university students reporting heavy drinking in the last week (more than four or five drinks in one occasion, for women and men respectively) as well as risky sexual behaviour (including having unprotected sex seven or more times in the previous 90 days, or having two or more sexual partners in the previous 90 days). All three were multi-session interventions delivered face to face, one on one, and assessed condom use compared to a no intervention control arm. The authors hypothesised that all three interventions could have an effect on sexual health behaviour (all trial outcomes reported in this section relate to sexual health behaviours; see Section 4.3.4 for alcohol outcomes for interventions Dermen_ALC 2011 [+] and Dermen_H&A 2011* [+]).

Dermen_ALC 2011 [+] assessed the effect of an intervention targeting risky drinking on condom use among university students who reported both heavy drinking and risky sexual behaviour. This intervention resulted in a very small,

non-significant effect on condom use in the compared to no intervention (SMD 0.05, 95% CI -0.59 to 0.69).

Dermen_HIV 2011 [+] focused on reducing HIV risk behaviours, and resulted in a very small, non-significant effect on condom use (SMD 0.11, 95% CI -0.52 to 0.75).

Finally, Dermen_H&A 2011* [+] addressed both alcohol and HIV risk behaviours, and resulted in a small, non-significant effect on condom use in the (SMD 0.38, 95% CI -0.27 to 1.03).

Multi-session face to face group intervention

Tross 2008 [+] recruited adult women participating in drug treatment who had reported one or more occasions of unprotected vaginal or anal sex with a male partner in the previous six months. The intervention was delivered over multiple sessions in a face to face group counselling environment. The intervention had a small, significant effect on reducing the occurrence of unprotected sex in the compared to usual care (SMD 0.42, 95% CI 0.22 to 0.62).

Table 4: Sexual Health interventions for individuals at risk of acquiring HIV or other STIs

Author year	Intervention Type	Primary delivery mode	Outcome	SMD	95% CI lower	95% CI upper	Intervention BCTs Control BCTs
Dermen_ALC 2011 [+]	Multi-session	Face to face, one on one	Protected sex/Condom use	0.05	-0.59	0.69	3 Social support (unspecified)[C2] 8 Feedback on behaviour[C1] 9 Feedback on outcome(s) of behaviour[A2] 25 Behaviour substitution[A] 34 Adding objects to the environment[A] 40 Verbal persuasion about capability[A] 71 Pros and cons[C1] 80 Information about social and environmental consequences[A1] 85 Social comparison[A] None reported
Dermen_HIV 2011 [+]	Multi-session	Face to face, one on one	Protected sex/Condom use	0.11	-0.52	0.75	3 Social support (unspecified)[C2] 8 Feedback on behaviour[C1] 34 Adding objects to the environment[A] 36 Instruction on how to perform a behaviour[C1] 40 Verbal persuasion about capability[A] 71 Pros and cons[C1] 78 Information about health consequences[C] 85 Social comparison[A] None reported
Dermen_H&A 2011* [+]	Multi-session	Face to face, one on one	Protected sex/Condom use	0.38	-0.27	1.03	3 Social support (unspecified)[C2] 8 Feedback on behaviour[C1] 9 Feedback on outcome(s) of behaviour[A2] 34 Adding objects to the environment[A] 80 Information about social and environmental consequences[A1] None reported
Tross 2008 [+]	Multi-session	Face to face, group	Protected sex/Condom use	0.42	0.22	0.62	3 Social support (unspecified)[C2] 9 Feedback on outcome(s) of behaviour[A2] 23 Behavioural practice/ rehearsal[C1] 36 Instruction on how to perform a behaviour[C1] 37 Information about antecedents[C1] 61 Problem solving[C1]

							84 Demonstration of the behaviour[C1] None reported
A positive SMD represents a benefit with the intervention (i.e. favours the intervention), and a negative SMD represents a benefit with the comparator (favours comparator). A SMD of <0.2 represents a very small effect size, of ≥0.2 to <0.5 represents a small effect size, of ≥0.5 to <0.8 a medium effect size, and of ≥0.8 a large effect size. * Intervention targeted multiple behaviour topcs							

Individuals with an STI

Five trials (Cortes-Bordoy 2010 [+], Golin 2012 [+], Crosby 2009 [+], Wolitski 2005 [+], Gilbert 2008* [++]) examined the effectiveness of behaviour change interventions at altering the sexual health behaviour (specifically, unprotected sexual behaviour) among individuals with STIs.

Overall, there was inconsistency across the trials in terms of direction, size and statistical significance of the effect of individual level behaviour change interventions to decrease the occurrences of unprotected sex amongst individuals with HIV or other STIs. Evidence for each of the intervention type-delivery mode combinations was limited to a single trial, however, when taken together the interventions delivered face to face were no more effective than comparators at changing sexual health behaviour among individuals with HIV or other STIs. The remotely delivered intervention (Gilbert 2008* [++]) reported a small, significant effect among HIV positive individuals who also exhibit illicit drug use, risky drinking patterns, and/or risky sexual behaviour; all other interventions resulted in non-significant effects.

Brief face to face one on one interventions

One trial (Cortes-Bordoy 2010 [+]) enrolled women with vulvoperineal (genital) warts who were attending a gynaecology outpatient clinic. The intervention consisted of an educational leaflet delivered during a face to face one on one consultation, and resulted in a very small, negative, non-significant effect on protected sex behaviour compared to no intervention (SMD -0.08, 95% CI -0.43 to 0.27).

Extended face to face one on one intervention

Crosby 2009 [+] recruited African American men newly diagnosed with a STI other than HIV. The extended intervention was delivered face to face and one on one, and resulted in a small, non-significant effect on reducing unprotected sexual behaviour (SMD 0.29, 95% CI -0.005 to 0.59).

Multi-session face to face one on one intervention

Golin 2012 [+] recruited HIV positive men and women, and provided multi-session one on one interventions, delivered primarily face to face, although telephone counselling was offered to participants who were unable to travel for the sessions. At follow-up, the intervention resulted in very small, non-significant reduction in the number of unprotected sex acts over the previous three months compared to the attention control arm (SMD 0.08, 95% CI -0.14 to 0.30).

Multi-session face to face group intervention

Wolitski 2005 [+] assessed the effect of a multi-session, face to face group intervention on reducing unprotected sex among HIV positive gay and bisexual men. The trial resulted in a very small, non-significant effect on protected sexual behaviour compared to usual care (SMD 0.14, 95% CI -0.06 to 0.34).

Multi-session remotely delivered intervention

Gilbert 2008* [++] assessed the effectiveness of a multiple session remotely delivered intervention targeting risky sexual behaviour, illicit drug use and risky drinking among HIV positive individuals, the majority of whom (63%) were black or Hispanic/Latino. The trial resulted in a small, significant effect on protected sexual behaviour compared to usual care (SMD 0.39, 95% CI 0.11 to 0.68).

Table 5: Sexual health interventions for individuals with HIV or other STIs

Author year	Intervention Type	Primary delivery mode	Outcome	SMD	95% CI lower	95% CI upper	Intervention BCTs Control BCTs
Cortes-Bordoy 2010 [+]	Brief	Face to face, one on one	Protected sex/Condom use	-0.08	-0.43	0.27	70 Persuasive source[B] 78 Information about health consequences[C] None reported
Crosby 2009 [+]	Extended	Face to face, one on one	Protected sex/Condom use	0.29	-0.005	0.59	1 Social support (practical)[A] 2 Social support (emotional)[A] 5 Reduce negative emotions[A] 23 Behavioural practice/ rehearsal[C1] 34 Adding objects to the environment[A] 36 Instruction on how to perform a behaviour[C1] 37 Information about antecedents[C1] 61 Problem solving[C1] 78 Information about health consequences[C] 84 Demonstration of the behaviour[C1] 34 Adding objects to the environment[A] 37 Information about antecedents[C1] 78 Information about health consequences[C]
Golin 2012 [+]	Multi-session	Face to face, one on one	Protected sex/Condom use	0.08	-0.14	0.30	3 Social support (unspecified)[C2] 23 Behavioural practice/ rehearsal[C1] 36 Instruction on how to perform a behaviour[C1] 61 Problem solving[C1] 62 Goal setting (behaviour)[A1] 65 Review behaviour goal(s)[A] 71 Pros and cons[C1] 84 Demonstration of the behaviour[C1] None reported
Wolitski 2005 [+]	Multi-session	Face to face, group	Protected sex/Condom use	0.14	-0.06	0.34	3 Social support (unspecified)[C2] 34 Adding objects to the environment[A] 37 Information about antecedents[C1] 61 Problem solving[C1] 78 Information about health consequences[C] 89 Vicarious consequences[A]

							3 Social support (unspecified)[C2] 70 Persuasive source[B] 78 Information about health consequences[C] 89 Vicarious consequences[A]
Gilbert 2008* [++]	Multi-session	Remote delivery	Protected sex/Condom use	0.40	0.11	0.68	3 Social support (unspecified)[C2] 9 Feedback on outcome(s) of behaviour[A2] None reported
A positive SMD represents a benefit with the intervention (i.e. favours the intervention), and a negative SMD represents a benefit with the comparator (favours comparator). A SMD of <0.2 represents a very small effect size, of ≥0.2 to <0.5 represents a small effect size, of ≥0.5 to <0.8 a medium effect size, and of ≥0.8 a large effect size. * Intervention targeted multiple behaviour topcs							

A overview of sexual health interventions according to the reviewed parameters of type, mode of delivery and population is provided in Table 6.

Table 6: Summary of sexual health interventions according to type, mode of delivery, population and significant of effect.

Category	Number of interventions	Number significant	% of 15 total SXH interventions (category interventions /topic total)	% of 3 total significant SXH interventions (category significant/ topic significant)	% of category resulting in significant effect (category significant/ category total)
Intervention Type					
Brief	2	0	13.33%	0.00%	0.00%
Extended	2	1	13.33%	33.33%	50.00%
Multi-session	11	2	73.33%	66.67%	18.18%
Mode of Delivery					
Face to face, one on one	10	1	66.67%	33.33%	10.00%
Face to face, group	4	1	26.67%	33.33%	25.00%
Face to face combined	0	0	0.00%	0.00%	NA
Face to face with remote	0	0	0.00%	0.00%	NA
Remote	1	1	6.67%	33.33%	100.00%
Population					
MSM	3	0	20.00%	0.00%	0.00%
Pregnant	4	1	26.67%	33.33%	25.00%
STI	4	1	26.67%	33.33%	25.00%
STI risk	4	1	26.67%	33.33%	25.00%

4.2.5 BCT clusters

A further synthesis at the BCT cluster level was conducted across the sexual health trials. Each of the individual BCTs can be classified into one of the following BCT clusters:

- 1: Social support

- 2: Regulation
- 3: Feedback and monitoring
- 5: Repetition and substitution
- 6: Antecedents
- 7: Shaping knowledge
- 8: Self-belief
- 10: Reward and threat
- 11: Goals and planning
- 12: Comparison of outcomes
- 14: Natural consequences
- 15: Comparison of behaviour
- 16: Covert learning

BCT clusters used in the sexual health interventions are summarised in Table 7.

The most commonly used BCT clusters in the sexual health interventions were BCT cluster (BCT-C) 1 “Social support” (86.7%) followed by BCT-C 3 “Feedback and monitoring” (60.0%). BCT-C 4 “Associations”, BCT-C 9 “Scheduled consequences”, and BCT-C 13 “Identity” were not used in any of the interventions.

The association between BCT clusters and intervention effectiveness was assessed in the meta-regression, and results are described in Section 4.2.8.

Table 7: Summary of BCT clusters used in behaviour change interventions across the five behavioural areas

Behaviour area	BCT clusters															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
	Social support	Regulation	Feedback and monitoring	Associations	Repetition and substitution	Antecedents	Shaping knowledge	Self-belief	Scheduled consequences	Reward and threat	Goals and planning	Comparison of outcomes	Identity	Natural consequences	Comparison of behaviour	Covert learning
Sexual health	86.7%	20.0%	60.0%	-	33.3%	53.3%	53.3%	13.3%	-	13.3%	53.3%	40.0%	-	53.3%	40.0%	6.7%
Alcohol	88.0%	2.0%	76.0%	-	6.0%	6.0%	16.0%	10.0%	-	-	40.0%	26.0%	-	66.0%	44.0%	-
Smoking	86.3%	57.5%	20.0%	-	13.8%	51.3%	17.5%	3.8%	1.3%	5.0%	65.0%	31.3%	8.8%	40.0%	5.0%	1.3%
Diet	77.8%	14.8%	59.3%	3.7%	40.7%	40.7%	40.7%	3.7%	-	14.8%	96.3%	18.5%	7.4%	14.8%	14.8%	-
Physical activity	85.7%	22.2%	61.9%	7.9%	31.7%	34.5	36.5%	3.2%	-	6.3%	96.8%	19.0%	1.6%	25.4%	14.3%	-

'-' Indicates that a BCT cluster has not been used. Only interventions which provided outcome data for meta-analysis and meta-regression were included in this tally.

4.2.6 Intervention functions

The most commonly used intervention functions (IFs) were IF9 “Enablement” (86.7%) and IF1 “Education” (73.3%). IF6 “Restriction” was not used in any of the interventions.

Interventions functions used in the sexual health interventions are summarised in Table 8.

The association between intervention function and intervention effectiveness was assessed in the meta-regression, and results are described in Section 4.2.8.

4.2.7 Theory use

Three RCTs explicitly linked their intervention to a theory or model. Two used Social Cognitive Theory (Golin 2012 [+], Koblin 2012 [++]), and one used an Information, Motivation and Behavioural Skills Model (Crosby 2009 [+]).

The presence of a theory was controlled for in the meta-regression, and results are described in Section 4.2.8.

Table 8: Summary of intervention functions used in behaviour change interventions across the five behavioural areas

Behaviour area	Intervention Functions								
	1	2	3	4	5	6	7	8	9
	Education	Persuasion	Incentivisation	Coercion	Training	Restriction	Environmental restructuring	Modelling	Enablement
Sexual health	73.3%	33.3%	13.3%	6.7%	40.0%	-	26.7%	20.0%	86.7%
Alcohol	90.0%	42.0%	2.0%	2.0%	16.0%	-	2%	-	90.0%
Smoking	63.8%	35.0%	7.5%	2.5%	26.3%	-	22.5%	1.3%	96.3%
Diet	70.4%	22.2%	18.5%	-	55.6%	-	25.9%	3.7%	100%
Physical activity	79.4%	17.5%	11.1%	-	50.8%	-	22.2%	4.8%	98.4%

'-' Indicates that an intervention function has not been used.

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4.2.8 Effects of behaviour change interventions, BCT clusters and intervention functions using meta-regression

Results from 15 comparisons (13 studies) were included in the meta-regression models. As shown in Figure 3, overall the studies found a very small significant effect of the individual level behaviour change interventions (SMD 0.14, 95% CI 0.05 to 0.24; random effects analysis). The analysis had moderate levels of heterogeneity (I^2=45.9%, 95% CI 0% to 69.1%, p=0.027). No studies were found to be outliers.

There was no statistical evidence of publication bias using Egger's test for small study effects (p=0.413), but this may have been due to the relatively small number of studies included (lack of power). Using a filled funnel plot approach, addition of hypothetical results from missing studies led to a reduction in the pooled effect size, and the effect became non-significant (SMD 0.04, 95% CI -0.07 to 0.16; p=0.449). This suggests that some publication bias is likely. This could relate in part to the exclusion of studies with small sample sizes from the review.

In unadjusted and adjusted univariate analysis none of the BCT clusters, intervention functions or accounted for any of the between study variance. Full meta-regression results are provided in Appendix H.

Due to the limited data available for sexual health, limited conclusions can be drawn regarding the effects of BCT clusters or intervention functions in this behaviour area.

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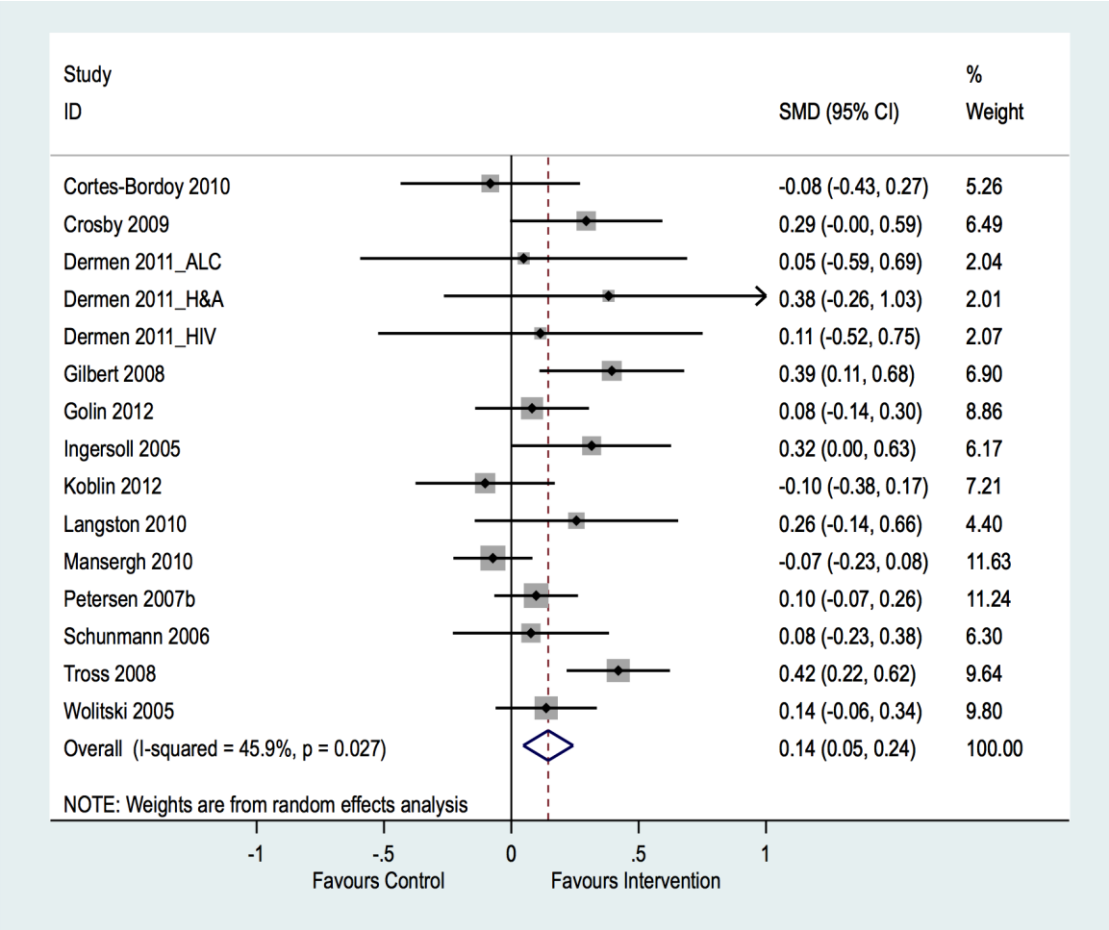
Figure 3: Overall effect of individual-level behaviour change interventions on sexual health behaviour



CI confidence interval; SMD standardised mean difference.
An SMD of 0 indicates no difference between intervention and control comparator. A positive SMD indicates that the intervention was more effective than control, and a negative SMD indicates that the intervention was less effective than control. If the 95% confidence interval spans 0, this indicates that the difference between the groups was not statistically significant.

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4.2.9 Evidence statements

Direction of effect across all interventions in the specified behaviour area	
A	BCT found in interventions with a positive direction of effect only (i.e. effect favours intervention)
B	BCT found in interventions with a negative direction of effect only (i.e. effect favours control)
C	BCT found in interventions with positive and negative directions of effect (i.e. inconsistent direction of effect – some favouring intervention, some favouring control)
Significance and consistency of effect across all interventions in the specified behaviour area	
1	BCT found in one intervention with a significant positive effect
2	BCT found in more than one intervention with a significant positive effect

Applicability and transferability of evidence to the UK

This applicability statement applies to all of the sexual health evidence statements for Review 2 (see below). A single study was carried out in the UK (Schunmann 2006 [++]). Of the remaining 12 studies, one was conducted in Spain (Cortes-Bordoy 2010 [+]) and 11 in the USA. Therefore caution is required when interpreting findings regarding the interventions carried out in populations that may have different access to services, as well as the interventions having different delivery methods and are provided in different settings from those found in the UK.

In terms of transferability to clinical or public health practice, it should be remembered that the behaviour change interventions in the randomised controlled trials in this review varied in the number of sessions provided (ranging from one to six) and the types of interventions (brief, extended and multi-session). Twelve of the studies primarily delivered the intervention in a face to face manner, although remote delivery was reported in one trial (Gilbert 2008* [++]). Also patients were sometimes selectively recruited based on characteristics in addition to sexual health behaviours; this includes the

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use of alcohol (Dermen 2011 [+], Gilbert 2008* [++] and Ingersoll 2005* [+]) or other substances (Tross 2008 [+], Gilbert 2008* [++] and Mansergh 2010 [+]).

Evidence statement 1.1 – Overall effectiveness of sexual health behaviour change interventions, BCT clusters and intervention functions

There is moderate evidence from the meta-analysis of 15 interventions described in 13 RCTs (Cortes-Bordoy 2010 [+], Crosby 2009 [+], Dermen_ALC 2011 [+], Dermen_HIV 2011 [+], Dermen_H&A 2011* [+], Gilbert 2008* [++], Golin 2012 [+], Ingersoll 2005* [+], Koblin 2012 [++], Langston 2010 [++], Mansergh 2010 [+], Petersen 2007 [++], Schunmann 2006 [++], Tross 2008 [+], Wolitski 2005 [+]) to suggest that individual level behaviour change interventions can have a very small positive effect on sexual health behaviour (SMD 0.14, 95% CI 0.05 to 0.24), but with moderate heterogeneity (I^2=45.9%, 95% CI 0% to 69.1%). The meta-regression of the results of these studies suggested that BCT clusters and intervention functions did not explain the variance between studies, but there may not have been enough power in the analyses to detect effects.

Evidence Statement 1.2 – BCTs reported in interventions with a positive effect across sexual health trials

Moderate evidence from a body of 15 interventions described in 13 RCTs (see Evidence Statement 1.1 for references) suggests that BCT 9 Feedback on outcome of behaviour[A2] is consistently associated with a significant intervention effect in sexual health trials (reported in more than one intervention with a positive and significant direction of effect).

Two BCTs were reported in one trial with a significant intervention effect: 62 Goal setting – behaviour[A1] and 80 Information about social and environmental consequences[A1].

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Twelve BCTs were reported only in trials that resulted in a positive direction of effect, however, the effect was non-significant: 1 Social support (practical)[A], 2 Social support (emotional)[A], 4 Pharmacological support[A], 5 Reduce negative emotions[A], 25 Behaviour substitution[A], 30 Restructuring the physical environment[A], 34 Adding objects to the environment[A], 40 Verbal persuasion about capability[A], 65 Review behavioural goals[A], 69 Discrepancy between current behaviour and goal[A], 85 Social comparison[A], and 89 Vicarious consequences[A].

Evidence Statement 1.3 – BCTs reported in interventions with inconsistent effects across sexual health trials

Moderate evidence from a body of 15 interventions (see Evidence Statement 1.1 for references) suggests that the following BCTs are associated with inconsistent effects, both in terms of direction and significance: 3 Social support – unspecified[C2], 8 Feedback on behaviour[C1], 23 Behaviour practice/rehearsal[C1], 36 Instruction on how to perform a behaviour[C1], 37 Information about antecedents[C1], 61 Problem solving[C1], 71 Pros and cons[C1], 78 Information about health consequences[C], and 84 Demonstration of the behaviour[C1]. None of the trials reporting these BCTs found significant effects favouring the comparator arms.

Evidence Statement 1.4 – BCTs reported in trials with an effect favouring the comparator arm across sexual health trials

There is moderate evidence from 13 RCTs (see Evidence Statement 1.1 for references) that BCTs 11 Self-monitoring of outcome of behaviour [B], 57 Non-specific reward[B], 58 Self reward[B], 63 Goal setting – outcome[B], 68 Commitment[B], and 70 Persuasive source[B] may be linked with ineffective interventions. These BCTs were only reported in a single trial each (Koblin 2012 [++], Cortes-Bordoy 2010 [+], or Mansergh 2010 [+]).

Evidence Statement 1.5 – Sexual health behaviour change interventions for men who have sex with men

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Moderate evidence was identified from three trials (Wolitski 2005 [+], Koblin 2012 [++], Mansergh 2010 [+]) that multi-session interventions delivered face to face in a group setting are no more effective than comparators at changing protected sexual behaviours or condom use among men who have sex with men. The non-significant effect was seen across participant characteristics and comparators, including in HIV positive MSM compared to usual care (Wolitski 2005 [+] SMD 0.14, 95% CI -0.06 to 0.34), out of treatment substance using MSM compared to an attention control arm (Mansergh 2010 [+] SMD -0.07, 95% CI -0.23 to 0.08) and black men of mixed serostatus compared to no intervention (Koblin 2012 [++] SMD -0.10, 95% CI -0.38 to 0.17).

All of the interventions reported use of BCTs 3 Social support (unspecified). Two of the interventions (Wolitski 2005 [+], Mansergh 2010 [+]) reported use of BCTs 37 Information about antecedents, and 61 Problem solving. These three techniques were reported in sexual health trials with inconsistent effects, both terms of direction and significance.

Wolitski 2005 (RCT [+], USA, n=727, 24 weeks)
BCTs present:
3 Social support (unspecified)[C2] (also reported in comparator)
34 Adding objects to the environment[A]
37 Information about antecedents[C1]
61 Problem solving[C1]
78 Information about health consequences[C] (also reported in comparator)
89 Vicarious consequences[A] (also reported in comparator)

Koblin 2012 (RCT [++], USA, n=258, 12 weeks)
BCTs present:
3 Social support (unspecified)[C2]
11 Self-monitoring of outcome(s) of behaviour[B]
58 Self-reward[B]
63 Goal setting (outcome)[B]
68 Commitment[B]
71 Pros and cons[C1]

Mansergh 2010 (RCT [+], USA, n=1,206, 52 weeks)

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BCTs present:
3 Social support (unspecified)[C2]
8 Feedback on behaviour[C1]
23 Behavioural practice/ rehearsal[C1]
36 Instruction on how to perform a behaviour[C1]
37 Information about antecedents[C1]
57 Non-specific reward[B]
61 Problem solving[C1]
84 Demonstration of the behaviour[C1]

Evidence Statement 1.6 – Sexual health behaviour change interventions in women at risk for unintended pregnancy

Inconsistent evidence was identified from four trails (Langston 2010 [++], Schunmann 2006 [++], Petersen 2007 [++], Ingersoll 2005* [+]) suggesting that brief and multi-session face to face interventions are no more effective than comparators at changing contraception use among women at risk for unintended pregnancy; an extended intervention significantly improved sexual health behaviour outcomes.

The brief intervention (Langston 2010 [++]) was no more effective than usual care at changing contraception use among Hispanic women with no desire to become pregnant right away who were seeking a first trimester procedure for a spontaneous or induced abortion (SMD 0.26, 95% CI -0.14 to 0.66).

The multi-session interventions were no more effective than usual care at altering contraception use (Schunmann 2006 [++] SMD 0.08, 95% CI -0.23 to 0.38) or initiation and maintenance of a very effective contraception method (Petersen 2007 [++] SMD 0.10, 95% CI -0.07 to 0.26).

An extended intervention (Ingersoll 2005* [+]) delivered face to face and one on one addressing both alcohol and sexual health behaviours has a small, significant effect on contraception use among female university students at risk for alcohol exposed pregnancy (SMD 0.32, 95% CI 0.004 to 0.63).

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The three interventions with non-significant effects (Langston 2010 [++], Schunmann 2006 [++], Petersen 2007 [++]) reported use of BCT 34 Adding objects to the environment. This technique was not reported in the intervention that resulted in significant changes, but was reported in the comparator arm of Langston 2010 [++].

Langston 2010 (RCT [++], USA, n=186, 12 weeks)
BCTs present:
3 Social support (unspecified)[C2]
4 Pharmacological support[A]
34 Adding objects to the environment[A] (also reported in comparator)
36 Instruction on how to perform a behaviour[C1] (also reported in comparator)

Ingersoll 2005** (RCT [+], USA, n=199, 4 weeks)
BCTs present:
3 Social support (unspecified)[C2]
8 Feedback on behaviour[C1]
62 Goal setting (behaviour)[A1]
71 Pros and cons[C1]
80 Information about social and environmental consequences[A1]

Schunmann 2006 (cRCT [++], UK, n=231, 16 weeks)
BCTs present:
4 Pharmacological support[A] (also reported in comparator)
30 Restructuring the physical environment[A] (also reported in comparator)
34 Adding objects to the environment[A1] (also reported in comparator)

Petersen 2007 (RCT [++], USA, n=737, 40 weeks)
BCTs present:
3 Social support (unspecified)[C2]
8 Feedback on behaviour
34 Adding objects to the environment[A]
36 Instruction on how to perform a behaviour[C1]
37 Information about antecedents[C1]
69 Discrepancy between current behaviour and goal[A]
80 Information about social and environmental consequences[A1]

Evidence Statement 1.7 – Sexual health behaviour change interventions for individuals at risk of acquiring an STI

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Inconsistent evidence from two trials describing four interventions (Dermen_HIV 2011 [+], Dermen_ALC 2011 [+], Dermen_H+A 2011* [+], Tross 2008 [+]) suggests that multi-session interventions delivered face to face and one on one are no more effective than no intervention at changing the sexual health behaviours of individuals considered to be at risk for acquiring an STI, while multi-session interventions delivered face to face at a group level may be effective at altering such behaviours.

One trial that included three multi-session interventions delivered face to face and one on one (Dermen_HIV 2011 [+], Dermen_ALC 2011 [+], Dermen_H+A 2011* [+]) suggests a sexual health or alcohol intervention for university students with a history of heavy drinking and risky sexual behaviour are no more effective than no intervention on changing condom use in this population. This non-significant effect was seen across behavioural target areas, including interventions that addressed alcohol consumption only (Dermen_ALC 2011 [+], SMD 0.05, 95% CI -0.59 to 0.69), HIV risk behaviours only (Dermen_HIV 2011 [+] SMD 0.11, 95% CI -0.52 to 0.75), and both alcohol and HIV risk behaviours (Dermen_H+A 2011 [+] SMD 0.38, 95% CI -0.27 to 1.03).

One trial (Tross 2008 [+]) suggests that a multi-session face to face group intervention may be effective at reducing the occurrence of unprotected sex over the among women participating in a drug treatment programme (SMD 0.42, 95% CI 0.22 to 0.62).

The two trials in this population were in quite different participant groups (university students vs. women in drug treatment programmes), but both assessed protected sexual behaviours among individuals with at risk for an STI based on their sexual health behaviour.. The trial with significant intervention effects (Tross 2008 [+]) reported use of BCTs 23 Behavioural practice/rehearsal, 37 Information about antecedents, 61 Problem solving, and 84 Demonstration of the behaviour; none of these BCTs were reported in

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the non-significant interventions, but did occur in sexual health trials with inconsistent results, both in terms of direction and significance of effect.

Dermen_ALC 2011 (RCT [+], USA, n=71, 59 weeks)
BCTs present:
3 Social support (unspecified)[C2]
8 Feedback on behaviour[C1]
9 Feedback on outcome(s) of behaviour[A2]
25 Behaviour substitution[A]
34 Adding objects to the environment[A]
40 Verbal persuasion about capability[A]
71 Pros and cons[C1]
80 Information about social and environmental consequences[A1]
85 Social comparison[A]

Dermen_HIV 2011 (RCT [+], USA, n=71, 59 weeks)
BCTs present:
3 Social support (unspecified)[C2]
8 Feedback on behaviour[C1]
34 Adding objects to the environment[A]
36 Instruction on how to perform a behaviour[C1]
40 Verbal persuasion about capability[A]
71 Pros and cons[C1]
78 Information about health consequences[C]
85 Social comparison[A]

Dermen_H&A 2011* (RCT [+], USA, n=69, 59 weeks)
BCTs present:
3 Social support (unspecified)[C2]
8 Feedback on behaviour[C1]
9 Feedback on outcome(s) of behaviour[A2]
34 Adding objects to the environment[A]
80 Information about social and environmental consequences[A1]

Tross 2008 (RCT [+], USA, n=384, 24 weeks)
BCTs present:
3 Social support (unspecified)[C2]
9 Feedback on outcome(s) of behaviour[A2]
23 Behavioural practice/ rehearsal[C1]
36 Instruction on how to perform a behaviour[C1]
37 Information about antecedents[C1]

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61 Problem solving[C1]
84 Demonstration of the behaviour[C1]

Evidence Statement 1.8 – Sexual health behaviour change interventions for individuals with HIV or other STIs

Inconsistent evidence was identified from five trials (Cortes-Bordoy 2010 [+], Crosby 2009 [+], Golin 2012 [+], Wolitski 2005 [+], Gilbert 2008* [++]) suggesting that interventions delivered face to face are no more effective than comparators at altering sexual health behaviours among individuals with HIV or other STIs. Remotely delivered interventions may be effective at changing sexual behaviour in this population.

The non-significant effect in interventions delivered face to face was seen across intervention types, genders, ethnicities, and comparators including: brief intervention compared to no intervention among women with genital wars (Cortes-Bordoy 2010 [+] SMD -0.08, 95% CI -0.43 to 0.27); an extended intervention compared to usual care among African American men newly diagnosed with an STI other than HIV (Crosby 2009 [+] SMD 0.29, 95% CI -0.005 to 0.59); a multi-session intervention compared to an attention control among HIV positive men (Golin 2012 [+] SMD 0.08, 95% CI -0.14 to 0.30), or compared to usual care among HIV positive MSM (Wolitski 2005 [+] SMD 0.14, 95% CI -0.06 to 0.34).

Evidence from one trial (Gilbert 2008* [++]) suggests that a multi-session remotely delivered intervention may be effective at reducing unprotected sexual behaviour in the among HIV positive men and women reporting substance use or risky sexual behaviour (SMD 0.39, 95% CI 0.11 to 0.68).

No BCTs were reported in all four interventions with non-significant effects (Cortes-Bordoy 2010 [+], Crosby 2009 [+], Golin 2012 [+], Wolitski 2005 [+]). The intervention that resulted in significant changes to sexual health behaviour reported use of BCT 9 Feedback on outcome(s) of behaviour; this BCT was not reported in any other intervention in this population, and was

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consistently used in sexual health interventions resulting in positive, significant effects.

Cortes-Bordoy 2010 (cRCT [+], Spain, n=172, 12 weeks)
BCTs present:
70 Persuasive source[B]
78 Information about health consequences[C]

Crosby 2009 (RCT [+], USA, n=197, 12 weeks)
BCTs present:
1 Social support (practical)[A]
2 Social support (emotional)[A]
5 Reduce negative emotions[A]
23 Behavioural practice/ rehearsal[C1]
34 Adding objects to the environment[A] (also reported in comparator)
36 Instruction on how to perform a behaviour[C1]
37 Information about antecedents[C1] (also reported in comparator)
61 Problem solving[C1]
78 Information about health consequences[C] (also reported in comparator)
84 Demonstration of the behaviour[C1]

Golin 2012 (RCT [+], USA, n=307, 32 weeks)
BCTs present:
3 Social support (unspecified)[C2]
23 Behavioural practice/ rehearsal[C1]
36 Instruction on how to perform a behaviour[C1]
61 Problem solving[C1]
62 Goal setting (behaviour)[A1]
65 Review behaviour goal(s)[A]
71 Pros and cons[C1]
84 Demonstration of the behaviour[C1]

Wolitski 2005 (RCT [+], USA, n=727, 24 weeks)
BCTs present:
3 Social support (unspecified)[C2] (also reported in comparator)
34 Adding objects to the environment[A]
37 Information about antecedents[C1]
61 Problem solving[C1]
78 Information about health consequences[C] (also reported in comparator)
89 Vicarious consequences[A] (also reported in comparator)

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Gilbert 2008* (RCT [++], USA, n=284, 24 weeks)
BCTs present:
3 Social support (unspecified)[C2]
9 Feedback on outcome(s) of behaviour[A2]

4.3 Alcohol

4.3.1 Included studies

Thirty two studies met the inclusion criteria after full text appraisal and provided outcome data which could be converted into standardised mean differences (SMDs) for comparison across studies and use in the meta-analysis and meta-regression. Study characteristics and results are summarised in the evidence tables in Appendix G.

Of the 32 included studies, five were cluster randomised controlled trials and the remainder were individually randomised controlled trials. The characteristics and applicability of these studies are discussed below.

4.3.2 Quality assessment

Using the NICE quality assessment checklist criteria, among the included studies, 12 studies were rated as very good [++], 20 studies as good [+]. The results of the quality appraisals for the individual studies are found in Evidence tables in Appendix G.

4.3.3 BCTs

The individual BCTs that occurred across 50 interventions described in the 32 alcohol trials are summarised in Figure 4, along with the effectiveness of the interventions including each BCT.

The following BCT was reported only in trials with positive intervention effects, more than one of which was significant (annotated A2 throughout the alcohol sections). See Figure 4 for details of frequency of use in significant interventions:

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- 9 Feedback on outcome(s) of behaviour

The following BCTs were reported only in trials with positive intervention effects, one of which was significant (annotated A1 throughout the alcohol sections). See Figure 4 for details of frequency of use in significant interventions:

- 5 Reduce negative emotions
- 11 Self-monitoring of outcome(s) of behaviour
- 13 Monitoring outcome(s) of behaviour by others without feedback
- 68 Commitment

The following BCTs were reported only in trials with positive intervention effects, none of which was significant (annotated A throughout the alcohol sections). See Figure 4 for details of frequency of use in interventions:

- 25 Behaviour substitution
- 39 Behavioural experiment
- 67 Behavioural contract

The following BCTs were reported in trials with an inconsistent directions of effect, more than one of which was a positive, significant effect (annotated C2). See Figure 4 for details of frequency of use in significant interventions:

- 3 Social support - unspecified
- 8 Feedback on behaviour
- 63 Goal setting – outcome
- 78 Information about health consequences

The following BCTs were reported in trials with an inconsistent directions of effect, one of which was a positive, significant effect (annotated C1). See Figure 4 for details of frequency of use in significant interventions:

- 10 Self-monitoring of behaviour
- 37 Information on antecedents
- 64 Action planning

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- 79 Information about emotional consequences
- 85 Social comparison

The following BCTs were reported in trials with an inconsistent directions of effect, n one of which were positive, significant effects (annotated C). See Figure 4 for details of frequency of use in interventions:

- 2 Social support – emotional
- 14 Biofeedback
- 34 Adding objects to the environment
- 36 Instruction on how to perform behaviour
- 40 Verbal persuasion about capability
- 62 Goal setting - behaviour
- 71 Pros and cons
- 80 Information about social and environmental consequences

The following BCTs were reported in only in trials with a negative effect intervention effect (annotated B throughout the alcohol sections). All effects in these trials were non-significant:

- 1 Social support – practical
- 42 Focus on past success
- 61 Problem solving

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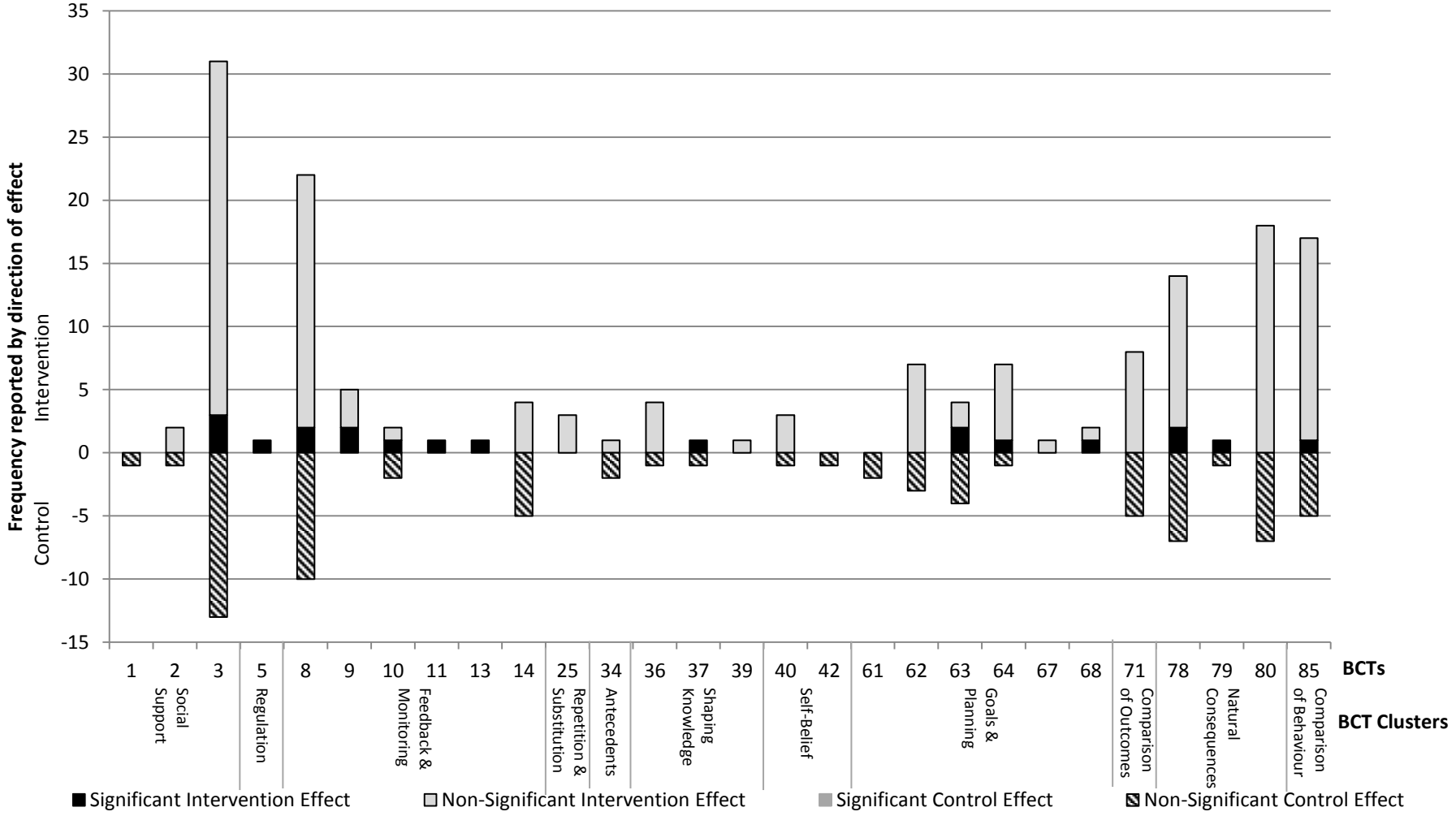
Figure 4: Distribution of BCTs in alcohol trials; with direction and significance of effect



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4.3.4 Variation of effects across population groups

Tables 9 to 15 summarise the intervention type, mode of delivery, and intervention effect size and significance of behaviour change interventions targeting individuals in hospital or admitted to the emergency department, university students, and other heavy or risky drinkers. Trials of interventions targeting multiple behaviour areas in patients with cardiovascular conditions were also analysed separately, with only results for the alcohol consumption behaviour are presented in this section, results for other behaviours are presented in the relevant sections.

Emergency Department or other hospital patients

Ten interventions, described in six trials (Dent_BI 2008 [++], Daeppen 2007 [+], Field_BP 2009 [+], Field_HP 2009 [+], Field_WP 2009 [+], Holloway_SEE 2007 [+], Holloway_SHB 2007 [+], Neumann 2006 [++], Dent_MI 2008 [++], Mello 2008 [++]) examined the effectiveness of individual level behaviour change interventions at reducing alcohol consumption among hospital and Emergency Department patients. One trial (Holloway 2007 [+]) included general hospital patients. The remaining five trials recruited individuals presenting to the Emergency Department or a trauma centre.

Overall, behaviour change interventions among drinkers who are hospitalised or who present to the Emergency Department are no more effective than usual care at reducing alcohol consumption. This pattern was found for brief, extended and multi-session interventions, delivered face to face one on one as well as those delivered remotely.

Brief face to face one on one interventions

Six comparisons from four studies (Dent_BI 2008 [++], Daeppen 2007 [+], Field_BP 2009 [+], Field_HP 2009 [+], Field_WP 2009 [+], Holloway_SEE 2007 [+]) assessed the effectiveness of brief interventions delivered face to face one on one. These interventions were no more effective than

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comparators at altering drinking behaviour among hospitalised patients or those presenting in the ED.

Dent_BI 2008 [++] assessed the effect of brief intervention delivered face to face and one on one among patients presenting in the Emergency Department. Compared to usual care, the intervention resulted in very small to small, negative, non-significant effect on daily alcohol consumption (SMD -0.30, 95% CI -0.70 to 0.10).

Daeppen 2007 [+] assessed the effectiveness of a brief alcohol intervention delivered face to face and one on one to injured, hazardous drinking ED patients. Compared to patients who were screened for hazardous drinking only (but received no intervention) the trial resulted in very small to small, negative, non-significant effect on weekly alcohol consumption (SMD -0.01, 95% CI -0.18 to 0.17).

Field_BP 2009 [+] assessed the effectiveness of a brief motivational intervention among black patients considered to be at risk drinkers who presented at a trauma centre for either intentional or unintentional injuries. The trial resulted in a very small, negative, non-significant effect in the change in weekly alcohol consumption compared to usual care (SMD -0.03, 95% CI -0.26 to 0.21).

Field_WP 2009 [+] assessed the effectiveness of a brief motivational intervention among white patients considered to be at risk drinkers who presented at a trauma centre for either intentional or unintentional injuries, and resulted in a very small, non-significant effect in the in change weekly alcohol consumption (SMD 0.04, 95% CI -0.11 to 0.19).

Field_HP 2009 [+] assessed the effectiveness of a brief motivational intervention among Hispanic patients considered to be at risk drinkers who presented at a trauma centre for either intentional or unintentional injuries. The intervention resulted in a very small, non-significant effect in the change in weekly alcohol consumption (SMD 0.14, 95% CI -0.03 to 0.31).

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Holloway_SEE 2007 [+] provided a brief intervention aimed at improving self-efficacy among hospitalised patients. The majority of these patients (63%) had a Carstairs deprivation score greater than 4, indicating that they were relatively deprived. The trial resulted in a small, non-significant effect on the change in weekly alcohol consumption (SMD 0.48, 95% CI -0.003 to 0.97).

Brief remotely delivered interventions

Two studies (Holloway_SHB 2007 [+], Neumann 2006 [++]) included a brief alcohol behaviour change intervention delivered remotely, and assessed the change in consumption between baseline and follow-up. Both trials resulted in intervention groups reducing their alcohol consumption more than the control groups, however, neither of the effects were significant. Both interventions reported use of BCTs 3 Social support (unspecified) and 78 Information about health consequences.

Holloway_SHB 2007 [+] provided a self-help booklet to hospitalised patients in need of an alcohol behaviour change intervention. The majority of these patients (63%) had a Carstairs deprivation score greater than 4, indicating that they were relatively deprived. The trial resulted in a small, non-significant effect on the change in weekly consumption compared to usual care (SMD 0.49, 95% CI -0.001 to 0.98).

Neumann 2006 [++] assessed the effect of a brief intervention delivered prior to discharge to injured ED patients. The trial resulted in a small, non-significant change in daily alcohol consumption compared to usual care (SMD 0.12, 95% CI -0.05 to 0.29).

Extended intervention delivered face to face and one on one

Finally, Dent_MI 2008 [++] assessed the effect of an extended motivational interviewing intervention provided post discharge to ED patients. The intervention resulted in a very small, negative, non-significant change in daily

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alcohol consumption compared to usual care (SMD -0.11, 95% CI -0.52 to 0.30).

Multi-session remotely delivered intervention

One study (Mello 2008 [++]) assessed a multi-session intervention delivered remotely to injured ED patients and reported a small, non-significant effect on impaired driving compared to usual care (SMD 0.22, 95% CI -0.01 to 0.46).

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Table 9: Alcohol interventions for Emergency Department patients or other hospital patients

Author year	Intervention Type	Primary delivery mode	Outcome	SMD	95% CI lower	95% CI upper	Intervention BCTs Control BCTs
Dent_BI 2008 [++]	Brief	Face to face, one on one	Daily consumption	-0.30	-0.70	0.10	3 Social support (unspecified)[C2] 8 Feedback on behaviour[C2] 8 Feedback on behaviour[C2]
Daeppen 2007 [+]	Brief	Face to face, one on one	Weekly consumption	-0.01	-0.18	0.17	3 Social support (unspecified)[C2] 8 Feedback on behaviour[C2] 71 Pros and cons[C] 85 Social comparison[C1] None reported
Field_BP 2009 [+]	Brief	Face to face, one on one	Change in weekly consumption	-0.03	-0.26	0.21	2 Social support (emotional)[C] 3 Social support (unspecified)[C2] 36 Instruction on how to perform a behaviour[C] 40 Verbal persuasion about capability[C] 71 Pros and cons[C] 80 Information about social and environmental consequences[C] 2 Social support (emotional)[C] 3 Social support (unspecified)[C2] 36 Instruction on how to perform a behaviour[C] 78 Information about health consequences[C2]
Field_WP 2009 [+]	Brief	Face to face, one on one	Change in weekly consumption	0.04	-0.11	0.19	2 Social support (emotional)[C] 3 Social support (unspecified)[C2] 36 Instruction on how to perform a behaviour[C] 40 Verbal persuasion about capability[C] 71 Pros and cons[C] 80 Information about social and environmental consequences[C] 2 Social support (emotional)[C] 3 Social support (unspecified)[C2] 36 Instruction on how to perform a behaviour[C] 78 Information about health consequences[C2]
Field_HP 2009 [+]	Brief	Face to face, one on one	Change in weekly	0.14	-0.03	0.31	2 Social support (emotional)[C] 3 Social support (unspecified)[C2]

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Author year	Intervention Type	Primary delivery mode	Outcome	SMD	95% CI lower	95% CI upper	Intervention BCTs Control BCTs
			consumption				36 Instruction on how to perform a behaviour[C] 40 Verbal persuasion about capability[C] 71 Pros and cons[C] 80 Information about social and environmental consequences[C] 2 Social support (emotional)[C] 3 Social support (unspecified)[C2] 36 Instruction on how to perform a behaviour[C] 78 Information about health consequences[C2]
Holloway_SEE 2007 [+]	Brief	Face to face, one on one	Change in weekly consumption	0.48	-0.003	0.97	3 Social support (unspecified)[C2] 9 Feedback on outcome(s) of behaviour[A2] None reported
Holloway_SHB 2007 [+]	Brief	Remote	Change in weekly consumption	0.49	-0.001	0.98	3 Social support (unspecified)[C2] 78 Information about health consequences[C2] None reported
Neumann 2006 [++]	Brief	Remote	Change in daily consumption	0.12	-0.05	0.29	3 Social support (unspecified)[C2] 8 Feedback on behaviour[C2] 62 Goal setting (behaviour)[C] 78 Information about health consequences[C2] 3 Social support (unspecified)[C2]
Dent_MI 2008 [++]	Extended	Face to face, one on one	Daily consumption	-0.11	-0.52	0.30	3 Social support (unspecified)[C2] 8 Feedback on behaviour[C2] 8 Feedback on behaviour[C2]
Mello 2008 [++]	Multi-session	Remote	Impaired driving	0.23	-0.01	0.46	3 Social support (unspecified)[C2] None reported

A positive SMD represents a benefit with the intervention (i.e. favours the intervention), and a negative SMD represents a benefit with the comparator (favours comparator). A SMD of <0.2 represents a very small effect size, of ≥0.2 to <0.5 represents a small effect size, of ≥0.5 to <0.8 a medium effect size, and of ≥0.8 a large effect size.
* Intervention targeted multiple behaviour topcs

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University students

Twenty-five interventions described in eleven trials (Carey_BMI 2006 [+], Carey_TLFB 2006 [+], Carey_BMI+TLFB 2006 [+], Carey_EBMI 2006 [+], Carey_EBMI+TLFB 2006 [+], Kulesza_10M 2010 [+], Juarez_MF 2006 [+], Walters_WEB 2009 [++], Neighbors 2006 [+], Lewis_GNSF 2007 [+], Lewis_GSF 2007 [+], Walters_MI 2009 [++], Juarez _MI 2006 [+], Juarez_MI+F 2006 [+], Kulesza_50M 2010 [+], Ingersoll 2005* [+], Mastroleo_EEA 2010 [+], Mastroleo_CPA 2010 [+], Walters_MI+F 2009 [++], Lau Barraco_EEC 2008 [+], Lau Barraco_EDU 2008 [+], Dermen_ALC 2011 [+], Dermen_H&A 2011* [+], Juarez_MI+MF 2006 [+], Fleming 2010 [++]) examined the effectiveness of individual level behaviour change interventions at reducing alcohol consumption among university students.

Overall, these interventions were no more effective than comparators at change alcohol consumption behaviour. This pattern was seen across intervention types (brief, extended, multi-session) and modes of delivery (face to face one on one, face to face group, face to face with remote follow-up and remote only). A single intervention (Lewis_GSF 2007 [+]), which provided feedback tailored to the gender of the participant, resulted in a significant effect.

Figure 5 presents the frequency of use for each reported behaviour change technique across alcohol interventions among university students. The x-axis is identical to that of Figure 4 to allow for comparison of reported BCTs in this population vs. alcohol interventions more generally; if a BCT was reported in any alcohol trial but not in the trials relevant to this population there is a gap for that BCT in Figure 5.

Brief face to face one on one interventions

Six interventions described in two trials (Carey_BMI 2006 [+], Carey_TLFB 2006 [+], Carey_BMI+TLFB 2006 [+], Carey_EBMI 2006 [+], Carey_EBMI+TLFB 2006 [+], Kulesza_10M 2010 [+]) assessed the effect of

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brief interventions delivered face to face and one on one to university students on alcohol consumption. Overall, these interventions resulted in no significant difference in drinking behaviours in this population.

One trial included five interventions, described as brief and delivered face to face and one on one, targeting alcohol consumption among heavy drinking university students. Carey_BMI 2006 [+] assessed the impact of a brief motivational intervention and resulted in a small, non-significant effect weekly alcohol consumption (SMD 0.22, 95% CI -0.42 to 0.86). Carey_TLFB 2006 [+] included a time line followback interview on alcohol consumption and resulted in a very small, negative, non-significant effect on weekly alcohol consumption (SMD -0.10, 95% CI -0.74 to 0.53). Carey_BMI+TLFB 2006 [+] combined the two above approaches into single brief motivational intervention using timeline followback alcohol assessment, and resulted in a very small, non-significant effect on weekly intake (SMD 0.03, 95% CI -0.61 to 0.67). Carey_EBMI 2006 [+] used the same brief motivational intervention approach as Carey_BMI 2006 [+], which was enhanced by the addition of a decisional balance component. This intervention resulted in a very small, negative, non-significant effect on alcohol intake (SMD -0.06, 95% CI -0.69 to 0.58). Finally, Carey_EBMI+TLFB 2006 [+] combined the enhance motivational intervention and time line followback interview and resulted in a very small, negative, non-significant effect on weekly consumption (SMD -0.12, 95% CI -0.76 to 0.52).

Kulesza_10M 2010 [+] assessed the effect of a ten minute version of the Brief Alcohol Screening and Intervention for College Students (BASICS) on daily alcohol consumption among university students identified as heavy drinkers. The trial resulted in a medium, non-significant effect compared to a waitlist control arm (SMD 0.55, 95% CI -0.003 to 1.09).

All of the interventions, save Carey_TLFB 2006 [+], reported use of BCTs 3 Social support (unspecified), 8 Feedback on behaviour, 71 Pros and cons, 78 Information about health consequences, 80 Information about social and environmental consequences, and 85 Social comparison.

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Brief remotely delivered interventions

Five interventions described in four trials (Juarez_MF 2006 [+], Walters_WEB 2009 [++], Neighbors 2006 [+], Lewis_GNSF 2007 [+], Lewis_GSF 2007 [+]) used a brief, remotely delivered intervention among university students.

One intervention (Juarez_MF 2006 [+]) intervention included university students identified as having at least one heavy drinking episode. The student received mailed feedback regarding their baseline assessment of drinking behaviour. This intervention resulted in a very small, non-significant difference in daily alcohol consumption compared to an assessment only control (SMD 0.11, 95% CI -1.13 to 1.35).

Participants in the Walters_WEB 2009 [++] were psychology students identified as heavy drinkers. The participants received internet based feedback on drinking behaviours, and exhibited a very small, non-significant difference in weekly alcohol consumption compared to an assessment only control group (SMD 0.07, 95% CI -0.45 to 0.58).

Neighbors 2006 [+] recruited university students enrolled in an introductory and lower level psychology course who reported at least one heavy drinking episode in the previous month. The intervention involved personalised feedback delivered via computer, and resulted in a very small, non-significant difference in weekly alcohol consumption compared to an assessment only control (SMD 0.09, 95% CI -0.20 to 0.38).

One study assessed two brief alcohol behaviour change interventions (Lewis_GNSF 2007 [+], Lewis_GSF 2007 [+]) delivered via computer to first year university students who reported drinking at dangerous levels. The first interventions, Lewis_GNSF 2007 [+], provided personalised feedback that had no gender specific content, and resulted in a small, non-significant effect on weekly alcohol consumption compared to an assessment only control (SMD 0.39, 95% CI -0.01 to 0.79). The second intervention, Lewis_GSF 2007 [+], provided personalised feedback on alcohol consumption behaviours that was

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tailored to the gender of the participant. This intervention resulted in a small, significant effect on weekly consumption behaviours (SMD 0.46, 95% CI 0.05 to 0.86).

All five interventions reported use of BCTs 8 Feedback on behaviour and 85 Social comparison. No BCTs were reported in the intervention with significant results that were not also reported in the interventions with non-significant results. Similarly, no BCTs were reported in all four interventions with non-significant results that didn't also appear in the single intervention with significant effects on alcohol consumption.

Extended face to face one on one interventions

Eight interventions described in five trials (Walters_MI 2009 [++], Walters_MI+F 2009 [++], Juarez _MI 2006 [+], Juarez _MI+F 2006 [+], Kulesza_50M 2010 [+], Ingersoll 2005* [+], Mastroleo_EEA 2010 [+], Mastroleo_CPA 2010 [+]) assessed the effect of extended interventions delivered face to face and one on one among heavy drinking university students. Overall, these interventions resulted in no significant difference in drinking behaviours compared to the trials' control arms.

Two arms of one trial (Walters_MI 2009 [++], Walters_MI+F 2009 [++]) recruited university level psychology students identified as heavy drinkers. In Walters_MI 2009 [++], the participants received a face to face one on one motivational interview intervention, and exhibited a very small, non-significant difference in weekly alcohol consumption compared to an assessment only control group (SMD 0.12, 95% -0.39 to 0.63). Walters_MI+F 2009 [++] provided a face to face one on one motivational interview with a computer feedback component, and resulted in a small, non-significant effect on weekly consumption (SMD 0.27, 95% CI -0.23 to 0.77).

Two extended interventions were described in one trial among university students identified as having at least one heavy drinking episode. Juarez _MI 2006 [+] included a motivational interviewing intervention and resulted in a

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medium, non-significant difference in daily alcohol consumption compared to the control arm (SMD 0.51; 95% CI -0.78 to 1.80). Juarez_MI+F 2006 [+] provided a motivational interviewing plus feedback intervention resulted in a small, negative, non-significant difference in daily alcohol consumption compared the control arm (SMD -0.23, 95% CI -1.51 to 1.05).

Kulesza_50M 2010 [+] assessed the effect of a fifty minute version of BASICS on daily alcohol consumption among university students identified as heavy drinkers. The trial resulted in a small, non-significant effect on weekly alcohol consumption compared to a waitlist control arm (SMD 0.23, 95% CI -0.32 to 0.78)

Ingersoll 2005* [+] recruited female university students reporting recent ineffective contraception use while binge drinking or having more than eight drinks per week; this study aimed to reduce the risk of alcohol exposed pregnancy. The trial used an extended single session intervention targeting birth control use and alcohol awareness, and resulted in a very small, non-significant effect on weekly alcohol consumption (SMD 0.15, 95% CI -0.13 to 0.43

Mastroleo_EEA 2010 [+] and Mastroleo_CPA 2010 [+] assessed the effect of the same BASICS programme on the alcohol consumption of first semester, first year university students identified as heavy drinkers. The Mastroleo_EEA 2010 [+] used a supervised evidence based application approach, and resulted in a small, non-significant difference in weekly alcohol consumption (SMD 0.31, 95% CI -0.07 to 0.69). Mastroleo_CPA 2010 [+] used an unsupervised common practice approach , and also resulted in a small, non-significant effect on weekly consumption (SMD 0.36, 95% CI -0.02 to 0.73).

All eight of the interventions reported use of BCTs 3 Social support (unspecified); seven of the interventions (Walters_MI+F 2009 [++], Juarez _MI 2006 [+], Juarez _MI+F 2006 [+], Kulesza_50M 2010 [+], Ingersoll 2005* [+], Mastroleo_EEA 2010 [+], Mastroleo_CPA 2010 [+]) also reported use of BCT 8 Feedback on behaviour.

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Extended face to face group interventions

Two interventions in one trial (Lau Barraco_EEC 2008 [+], Lau Barraco_EDU 2008 [+]) assessed the effect of extended interventions delivered face to face on a group level to university psychology students identified as having a heavy episodic drinking. The first intervention Lau Barraco_EEC 2008 [+] assessed the effect of a gender specific experiential expectancy challenge, and resulted in a small, non-significant difference in weekly consumption (SMD 0.22, 95% CI -0.17 to 0.61). Lau Barraco_EDU 2008 [+] assessed the effect of an alcohol education only intervention, and resulted in a very small, non-significant effect (SMD 0.14, 95% CI -0.33 to 0.61). Both interventions reported use of BCT 3 Social support (unspecified).

Multi-session face to face one on one interventions

Two interventions described in one trials (Dermen_ALC 2011 [+], Dermen_H&A 2011* [+]) utilised a multi-session approach delivered face to face and one on one.

Two arms of one trial (Dermen_ALC 2011 [+], Dermen_H&A 2011* [+]) assessed alcohol behavioural outcomes among university students reporting heavy drinking in the last week (more than four or five drinks in one occasion, for women and men respectively) as well as risky sexual behaviour (including having unprotected sex seven or more times in the previous 90 days, or having two or more sexual partners in the previous 90 days). Dermen_ALC 2011 [+] focused on reducing alcohol risk behaviour and resulted in a small, non-significant effect on daily alcohol consumption (SMD 0.46, 95% CI -0.11 to 1.02). Dermen_H&A 2011* [+] focused on both alcohol and HIV risk behaviours, and resulted in a very small, negative, non-significant effect on daily consumption (SMD -0.04, 95% CI -0.60 to 0.53). Both interventions reported use of BCTs 3 Social support (unspecified), 8 Feedback on behaviour, 34 Adding objects to the environment, and 80 Information about social and environmental consequences.

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Multi-session face to face one on one interventions with remote follow-up

Two trials assessed the effect of multi-session interventions delivered face to face with remote follow-up (Juarez_MI+MF 2006 [+], Fleming 2010 [++]) on the drinking behaviour of university students.

Juarez_MI+MF 2006 [+] assessed the effect of a multi-session intervention delivered face to face and remotely among university students identified as having at least one heavy drinking episode. The intervention included a motivational interview and mailed feedback report, and resulted in a medium, non-significant effect on daily alcohol consumption (SMD 0.56, 95% CI -0.71 to 1.84).

Fleming 2010 [++] provided a multiple brief alcohol interventions with telephone or e-mail follow-up to university students identified as high risk drinkers in university health clinics. The trial resulted in a very small, non-significance difference in the number of days on which alcohol was consumed at follow-up, compared to a usual care group (SMD 0.07, 95% CI -0.05 to 0.20).

Both interventions reported use of BCTs 3 Social support (unspecified), 78 Information about health consequences, 80 Information about social and environmental consequences and 85 Social comparison.

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Table 10: Alcohol interventions for university students

Author year	Intervention Type	Primary delivery mode	Outcome	SMD	95% CI lower	95% CI upper	Intervention BCTs Control BCTs
Carey_BMI 2006 [+]	Brief	Face to face one on one	Weekly consumption	0.22	-0.42	0.86	3 Social support (unspecified)[C2] 8 Feedback on behaviour[C2] 14 Biofeedback[C] 63 Goal setting (outcome)[C2] 78 Information about health consequences[C2] 80 Information about social and environmental consequences[C] 85 Social comparison[C1] None reported
Carey_TLFB 2006 [+]	Brief	Face to face one on one	Weekly consumption	-0.10	-0.74	0.53	None reported None reported
Carey_ BMI+TLFB 2006 [+]	Brief	Face to face one on one	Weekly consumption	0.03	-0.61	0.67	3 Social support (unspecified)[C2] 8 Feedback on behaviour[C2] 14 Biofeedback[C] 63 Goal setting (outcome)[C2] 78 Information about health consequences[C2] 80 Information about social and environmental consequences[C] 85 Social comparison[C1] None reported
Carey_EBMI 2006 [+]	Brief	Face to face one on one	Weekly consumption	-0.06	-0.69	0.58	3 Social support (unspecified)[C2] 8 Feedback on behaviour[C2] 14 Biofeedback[C] 63 Goal setting (outcome)[C2] 71 Pros and cons[C] 78 Information about health consequences[C2] 80 Information about social and environmental consequences[C] 85 Social comparison[C1] None reported
Carey_EBMI+	Brief	Face to face one on	Weekly	-0.12	-0.76	0.52	3 Social support (unspecified)[C2]

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Author year	Intervention Type	Primary delivery mode	Outcome	SMD	95% CI lower	95% CI upper	Intervention BCTs Control BCTs
TLFB 2006 [+]		one	consumption				8 Feedback on behaviour[C2] 14 Biofeedback[C] 63 Goal setting (outcome)[C2] 71 Pros and cons[C] 78 Information about health consequences[C2] 80 Information about social and environmental consequences[C] 85 Social comparison[C1] None reported
Kulesza_ 10M 2010 [+]	Brief	Face to face one on one	Weekly consumption	0.55	-0.003	1.09	3 Social support (unspecified)[C2] 8 Feedback on behaviour[C2] 71 Pros and cons[C] 78 Information about health consequences[C2] 80 Information about social and environmental consequences[C] 85 Social comparison[C1] None reported
Juarez_MF 2006 [+]	Brief	Remote	Daily consumption	0.11	-1.13	1.35	8 Feedback on behaviour[C2] 14 Biofeedback[C] 78 Information about health consequences[C2] 80 Information about social and environmental consequences[C] 85 Social comparison[C1] None reported
Walters_WEB 2009 [++]	Brief	Remote	Weekly consumption	0.07	-0.45	0.58	3 Social support (unspecified)[C2] 8 Feedback on behaviour[C2] 80 Information about social and environmental consequences[C] 85 Social comparison[C1] None reported
Neighbors 2006 [+]	Brief	Remote	Weekly consumption	0.09	-0.21	0.38	8 Feedback on behaviour[C2] 85 Social comparison[C1] None reported
Lewis_GNSF	Brief	Remote	Monthly	0.39	-0.01	0.79	8 Feedback on behaviour[C2]

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Author year	Intervention Type	Primary delivery mode	Outcome	SMD	95% CI lower	95% CI upper	Intervention BCTs Control BCTs
2007 [+]			consumption				85 Social comparison[C1] None reported
Lewis_GSF 2007 [+]	Brief	Remote	Monthly consumption	0.46	0.05	0.86	8 Feedback on behaviour[C2] 85 Social comparison[C1] None reported
Walters_MI 2009 [++]	Extended	Face to face one on one	Weekly consumption	0.12	-0.39	0.63	3 Social support (unspecified)[C2] 64 Action planning[C1] None reported
Walters_MI+F 2009 [++]	Extended	Face to face one on one	Weekly consumption	0.27	-0.23	0.77	3 Social support (unspecified)[C2] 8 Feedback on behaviour[C2] 64 Action planning[C1] 80 Information about social and environmental consequences[C] 85 Social comparison[C1] None reported
Juarez _MI 2006 [+]	Extended	Face to face one on one	Daily consumption	0.51	-0.78	1.80	3 Social support (unspecified)[C2] 8 Feedback on behaviour[C2] 71 Pros and cons[C] 80 Information about social and environmental consequences[C] None reported
Juarez_MI+F 2006 [+]	Extended	Face to face, one on one	Daily consumption	-0.23	-1.51	1.05	3 Social support (unspecified)[C2] 8 Feedback on behaviour[C2] 14 Biofeedback[C] 71 Pros and cons[C] 78 Information about health consequences[C2] 80 Information about social and environmental consequences[C] 85 Social comparison[C1] None reported
Kulesza_50M 2010 [+]	Extended	Face to face one on one	Weekly consumption	0.23	-0.32	0.78	3 Social support (unspecified)[C2] 8 Feedback on behaviour[C2]

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Author year	Intervention Type	Primary delivery mode	Outcome	SMD	95% CI lower	95% CI upper	Intervention BCTs Control BCTs
							71 Pros and cons[C] 78 Information about health consequences[C2] 80 Information about social and environmental consequences[C] 85 Social comparison[C1] None reported
Ingersoll 2005* [+]	Extended	Face to face one on one	Weekly consumption	0.15	-0.13	0.43	3 Social support (unspecified)[C2] 8 Feedback on behaviour[C2] 62 Goal setting (behaviour)[C] 71 Pros and cons[C] 80 Information about social and environmental consequences[C] None reported
Mastroleo_EEA 2010 [+]	Extended	Face to face one on one	Weekly consumption	0.31	-0.07	0.69	3 Social support (unspecified)[C2] 8 Feedback on behaviour[C2] None reported
Mastroleo_CPA 2010 [+]	Extended	Face to face one on one	Weekly consumption	0.36	-0.02	0.73	3 Social support (unspecified)[C2] 8 Feedback on behaviour[C2] None reported
Lau Barraco_EEC 2008 [+]	Extended	Face to face group	Weekly consumption	0.22	-0.17	0.61	3 Social support (unspecified)[C2] 39 Behavioural experiments[A] 78 Information about health consequences[C2] 85 Social comparison[C1] None reported
Lau Barraco_EDU 2008 [+]	Extended	Face to face group	Weekly consumption	0.14	-0.33	0.61	3 Social support (unspecified)[C2] None reported
Dermen_ALC 2011 [+]	Multi-session	Face to face one on one	Daily consumption	0.459	-0.11	1.02	3 Social support (unspecified)[C2] 8 Feedback on behaviour[C2] 9 Feedback on outcome(s) of behaviour[A2] 25 Behaviour substitution[A] 34 Adding objects to the environment[C]

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Author year	Intervention Type	Primary delivery mode	Outcome	SMD	95% CI lower	95% CI upper	Intervention BCTs Control BCTs
							40 Verbal persuasion about capability[C] 71 Pros and cons[C] 80 Information about social and environmental consequences[C] 85 Social comparison[C1] None reported
Dermen_H&A 2011* [+]	Multi-session	Face to face one on one	Daily consumption	-0.04	-0.60	0.53	3 Social support (unspecified)[C2] 8 Feedback on behaviour[C2] 34 Adding objects to the environment[C] 80 Information about social and environmental consequences[C] None reported
Juarez_MI+MF 2006 [+]	Multi-session	Face to face one on one with remote follow up	Daily consumption	0.56	-0.71	1.84	3 Social support (unspecified)[C2] 8 Feedback on behaviour[C2] 14 Biofeedback[C] 71 Pros and cons[C] 78 Information about health consequences[C2] 80 Information about social and environmental consequences[C] 85 Social comparison[C1] None reported
Fleming 2010 [++]	Multi-session	Face to face one on one with remote follow up	Monthly consumption	0.07	-0.05	0.20	3 Social support (unspecified)[C2] 10 Self-monitoring of behaviour[C1] 62 Goal setting (behaviour)[C] 64 Action planning[C1] 67 Behavioural contract[A] 78 Information about health consequences[C2] 80 Information about social and environmental consequences[C] 85 Social comparison[C1] None reported

A positive SMD represents a benefit with the intervention (i.e. favours the intervention), and a negative SMD represents a benefit with the comparator (favours comparator). A SMD of <0.2 represents a very small effect size, of ≥0.2 to <0.5 represents a small effect size, of ≥0.5 to <0.8 a medium effect size, and of ≥0.8 a large effect size.
* Intervention targeted multiple behaviour topcs

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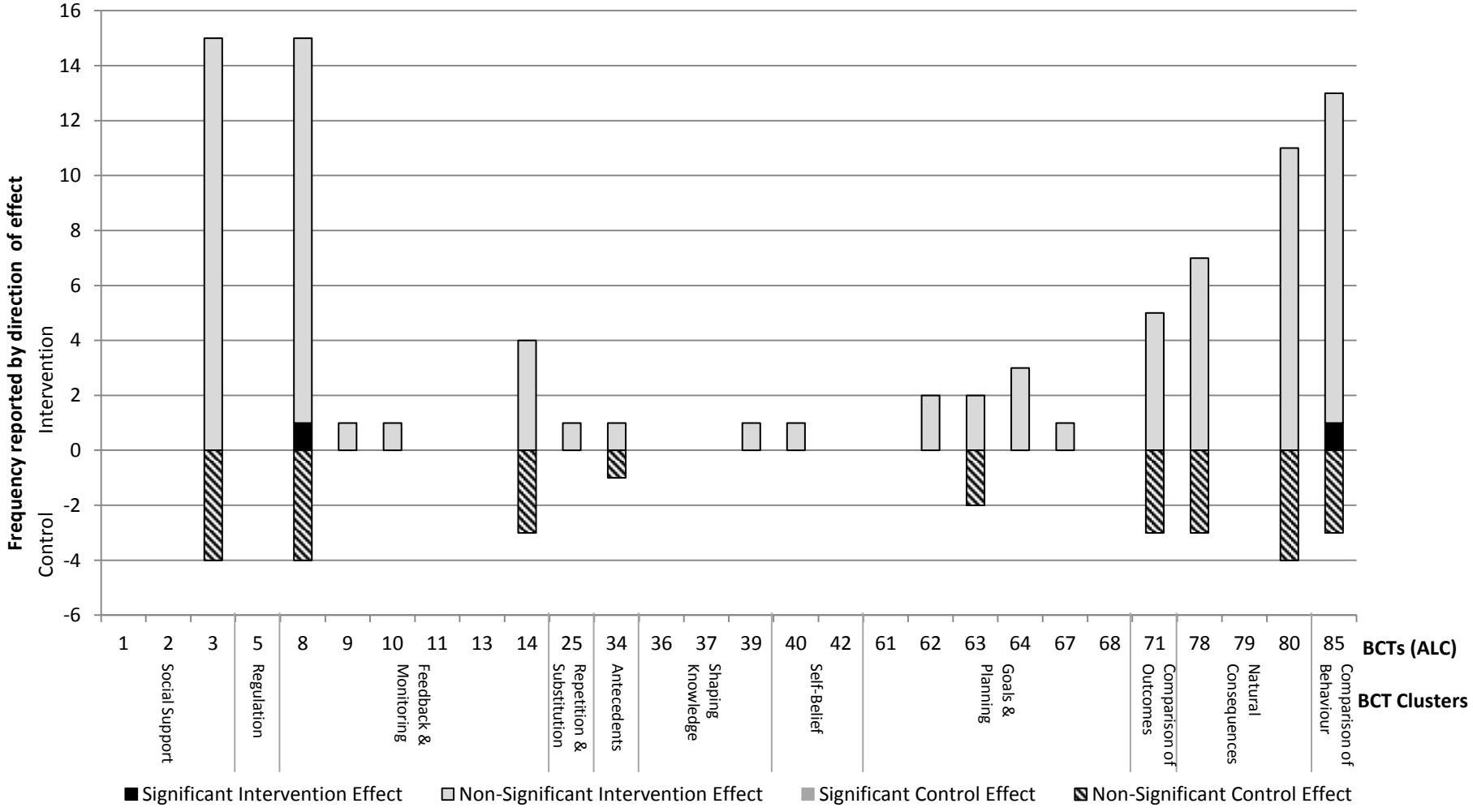
Figure 5: Distribution of BCTs in alcohol trials among university students; with direction and significance of effect



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Cardiovascular conditions

Three trials (Koelewijn-van Loon 2010* [+], Smeulders 2009* [+], Burke 2008* [+]) assessed the effectiveness multi-target lifestyle interventions at changing alcohol consumption among individuals with or at risk for cardiovascular conditions.

Overall, interventions in this population were no more effective than usual care at changing alcohol intake.

Multi-session face to face one on one interventions with remote follow-up

Koelewijn-van Loon 2010* [+] assessed the effectiveness of a multi-session face to face one on one intervention with telephone follow-up among patients deemed eligible for cardiovascular risk management. The intervention targeted multiple behaviours (alcohol, diet, physical activity and smoking) and resulted in a large, negative, non-significant difference in the proportion of participants drinking above nationally recommended limits at follow-up (SMD -0.85, 95% CI -2.04 to 0.34).

Multi-session face to face group interventions

Two trials (Smeulders 2009* [+], Burke 2008* [+]) assessed the effectiveness of multi-session, face to face group interventions at reducing weekly alcohol consumption.

Smeulders 2009* [+] assessed the effectiveness of a multi-session chronic disease self-management programme delivered face to face and over the telephone to groups of congestive heart failure patients. The intervention addressed alcohol, diet and physical activity behaviours, and resulted in a very small, non-significant effect on weekly alcohol consumption compared to usual care (SMD 0.08, 95% CI -0.14 to 0.31).

Burke 2008* [+] compared a lifestyle modification programme, which addressed alcohol, diet and physical activity, for overweight, hypertensive

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patients to usual care. The trial resulted a very small, negative, non-significant difference in weekly alcohol consumption (SMD -0.16, 95% CI -0.41 to 0.10).

Both trials reported use of BCTs 3 Social support (unspecified), 62 Goal setting (behaviour), and 64 Action planning.

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Table 11: Alcohol interventions for patients with cardiovascular conditions

Author year	Intervention Type	Primary delivery mode	Outcome	SMD	95% CI lower	95% CI upper	Intervention BCTs Control BCTs
Koelewijn-van Loon 2010* [+]	Multi-session	Face to face, one on one; Remote follow up	Drinking above recommended limit	-0.85	-2.04	0.34	3 Social support (unspecified)[C2] 34 Adding objects to the environment[C] 62 Goal setting (behaviour)[C] 63 Goal setting (outcome)[C2] 78 Information about health consequences[C2] 80 Information about social and environmental consequences[C]
Smeulders 2009* [+]	Multi-session	Face to face, group	Weekly consumption	0.08	-0.14	0.31	3 Social support (unspecified)[C2] 62 Goal setting (behaviour)[C] 64 Action planning[C1] None reported
Burke* 2008 [+]	Multi-session	Face to face, group	Weekly consumption	-0.16	-0.41	0.10	1 Social support (practical)[B] 3 Social support (unspecified)[C2] 8 Feedback on behaviour[C2] 10 Self-monitoring of behaviour[C1] 14 Biofeedback[C] 62 Goal setting (behaviour)[C] 63 Goal setting (outcome)[C2] 64 Action planning[C1] 14 Biofeedback[C] 34 Adding objects to the environment[C]
A positive SMD represents a benefit with the intervention (i.e. favours the intervention), and a negative SMD represents a benefit with the comparator (favours comparator). An SMD of <0.2 represents a very small effect size, of ≥0.2 to <0.5 represents a small effect size, of ≥0.5 to <0.8 a medium effect size, and of ≥0.8 a large effect size.							

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Drinkers recruited in primary care

Four studies (Ockene 2009 [++], Lock 2006 [++], Curry 2003 [+], Moore 2010 [+]) recruited participants identified in primary care as at risk or hazardous drinkers.

Overall, brief face to face one on one interventions in this population were no more effective at altering alcohol consumption than usual care. Multi-session face to face one on one interventions with remote follow-up exhibited inconsistent effectiveness, with significant effects seen amongst patients over the age of 55 in one trial, and no significant effects seen among a population of primary care risky drinkers with no lower age limit.

All four interventions reported use of BCT 3 Social support (unspecified). The three interventions resulting in non-significant effects all reported use of BCT 80 Information about social and environmental consequences; this was not reported in the trial that resulted in a significant intervention effect. Finally, BCTs 9 Feedback on outcome(s) of behaviour, 11 Self-monitoring of outcome(s) of behaviour, and 37 Information about antecedents were reported only in the intervention with a significant effect on drinking behaviour.

Brief face to face one on one interventions

Ockene 2009 [++] recruited men and women identified as high risk drinkers in primary care settings. The trial resulted in a very small, negative, non-significant effect on weekly consumption compared to usual care (SMD -0.04, 95% CI -0.13 to 0.06).

Lock 2006 [++] recruited high risk drinkers identified in primary care, and resulted in a very small, non-significant effect on weekly alcohol consumption compared to (SMD 0.15, 95% CI -0.20 to 0.50).

Both interventions reported use of BCTs 3 Social support (unspecified), 78 Information about health consequences, and 80 Information about social and environmental consequences.

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Multi-session face to face one on one interventions with remote follow-up

Two trials (Curry 2003 [+], Moore 2010 [+]) assessed the effectiveness of multiple face to face one on one interventions with remote follow-up. The evidence surrounding the effectiveness of these interventions was inconsistent in terms of effectiveness.

Curry 2003 [+] assessed the effectiveness of a face to face one on one intervention with follow-up telephone calls on risky drinking (defined as chronic drinking, binge drinking or drink driving) among primary care patients identified as having at risk drinking patterns. The trial resulted in a small, non-significant effect on drinking patterns compared to usual care (SMD 0.20, 95% CI -0.06 to 0.47

Moore 2010 [+] assessed the effect of a face to face one on one intervention with remote follow-up on the weekly alcohol consumption of at risk drinkers over the age of 55 years in primary care. The trial resulted in a very small, significant effect on consumption compared to usual care (SMD 0.16, 95% CI 0.003 to 0.32).

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Table 12: Alcohol interventions for patients recruited in primary care

Author year	Intervention Type	Primary delivery mode	Outcome	SMD	95% CI lower	95% CI upper	Intervention BCTs Control BCTs
Ockene 2009 [++]	Brief	Face to face, one on one	Weekly consumption	-0.04	-0.13	0.06	3 Social support (unspecified)[C2] 42 Focus on past success[B] 61 Problem solving[B] 78 Information about health consequences[C2] 79 Information about emotional consequences[C1] 80 Information about social and environmental consequences[C] None reported
Lock 2006 [++]	Brief	Face to face, one on one	Weekly consumption	0.15	-0.20	0.50	3 Social support (unspecified)[C2] 8 Feedback on behaviour[C2] 25 Behaviour substitution[A] 36 Instruction on how to perform a behaviour[C] 62 Goal setting (behaviour)[C] 64 Action planning[C1] 78 Information about health consequences[C2] 80 Information about social and environmental consequences[C] 85 Social comparison[C1] None reported
Curry 2003 [+]	Multi-session	Face to face, one on one; remote follow up	Risky drinking (chronic drinking, binge drinking, drink driving)	0.20	-0.06	0.47	3 Social support (unspecified)[C2] 8 Feedback on behaviour[C2] 80 Information about social and environmental consequences[C] 85 Social comparison[C1] None reported
Moore 2010 [+]	Multi-session	Face to face, one on one; remote follow up	Weekly consumption	0.16	0.003	0.32	3 Social support (unspecified)[C2] 9 Feedback on outcome(s) of behaviour[A2] 11 Self-monitoring of outcome(s) of behaviour[A1] 37 Information about antecedents[C1] 78 Information about health consequences[C2] None reported
A positive SMD represents a benefit with the intervention (i.e. favours the intervention), and a negative SMD represents a benefit with the comparator (favours comparator).							

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Drinkers recruited from non-primary care settings

Five trials recruited participants from other healthcare settings (Chang 2011 [++], Lane 2008 [+], Feldman 2011 [++], Emmen 2005 [++], Gilbert 2008* [++]).

Overall, these interventions were no more effective than comparators at altering alcohol consumption. This lack of effect held across intervention types (brief and multi-session) as well as mode of delivery (face to face and remotely delivered). There was substantial variability in participants' characteristics across these trials, making it difficult to conclude whether the lack of effect was due to the intervention, patient or other factors.

Brief face to face one on one interventions

Chang 2011 [++] recruited female risky drinkers (defined as consuming more than seven drinks per week, or more than two drinks per occasion) from a hospital outpatient clinic. The brief face to face one on one intervention resulted in a very small, negative, non-significant difference in daily consumption compared to an assessment only control group (SMD -0.06, 95% CI -0.23 to 0.12

Lane 2008 [+] recruited patients presenting at a sexual health clinic who were identified as hazardous or harmful drinkers. The brief 'drink less' intervention resulted in a very small, non-significant effect on alcohol consumption (quantity and frequency) compared to a no intervention control group (SMD 0.18, 95% CI -0.16 to 0.52).

Feldman 2011 [++] enrolled individuals receiving opioid or cocaine dependence treatment in a hospital outpatient clinic, who were also excessive drinkers. The brief intervention had a very small, non-significant effect on weekly alcohol consumption in this population, compared to usual care (SMD 0.09, 95% CI -0.29 to 0.46).

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All three interventions reported use of BCTs 3 Social support (unspecified) and 8 Feedback on behaviour.

Multi-session face to face one on one interventions

Emmen 2005 [++] included problem drinkers recruited from a general internal medicine outpatient clinic. The multi-session, face to face one on one psychosocial intervention resulted in a very small, negative non-significant effect on daily alcohol consumption compared to usual care (SMD -0.19, 95% CI -0.54 to 0.17).

Multi-session remotely delivered interventions

Gilbert 2008* [++] recruited HIV positive adults exceeding the United States recommendations for number of drinks per week, or who reported three or more binge drinking episodes during the previous three months. This multi-session remotely delivered intervention had a very small, non-significant intervention effect on risky drinking compared to usual care (SMD 0.17, 95% CI -0.15 to 0.50).

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Table 13: Alcohol interventions for drinkers recruited in non-primary care settings

Author year	Intervention Type	Primary delivery mode	Outcome	SMD	95% CI lower	95% CI upper	Intervention BCTs Control BCTs
Chang 2011 [++]	Brief	Face to face, one on one	Daily consumption	-0.06	-0.23	0.12	3 Social support (unspecified)[C2] 8 Feedback on behaviour[C2] 61 Problem solving[B] 62 Goal setting (behaviour)[C] 78 Information about health consequences[C2] 85 Social comparison[C1] None reported
Lane 2008 [+]	Brief	Face to face, one on one	Quantity and frequency of consumption (AUDIT-C)	0.18	-0.16	0.52	3 Social support (unspecified)[C2] 8 Feedback on behaviour[C2] 25 Behaviour substitution[A] 36 Instruction on how to perform a behaviour[C] 62 Goal setting (behaviour)[C] 64 Action planning[C1] 78 Information about health consequences[C2] 80 Information about social and environmental consequences[C] 85 Social comparison[C1] 8 Feedback on behaviour[C2]
Feldman 2011 [++]	Brief	Face to face, one on one	Weekly consumption	0.09	-0.29	0.46	3 Social support (unspecified)[C2] 8 Feedback on behaviour[C2] 62 Goal setting (behaviour)[C] 68 Commitment[A1] 80 Information about social and environmental consequences[C] 4 Pharmacological support 34 Adding objects to the environment[C]
Emmen 2005 [++]	Multi-session	Face to face, one on one	Daily consumption	-0.19	-0.54	0.17	3 Social support (unspecified)[C2] 8 Feedback on behaviour[C2] 14 Biofeedback[C] 37 Information about antecedents[C1] 78 Information about health consequences[C2] 80 Information about social and environmental consequences[C]

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Author year	Intervention Type	Primary delivery mode	Outcome	SMD	95% CI lower	95% CI upper	Intervention BCTs Control BCTs
							None reported
Gilbert 2008* [++]	Multi-session	Remote	Risky drinking	0.17	-0.15	0.50	3 Social support (unspecified)[C2] 9 Feedback on outcome(s) of behaviour[A2] None reported
A positive SMD represents a benefit with the intervention (i.e. favours the intervention), and a negative SMD represents a benefit with the comparator (favours comparator). A SMD of <0.2 represents a very small effect size, of ≥0.2 to <0.5 represents a small effect size, of ≥0.5 to <0.8 a medium effect size, and of ≥0.8 a large effect size. * Intervention targeted multiple behaviour topcs							

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Pregnant or postpartum drinkers

Two trials (Fleming 2008 [++], O'Connor 2007 [+]) enrolled pregnant or postpartum with high risk drinking behaviours. Both trials resulted in a significant intervention effect.

Overall, multi-session behaviour change interventions among pregnant and postpartum women were effective at altering alcohol consumption behaviour.

Multi-session face to face interventions

Fleming 2008 [++] recruited postpartum women identified as high risk drinkers in primary care to a multi-session face to face intervention with remote follow-up. The trial resulted in a small, significant effect on monthly alcohol consumption compared to usual care (SMD 0.35, 95% CI 0.10 to 0.61).

O'Connor 2007 [+] recruited low-income pregnant drinkers in a primary care setting to a multi-session face to face intervention. The trial resulted in a large, significant effect on the proportion of women reporting alcohol abstinence during the third trimester, compared to an assessment only control arm (SMD 0.93, 95% CI 0.26 to 1.60).

The two interventions reported no common behaviour change techniques, however Fleming 2008 [+] reported use of BCT 68 Commitment, which was consistently reported in alcohol interventions with positive effects (Fleming 2008 [+] was the only intervention reporting a significant effect in this group). O'Connor 2007 [++] reported use of BCT 9 Feedback on outcome(s) of behaviour, which was consistently reported in alcohol intervention with positive, significant effects. All other BCTs reported in this population were also reported in alcohol interventions with inconsistent results in terms of both direction and significance.

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Table 14: Alcohol interventions for pregnant women

Author year	Intervention Type	Primary delivery mode	Outcome	SMD	95% CI lower	95% CI upper	Intervention BCTs Control BCTs
Fleming 2008 [+]	Multi-session	Face to face, one on one	Monthly consumption	0.35	0.10	0.61	3 Social support (unspecified)[C2] 8 Feedback on behaviour[C2] 10 Self-monitoring of behaviour[C1] 68 Commitment[A1] 78 Information about health consequences[C2] None reported
O'Connor 2007 [++]	Multi-session	Face to face, one on one	Abstinence during third trimester	0.93	0.26	1.60	9 Feedback on outcome(s) of behaviour[A2] 63 Goal setting (outcome)[C2] None reported

A positive SMD represents a benefit with the intervention (i.e. favours the intervention), and a negative SMD represents a benefit with the comparator (favours comparator). A SMD of <0.2 represents a very small effect size, of ≥0.2 to <0.5 represents a small effect size, of ≥0.5 to <0.8 a medium effect size, and of ≥0.8 a large effect size.
* Intervention targeted multiple behaviour topcs

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Other drinkers

Woodall 2007 [+] included first time offenders convicted of driving while intoxicated in a trial comparing a multi-session, face to face one on one intervention delivered during 28 days of incarceration. The trial included mainly Native American participants (76%), and resulted in a small, significant effect on alcohol consumption (SMD 0.33, 95% CI 0.10 to 0.56).

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Table 15: Alcohol interventions for other drinkers

Author year	Intervention Type	Primary delivery mode	Outcome	SMD	95% CI lower	95% CI upper	Intervention BCTs Control BCTs
Woodall 2007 [+]	Multi-session	Face to face, one on one	Change in consumption over 3 months	0.33	0.10	0.56	3 Social support (unspecified)[C2] 5 Reduce negative emotions[A1] 13 Monitoring outcome of behaviour by others without feedback[A1] 63 Goal setting (outcome)[C2] 64 Action planning[C1] 79 Information about emotional consequences[C1] None reported
A positive SMD represents a benefit with the intervention (i.e. favours the intervention), and a negative SMD represents a benefit with the comparator (favours comparator). A SMD of <0.2 represents a very small effect size, of ≥0.2 to <0.5 represents a small effect size, of ≥0.5 to <0.8 a medium effect size, and of ≥0.8 a large effect size. * Intervention targeted multiple behaviour topcs							

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A overview of alcohol interventions by type, mode of delivery and population is provided in Table 16.

Table 16: Summary of alcohol interventions according to type, mode of delivery, population and significant of effect

Category	Number of interventions	Number significant	% of 50 total ALC interventions (category interventions /topic total)	% of 5 total significant ALC interventions (category significant/ topic significant)	% of category resulting in significant effect (category significant/ category total)
Intervention Type					
Brief	24	1	48.00%	20.00%	4.17%
Extended	11	0	22.00%	0.00%	0.00%
Multi-session	15	4	30.00%	80.00%	26.67%
Mode of Delivery					
Face to face, one on one	32	3	64.00%	60.00%	9.38%
Face to face, group	4	0	8.00%	0.00%	0.00%
Face to face combined	0	0	0.00%	0.00%	#DIV/0!
Face to face with remote	5	1	10.00%	20.00%	20.00%
Remote	9	1	18.00%	20.00%	11.11%
Population					
CV disease or risk	3	0	6.00%	0.00%	0.00%
Pregnant/postpartum	2	2	4.00%	40.00%	100.00%
ED or Hospital	10	0	20.00%	0.00%	0.00%
Primary care	4	1	8.00%	20.00%	25.00%
Non-primary care	5	0	10.00%	0.00%	0.00%
University	25	1	50.00%	20.00%	4.00%

4.3.5 BCT clusters

The most commonly used BCT clusters were BCT-C 1 “Social Support” (88%), BCT-C 3 “Feedback and monitoring” (76%), and BCT-C 14 “Natural

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consequences” (66%). BCT-C 4 “Associations”, BCT-C 9 “Scheduled consequences”, BCT-C 10 “Reward and threat”, BCT-C 13 “Identity”, and BCT-C 16 “Covert learning” were not used in any of the interventions.

BCT clusters used in the interventions are summarised in Table 7.

4.3.6 Intervention functions

The most commonly used intervention functions were IF9 “Enablement” (90%) and IF1 “Education” (90%). IF6 “Restriction”, and IF8 “Modelling” were not used in any of the interventions.

Interventions functions used in the interventions are summarised in Table 8.

4.3.7 Theory use

Six of the interventions included in the meta-regression were based on theories or models. These were the Social Learning Theory (O’Connor 2007 [+]), the Stages of Change (Transtheoretical) Model (Emmen 2005 [++]), Transtheoretical Model and Social Cognitive Theory (Curry 2003 [+]), the FRAMES model (Feedback, Responsibility, Advice, Menu of Options, Empathy, Self-Efficacy) (Holloway_SEE 2007 [+]), Self-efficacy Theory (Smeulders 2009 [+]), and Social Norms Marketing (Neighbors 2006 [+]).

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4.3.8 Effects of BCT clusters and intervention functions using meta-regression

Results from 50 comparisons (32 studies) could be included in the meta-regression. As shown in Figure 6, overall the studies found a small significant effect of the individual level behaviour change interventions (SMD 0.11, 95% CI 0.06 to 0.16; random effects analysis). The analysis had low levels of heterogeneity (I^2=24.7%, 95% CI 0% to 46.9%, p=0.062). There were no outliers in this analysis.

Egger's test for small study effects suggested that there was publication bias (p=0.019). This could relate in part to the exclusion of studies with small sample sizes from the review. A filled funnel plot analysis suggested that adding the hypothetical missing studies could have a small effect on the effect size, reducing it slightly but with the effect remaining significant (SMD 0.09, 95% CI 0.04 to 0.15; random effects analysis).

In adjusted univariate analysis, the following variables were found to explain some of the between study variance (see Table 17) (adjusted for presence of the BCT-C/IF in the control group if present):

- BCT-C 8 Self-belief: 32.5% of between study variance
- BCT-C 3 Feedback and monitoring: 28.3% of between study variance
- IF2 Persuasion: 13.8% of between study variance
- BCT-C 11 Goals and planning: 3.3% of between study variance
- BCT-C 5 Repetition and substitution: 1.5% of between study variance

These variables were entered in this order into the multivariate model, which was also controlled for these BCT-Cs and IFs in the comparator group and theory use in the intervention. BCT-C 5 was dropped from the model because of insufficient data, and BCT-Clusters 8 and 11 were dropped as they did not improve model fit.

The final multivariate model explained 100% of between study variance, and residual variation due to heterogeneity was reduced from 24.7% in the

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univariate analysis to 11.1% in the multivariate analysis, suggesting a good fit. Table 17 summarises the results of the multivariate meta-regression.

The presence of BCT-C 3 “Feedback and monitoring” was significantly associated with increased effectiveness of the intervention i.e. its presence had a positive effect (regression coefficient 0.12, 95% CI 0.04 to 0.21; p=0.006). The presence of Intervention function 2 “Persuasion” was significantly associated with reduced effectiveness of the intervention i.e. its presence had a negative effect (regression coefficient -0.09, 95% CI -0.17 to -0.004; p=0.04).

Results for these factors in the univariate and multivariate analysis are shown in Table 17.

Sensitivity analysis was carried out including only the studies with long-term (>6 months) post-treatment (23 comparisons; see Table 17). In this analysis, before the variables were added to the model, there was only very limited between study variance (residual I^2 =10.2%). This may make it difficult to establish the relationship between the variables and intervention effectiveness, as there is only limited between study variance to be explained by the variables being added.

The sensitivity analysis provided similar results to the primary multivariate analysis. The size of the effects of the two variables remained similar, with the association between Intervention function 2 “Persuasion” becoming just non-significant. This suggests that the effects of BCT-C 3 and IF 2 are maintained in the long term.

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Figure 6: Overall effects of individual-level behaviour change interventions on alcohol consumption behaviour

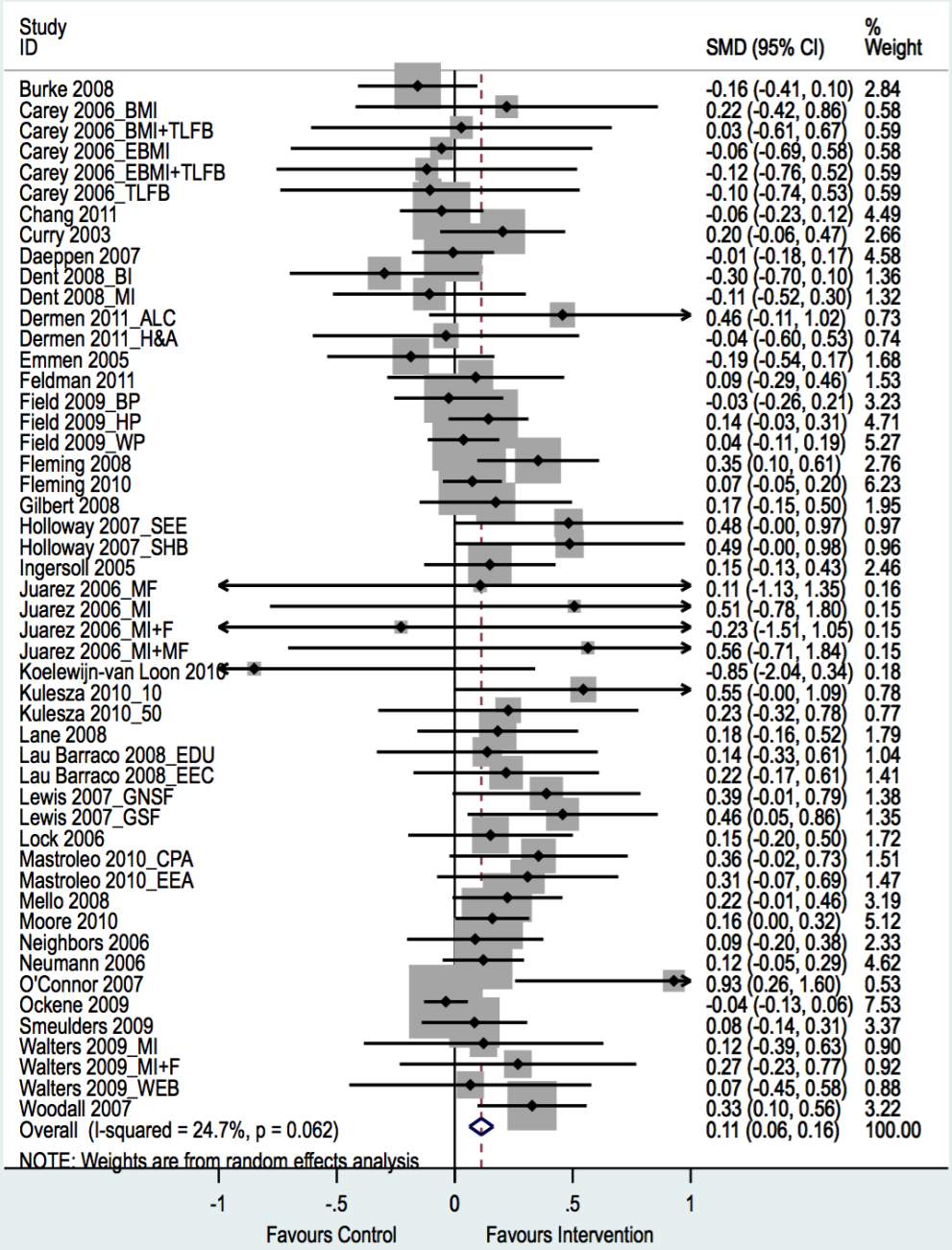

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Table 17: Meta-regression results for the effect of BCT clusters and intervention functions in individual-level interventions for alcohol

Covariate	β	95% CI	P value	Adjusted R^2
Adjusted univariate analysis				
BCT-C 8 Self-belief	-0.10	-0.21 to 0.02	0.106	32.5%
BCT-C 3 Feedback and monitoring	0.11	0.01 to 0.21	0.032	28.3%
IF2 Persuasion	-0.04	-0.14 to 0.07	0.463	13.8%
BCT-C 11 Goals and planning	-0.05	-0.15 to 0.06	0.371	3.3%
BCT-C 5 Repetition and substitution	0.11	-0.15 to 0.37	0.395	1.5%
Primary multivariate analysis				
BCT-C 5 Repetition and substitution	Removed due to insufficient data			
BCT-C 8 Self-belief	Removed as did not improve model fit			
BCT-C 11 Goals and planning				
BCT-C 3 Feedback and monitoring	0.12	0.04 to 0.21	0.006	100%
IF 2 Persuasion	-0.09	-0.17 to -0.004	0.040	
Multivariate analysis – long term follow up only (sensitivity analysis)				
BCT-C 3 Feedback and monitoring	0.11	0.01 to 0.20	0.028	100%
IF 2 Persuasion	-0.09	-0.19 to 0.003	0.056	

β = Regression coefficient; BCT-C = behaviour change technique cluster;

CI = Confidence interval; IF = intervention function

Adjusted R^2 indicates the proportion of between study variance explained by a variable(s). A positive regression coefficient indicates that the presence of the cluster or intervention function is associated with increased effectiveness of the intervention; a negative regression coefficient indicates that the presence of the cluster or intervention function is associated with decreased effectiveness of the intervention. BCT clusters and intervention functions in the comparator group and theory use were controlled for in the analysis.

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4.3.9 Evidence statements

Direction of effect across all interventions in the specified behaviour area	
A	BCT found in interventions with a positive direction of effect only (i.e. effect favours intervention)
B	BCT found in interventions with a negative direction of effect only (i.e. effect favours control)
C	BCT found in interventions with positive and negative directions of effect (i.e. inconsistent direction of effect – some favouring intervention, some favouring control)
Significance and consistency of effect across all interventions in the specified behaviour area	
1	BCT found in one intervention with a significant positive effect
2	BCT found in more than one intervention with a significant positive effect

Applicability statement

This applicability statement applies to all of the alcohol evidence statements in this review. Two trials were carried out in the UK (Lock 2006 [++, Holloway 2007 [+]). Of the remaining 30 studies, six were conducted in other European countries, three in Australia and 20 in the USA. Caution is required when interpreting findings regarding the interventions carried out in populations that may have different access to services or varying definitions of at risk, hazardous or illegal alcohol consumption.

In terms of transferability to clinical or public health practice, it should be noted that the behaviour change interventions in the randomised controlled trials in this review varied in the number of sessions provided (ranging from one to six) and the types of interventions (brief, extended and multi-session). Twenty-seven of the studies primarily delivered the intervention in a face to face manner, and remote delivery was reported in six trials. Also participants were sometimes selectively recruited based on other characteristics in addition to alcohol consumption behaviours; this includes the substance use or dependence (Feldman 2011 [++]), risky sexual behaviour (Dermen 2011 [+], Ingersoll 2005* [+]), or conviction and incarceration for driving while

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intoxicated (Woodall 2007 [+]). Caution is required when interpreting the findings of these studies.

The 32 alcohol behaviour change interventions have been grouped according to population studied in both the narrative review and the evidence statements in order to facilitate assessment of evidence applicability and generalisability. Specific attention is directed toward the 11 studies (describing 25 separate interventions) enrolling university students, all conducted in the USA, which may have reduced applicability to the UK due to the study setting, type of participants, and different legal restrictions on drinking age in the USA.

Evidence Statement 2.1 – Overall Effectiveness of alcohol behaviour change interventions, BCT clusters and intervention functions

There is strong evidence from 32 trials describing 50 interventions (Burke 2008* [+], Carey_BMI 2006 [+], Carey_BMI+TLFB 2006 [+], Carey_EBMI 2006 [+], Carey_EBMI+TLFB 2006 [+], Carey_TLFB 2006 [+], Chang 2011 [++], Curry 2003 [+], Daeppen 2007 [+], Dent_BI 2008 [++], Dent_MI 2008 [++], Dermen_ALC 2011 [+], Dermen_H&A 2011* [+], Emmen 2005 [++], Feldman 2011 [++], Field_BP 2009 [+], Field_HP 2009 [+], Field_WP 2009 [+], Fleming 2008 [++], Fleming 2010 [++], Gilbert 2008* [++]), Holloway_SEE 2007 [+], Holloway_SHB 2007 [+], Ingersoll 2005* [+], Juarez _MI 2006 [+], Juarez_MF 2006 [+], Juarez_MI+F 2006 [+], Juarez_MI+MF 2006 [+], Koelewijn-van Loon 2010* [+], Kulesza_10M 2010 [+], Kulesza_50M 2010 [+], Lane 2008 [+], Lau Barraco_EDU 2008 [+], Lau Barraco_EEC 2008 [+], Lewis_GNSF 2007 [+], Lewis_GSF 2007 [+], Lock 2006 [++], Mastroleo_CPA 2010 [+], Mastroleo_EEA 2010 [+], Mello 2008 [++], Moore 2010 [+], Neighbors 2006 [+], Neumann 2006 [++], O'Connor 2007 [+], Ockene 2009 [++], Smeulders 2009* [+], Walters_MI 2009 [++], Walters_MI+F 2009 [++], Walters_WEB 2009 [++], Woodall 2007 [+]) that individual level behaviour change interventions can have a small effect on alcohol consumption behaviour, with an effect size of 0.11 (95% CI 0.06 to 0.16).

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Meta-regression of data from these RCTs suggested that use of BCT cluster 3 – Feedback and monitoring is associated with increased effectiveness of interventions (regression coefficient 0.12, 95% CI 0.04 to 0.21; p=0.006), while intervention function 2 – Persuasion is associated with reduced effectiveness of interventions (regression coefficient -0.09, 95% CI -0.17 to -0.004; p=0.040) These two variables account for 100% of between study variance, and the effects are maintained in the long term.

Evidence Statement 2.2 – BCTs reported in interventions with a positive effect across alcohol trials

Moderate evidence from a body of 50 interventions (see Evidence Statement 2.1 for references) suggests that BCT 9 Feedback on outcome(s) of behaviour [A2] is consistently associated with a significant intervention effect in alcohol trials (reported in more than one intervention with a positive and significant direction of effect).

The following four BCTs were reported in one trial with a significant intervention effect: 5 Reduce negative emotions[A1], 11 Self-monitoring of outcome(s) of behaviour[A1], 13 Monitoring outcome(s) of behaviour by others without feedback[A1], and 68 Commitment[A1].

Three BCTs were reported only in trials that resulted in a positive direction of effect, however, the effect was non-significant: 25 Behaviour substitution[A], 39 Behavioural experiment[A], and 67 Behavioural contract[A].

Evidence Statement 2.3 – Individual BCTs reported in interventions with inconsistent effects across alcohol trials

There is inconsistent evidence from a body of 50 interventions (see Evidence Statement 2.1 for references) that the following 17 BCTs are found in trials with both positive and negative directions of effect, although the size and significance of this effect varied: 2 Social support emotional[C], 3 Social support unspecified[C2], 8 Feedback on behaviour [C2], 10 Self-monitoring of behaviour[C1],

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14 Biofeedback[C], 34 Adding objects to the environment[C], 36 Instruction on how to perform a behaviour[C], 37 Information about antecedents[C1], 40 Verbal persuasion about capability[C], 62 Behaviour goal setting[C], 63 Outcome goal setting[C2], 64 Action planning[C1], 71 Pros and cons[C], 78 Information about health consequences[C2], 79 Information about emotional consequences[C1], 80 Information about social or environmental consequences[C], and 85 Social comparison[C1]. None of the trials reporting these BCTs found significant effects favouring the comparator arms.

Evidence Statement 2.4 – Individual BCTs reported in trials with an effect favouring the comparator arms across alcohol trials

A body of 50 interventions (see Evidence Statement 2.1 for references) indicates that BCTs 1 Social support practical[B], 42 Focus on past success[B], and 61 Problem solving[B] may be linked with ineffective interventions, and only appear in trials in which behaviour is changed to a greater degree in comparator than intervention arms. While the direction of effect favoured the comparator across the trials using these three BCTs, all effects were non-significant.

Evidence Statement 2.5 – Alcohol behaviour change interventions among hospital and Emergency Department patients

Strong evidence from ten interventions described in six trials (Dent_BI 2008 [++], Field_BP 2009 [+], Field_HP 2009 [+], Field_WP 2009 [+], Daeppen 2007 [+], Holloway_SEE 2007 [+], Holloway_SHB 2007 [+], Neumann 2006 [+], Dent_MI 2008 [++], Mello 2008 [++]) suggests that alcohol interventions delivered to Emergency Department or hospital patients are no more effective than usual care at altering alcohol consumption.

This non-significant effect was across intervention type, mode of delivery, and patient characteristics. Interventions resulted in no significant difference in consumption behaviours among ED patients (Dent_BI 2008 [++] SMD -0.30,

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95% CI -0.70 to 0.10); injured ED patients (Daeppen 2007 [+] SMD -0.01, 95% CI -0.18 to 0.17; Neumann 2006 [+] SMD 0.12, 95% CI -0.05 to 0.29; Dent_MI 2008 [++] SMD -0.11, 95% CI -0.52 to 0.30; Mello 2008 [++] SMD 0.22, 95% CI -0.01 to 0.46) or hospitalised patients (Holloway_SEE 2007 [+] SMD 0.48, 95% CI -0.003 to 0.97; Holloway_SHB 2007 [+] SMD 0.49, 95% CI -0.001 to 0.98). The effect was also consistent (in terms of significance) across ethnic groups among trauma centre patients admitted for intentional or unintentional injuries (black patients: Field_BP 2009 [+] SMD -0.03, 95% CI -0.26 to 0.21, Hispanic patients: Field_HP 2009 [+] SMD 0.14, 95% CI -0.03 to 0.31, white patients: Field_WP 2009 [+] SMD 0.04, 95% CI -0.11 to 0.19).

The only BCT common to all these interventions is 3 Social support (unspecified); this technique is also reported in the comparator arm of several of the trials (Field_BP 2009 [+], Field_HP 2009 [+], Field_WP 2009 [+], Neumann 2006 [+]). No other BCTs were reported in the majority of interventions among this population.

Brief interventions

Dent_BI 2008 (RCT [++], Australia, n=177, 12 weeks)
BCTs present:
3 Social support (unspecified)[C2]
8 Feedback on behaviour[C2] (also reported in comparator)

Daeppen 2007 (RCT [+], Switzerland, n=513, 52 weeks)
BCTs present:
3 Social support (unspecified)[C2]
8 Feedback on behaviour[C2]
71 Pros and cons[C]
85 Social comparison[C1]

Field_BP 2009 (RCT [+], USA, n=288, 52 weeks)
BCTs present:
2 Social support (emotional)[C] (also reported in comparator)
3 Social support (unspecified)[C2] (also reported in comparator)
36 Instruction on how to perform a behaviour[C] (also reported in comparator)
40 Verbal persuasion about capability[C]

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71 Pros and cons[C]
80 Information about social and environmental consequences[C]

Field_HP 2009 (RCT [+], USA, n=537, 52 weeks)
BCTs present:
2 Social support (emotional)[C] (also reported in comparator)
3 Social support (unspecified)[C2] (also reported in comparator)
36 Instruction on how to perform a behaviour[C] (also reported in comparator)
40 Verbal persuasion about capability[C]
71 Pros and cons[C]
80 Information about social and environmental consequences[C]

Field_WP 2009 (RCT [+], USA, n=668 52 weeks)
BCTs present:
2 Social support (emotional)[C] (also reported in comparator)
3 Social support (unspecified)[C2] (also reported in comparator)
36 Instruction on how to perform a behaviour[C] (also reported in comparator)
40 Verbal persuasion about capability[C]
71 Pros and cons[C]
80 Information about social and environmental consequences[C]

Holloway_SEE 2007 (cRCT [+], UK, n=104, 24 weeks)
BCTs present:
3 Social support (unspecified)[C2]
9 Feedback on outcome(s) of behaviour[A2]

Holloway_SHB 2007 (cRCT [+], UK, n=102, 24 weeks)
BCTs present:
3 Social support (unspecified)[C2]
78 Information about health consequences[C2]

Neumann 2006 (RCT [++], Germany, n=660, 52 weeks)
BCTs present:
3 Social support (unspecified)[C2] (also reported in comparator)
8 Feedback on behaviour[C2]
62 Goal setting (behaviour)[C]
78 Information about health consequences[C2]

Extended intervention
Dent_MI 2008 (RCT [++], Australia, n=170, 11 weeks)
BCTs present:

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3 Social support (unspecified)[C2]
8 Feedback on behaviour[C2] (also reported in comparator)

Multi-session intervention
Mello 2008 (RCT [++], USA, n=285, 10 weeks)
BCTs present:
3 Social support (unspecified)[C2]

Evidence Statement 2.6 – Brief alcohol interventions among university students

Moderate evidence from six trials assessing eleven interventions suggests that brief alcohol interventions delivered either face to face, one on one (Carey_BMI 2006 [+], Carey_TLFB 2006 [+], Carey_BMI+TLFB 2006 [+], Carey_EBMI 2006 [+], Carey_EBMI+TLFB 2006 [+], Kulesza_10M 2010 [+]) or remotely (Juarez_MF 2006 [+], Walters_WEB 2009 [++], Neighbors 2006 [+], Lewis_GNSF 2007 [+], Lewis_GSF 2007 [+]) are no more effective than comparators at changing the drinking behaviours of university students. Among interventions delivered face to face and one on one, no significant differences in alcohol consumption were seen (SMD range: -0.12 to 0.55; all non-significant versus a no intervention comparator).

Four of the five remotely delivered interventions resulted in no significant difference in alcohol consumption (Juarez_MF 2006 [+] SMD 0.11, 95% CI -1.13 to 1.35; Neighbors 2006 [+] SMD 0.09, 95% CI -0.20 to 0.38; Lewis_GNSF 2007 [+] SMD 0.39, 95% CI -0.01 to 0.79; Walters_WEB 2009 [++] SMD 0.07, 95% CI -0.45 to 0.58). The fifth intervention, which supplied feedback on drinking behaviours tailored to the gender of the participant, resulted in a significant difference in weekly alcohol consumption (Lewis_GSF 2007 [+] SMD 0.46, 95% CI 0.05 to 0.86).

No BCTs were reported in the significant intervention (Lewis_GSF 2007 [+]) that weren't all reported in other, non-significant interventions in this population. Among the non-significant interventions, all reported use of BCT

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80 Information about social and environmental consequences; this BCT was not reported in Lewis_GSF 2007 [+]).

Face to face one on one:

Carey_BMI 2006 (RCT [+], USA, n=123, 52 weeks)
BCTs present:
3 Social support (unspecified)[C2]
8 Feedback on behaviour[C2]
14 Biofeedback[C]
63 Goal setting (outcome)[C2]
78 Information about health consequences[C2]
80 Information about social and environmental consequences[C]
85 Social comparison[C1]

Carey_TLFB 2006 (RCT [+], USA, n=131, 52 weeks)
BCTs present:
None reported

Carey_BMI+TLFB 2006 (RCT [+], USA, n=127, 52 weeks)
BCTs present:
3 Social support (unspecified)[C2]
8 Feedback on behaviour[C2]
14 Biofeedback[C]
63 Goal setting (outcome)[C2]
78 Information about health consequences[C2]
80 Information about social and environmental consequences[C]
85 Social comparison[C1]

Carey_EBMI 2006 (RCT [+], USA, n=124, 52 weeks)
BCTs present:
3 Social support (unspecified)[C2]
8 Feedback on behaviour[C2]
14 Biofeedback[C]
63 Goal setting (outcome)[C2]
71 Pros and cons[C]
78 Information about health consequences[C2]
80 Information about social and environmental consequences[C]
85 Social comparison[C1]

Carey_EBMI+TLFB 2006 (RCT [+], USA, n=127, 52 weeks)

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BCTs present:
3 Social support (unspecified)[C2]
8 Feedback on behaviour[C2]
14 Biofeedback[C]
63 Goal setting (outcome)[C2]
71 Pros and cons[C]
78 Information about health consequences[C2]
80 Information about social and environmental consequences[C]
85 Social comparison[C1]

Kulesza_10M 2010 (RCT [+], USA, n=79, 4 weeks)
BCTs present:
3 Social support (unspecified)[C2]
8 Feedback on behaviour[C2]
71 Pros and cons[C]
78 Information about health consequences[C2]
80 Information about social and environmental consequences[C]
85 Social comparison[C1]

Remotely delivered:

Juarez_MF 2006 (RCT [+], USA, n=30, 8 weeks)
BCTs present:
8 Feedback on behaviour[C2]
14 Biofeedback[C]
78 Information about health consequences[C2]
80 Information about social and environmental consequences[C]
85 Social comparison[C1]

Walters_WEB 2009 (RCT [++], USA, n=115, 24 weeks)
BCTs present:
3 Social support (unspecified)[C2]
8 Feedback on behaviour[C2]
80 Information about social and environmental consequences[C]
85 Social comparison[C1]

Neighbors 2006 (RCT [+], USA, n=185, 8 weeks)
BCTs present:
8 Feedback on behaviour[C2]
85 Social comparison[C1]

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Lewis_GNSF 2007 (RCT [+], USA, n=145, 20 weeks)
BCTs present:
8 Feedback on behaviour[C2]
85 Social comparison[C1]

Lewis_GSF 2007 (RCT [+], USA, n=142, 20 weeks)
BCTs present:
8 Feedback on behaviour[C2]
85 Social comparison[C1]

Evidence Statement 2.7 – Extended alcohol interventions among university students

Strong evidence was identified from ten interventions described in six studies that extended face to face interventions delivered one on one (Walters_MI 2009 [++], Walters_MI+F 2009 [++], Juarez _MI 2006 [+], Juarez _MI+F 2006 [+], Kulesza_50M 2010 [+], Ingersoll 2005* [+], Mastroleo_EEA 2010 [+], Mastroleo_CPA 2010 [+]) or to groups (Lau Barraco_EEC 2008 [+], Lau Barraco_EDU 2008 [+]) are no more effective than comparators at altering the drinking behaviour of university students (SMD range -0.23 to 0.51; all non-significant).

All of the interventions reported use of BCT 3 Social support (unspecified), and seven (Walters_MI+F 2009 [++], Juarez _MI 2006 [+], Juarez _MI+F 2006 [+], Kulesza_50M 2010 [+], Ingersoll 2005* [+], Mastroleo_EEA 2010 [+], Mastroleo_CPA 2010 [+]) reported use of BCT 8 Feedback on behaviour. Half of the interventions (Walters_MI+F 2009 [++], Juarez _MI 2006 [+], Juarez _MI+F 2006 [+], Kulesza_50M 2010 [+], Ingersoll 2005* [+]) reported use of BCT 80 Information about social and environmental consequences.

Walters_MI 2009 (RCT [++], USA, n=120, 24 weeks)
BCTs present:
3 Social support (unspecified)[C2]
64 Action planning[C1]

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Walters_MI+F 2009 (RCT [++], USA, n=128, 24 weeks)
BCTs present:
3 Social support (unspecified)[C2]
8 Feedback on behaviour[C2]
64 Action planning[C1]
80 Information about social and environmental consequences[C]
85 Social comparison[C1]

Juarez_MI 2006 (RCT [+], USA, n=26, 8 weeks)
BCTs present:
3 Social support (unspecified)[C2]
8 Feedback on behaviour[C2]
71 Pros and cons[C]
80 Information about social and environmental consequences[C]

Juarez_MI+F 2006 (RCT [+], USA, n=26, 8 weeks)
BCTs present:
3 Social support (unspecified)[C2]
8 Feedback on behaviour[C2]
14 Biofeedback[C]
71 Pros and cons[C]
78 Information about health consequences[C2]
80 Information about social and environmental consequences[C]
85 Social comparison[C1]

Kulesza_50M 2010 (RCT [+], USA, n=75, 4 weeks)
BCTs present:
3 Social support (unspecified)[C2]
8 Feedback on behaviour[C2]
71 Pros and cons[C]
78 Information about health consequences[C2]
80 Information about social and environmental consequences[C]
85 Social comparison[C1]

Ingersoll 2005* (RCT [+], USA, n=199, 4 weeks)
BCTs present:
3 Social support (unspecified)[C2]
8 Feedback on behaviour[C2]
62 Goal setting (behaviour)[C]

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71 Pros and cons[C]
80 Information about social and environmental consequences[C]

Mastroleo_CPA 2010 (RCT [+], USA, n=164, 10 weeks)
BCTs present:
3 Social support (unspecified)[C2]
8 Feedback on behaviour[C2]

Mastroleo_EEA 2010 (RCT [+], USA, n=156, 10 weeks)
BCTs present:
3 Social support (unspecified)[C2]
8 Feedback on behaviour[C2]

Lau Barraco_EDU 2008 (RCT [+], USA, n=103, 4 weeks)
BCTs present:
3 Social support (unspecified)[C2]

Lau Barraco_EEC 2008 (RCT [+], USA, n=178, 4 weeks)
BCTs present:
3 Social support (unspecified)[C2]
39 Behavioural experiments[A]
78 Information about health consequences[C2]
85 Social comparison[C1]

Evidence Statement 2.8 – Multi-session alcohol interventions delivered face to face and one on one among university students

Moderate evidence from three trials describing four alcohol behaviour change interventions (Dermen_ALC 2011 [+], Dermen_H&A 2011* [+], Juarez_MI+MF 2006 [+], Fleming 2010 [++]) suggests that that multi-session alcohol interventions are no more effective than comparators at altering drinking behaviour among university students.

Multi-session face to face interventions among university students with both risky alcohol consumption and sexual health behaviours resulted in non-significant effects. One intervention targeted alcohol consumption only (Dermen_ALC 2011 [+] SMD 0.46, 95% CI -0.11 to 1.02). The other

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intervention targeted both risky drinking and risky sexual behaviour (Dermen_H&A 2011* [+] SMD -0.04, 95% CI -0.60 to 0.53).

The inclusion of a remote follow-up component did not alter the effectiveness of face to face interventions. No significant effect was seen the trials that incorporated either a mailed feedback component (Juarez_MI+MF 2006 [+] SMD 0.56, 95% CI -0.71 to 1.84) or a telephone/e-mail follow-up component (Fleming 2010 [++] SMD 0.07, 95% CI -0.05 to 0.20).

All four interventions reported use of BCTs 3 Social support unspecified, and 80 Information about environmental consequences. Three of the four interventions (Dermen_ALC 2011 [+], Juarez_MI+MF 2006 [+], Fleming 2010 [++]) reported use of BCT 85 Social comparison.

Dermen_ALC 2011 (RCT [+], USA, n=71, 59 weeks)
BCTs present:
3 Social support (unspecified)[C2]
8 Feedback on behaviour[C2]
9 Feedback on outcome(s) of behaviour[A2]
25 Behaviour substitution[A]
34 Adding objects to the environment[C]
40 Verbal persuasion about capability[C]
71 Pros and cons[C]
80 Information about social and environmental consequences[C]
85 Social comparison[C1]

Dermen_H&A 2011* (RCT [+], USA, n=69, 59 weeks)
BCTs present:
3 Social support (unspecified)[C2]
8 Feedback on behaviour[C2]
34 Adding objects to the environment[C]
80 Information about social and environmental consequences[C]

Juarez_MI+MF 2006 (RCT [+], USA, n=28, 8 weeks)
BCTs present:
3 Social support (unspecified)[C2]
8 Feedback on behaviour[C2]
14 Biofeedback[C]

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71 Pros and cons[C]
78 Information about health consequences[C2]
80 Information about social and environmental consequences[C]
85 Social comparison[C1]

Fleming 2010 (RCT [++], USA and Canada, n=986, 40 weeks)
BCTs present:
3 Social support (unspecified)[C2]
10 Self-monitoring of behaviour[C1]
62 Goal setting (behaviour)[C]
64 Action planning[C1]
67 Behavioural contract[A]
78 Information about health consequences[C2]
80 Information about social and environmental consequences[C]
85 Social comparison[C1]

Evidence Statement 2.9 – Multi-session alcohol interventions among patients with or at risk for a cardiovascular condition

Moderate evidence from three trials (Koelewijn-van Loon 2010* [+], Smeulders 2009* [+], Burke 2008* [+]) suggests that multi-session, face to face interventions that target multiple risk behaviours no more effective than usual care at reducing alcohol consumption among individuals with or at risk for cardiovascular conditions.

This was seen in a one on one intervention with remote follow-up among individuals deemed eligible for cardiovascular risk management (Koelewijn-van Loon 2010* [+] SMD -0.85, 95% CI -2.04 to 0.34), as well as multi-session group interventions among individuals with congestive heart failure (Smeulders 2009* [+] SMD 0.08, 95% CI -0.14 to 0.31) and overweight, hypertensive patients at risk for cardiovascular conditions (Burke 2008* [+] SMD -0.16, 95% CI -0.41 to 0.10).

All three interventions reported use of BCT 3 Social support (unspecified), and 62 Goal setting (behaviour). Two of the trials (Koelewijn-van Loon 2010* [+], Burke 2008* [+]) reported using BCT 63 Goal setting (outcome), and two

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(Smeulders 2009* [+], Burke 2008* [+]) reported use of BCT 64 Action planning.

Koelewijn-van Loon 2010* (cRCT [+] The Netherlands, n=58, 40 weeks)
BCTs present:
3 Social support (unspecified)[C2]
34 Adding objects to the environment[C]
62 Goal setting (behaviour)[C]
63 Goal setting (outcome)[C2]
78 Information about health consequences[C2]

Smeulders 2009* (RCT [+] The Netherlands, n=317, 44 weeks)
BCTs present:
3 Social support (unspecified)[C2]
62 Goal setting (behaviour)[C]
64 Action planning[C1]

Burke 2008* (RCT [+] Australia, n=241, 156 weeks)
BCTs present:
1 Social support (practical)[B]
3 Social support (unspecified)[C2]
8 Feedback on behaviour[C2]
10 Self-monitoring of behaviour[C1]
14 Biofeedback[C] (also reported in comparator arm)
62 Goal setting (behaviour)[C]
63 Goal setting (outcome)[C2]
64 Action planning[C1]

Evidence Statement 2.10 – Alcohol interventions among at risk or heavy drinkers identified in primary care

Inconsistent evidence was identified from four trials (Ockene 2009 [++], Lock 2006 [++], Curry 2003 [+], Moore 2010 [+]) regarding the effectiveness of alcohol interventions among drinkers identified in primary care.

Two trials (Ockene 2009 [++], Lock 2006 [++]) of brief interventions delivered face to face and one on one were found to be no more effective than usual care at changing alcohol consumption among heavy- or at risk- drinkers in

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primary care (Ockene 2009 [++] SMD -0.04, 95% CI -0.13 to 0.06; Lock 2006 [++] SMD 0.15, 95% CI -0.20 to 0.50).

One multi-session intervention (Curry 2003 [+]) was no more effective than usual care at alter chronic drinking, binge drinking or drink driving behaviours (SMD 0.20, 95% CI -0.06 to 0.47). The other multi-session trial (Moore 2010 [+]) resulted in very small, significant change in weekly alcohol consumption among at risk drinkers over the age of 55 years (SMD 0.16, 95% CI 0.003 to 0.32).

The three interventions with non-significant effects (Ockene 2009 [++], Lock 2006 [++], Curry 2003 [+]) all reported use of BCT 80 80 Information about social and environmental consequences; this BCT was not reported in the significant effects intervention. The trial with a significant intervention effect (Moore 2010 [+]) reported use of several techniques that were not found in the other three interventions in this population, including BCT 9 Feedback on outcome(s) of behaviour, 11 Self-monitoring of outcome(s) of behaviour, and 37 Information about antecedents. Across the alcohol interventions, BCTs 9 and 11 were only reported in trials with positive intervention effects, although the size and significance of these effects varied.

Ockene 2009 (cRCT [++] USA, n=530, 208 weeks)
BCTs present:
3 Social support (unspecified)[C2]
42 Focus on past success[B]
61 Problem solving[B]
78 Information about health consequences[C2]
79 Information about emotional consequences[C1]
80 Information about social and environmental consequences[C]

Lock 2006 (cRCT [++] UK, n=127, 52 weeks)
BCTs present:
3 Social support (unspecified)[C2]
8 Feedback on behaviour[C2]
25 Behaviour substitution[A]
36 Instruction on how to perform a behaviour[C]

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62 Goal setting (behaviour)[C]
64 Action planning[C1]
78 Information about health consequences[C2]
80 Information about social and environmental consequences[C]
85 Social comparison[C1]

Curry 2003 (RCT [+] USA, n=307, 42 weeks)
BCTs present:
3 Social support (unspecified)[C2]
8 Feedback on behaviour[C2]
80 Information about social and environmental consequences[C]
85 Social comparison[C1]

Moore 2010 (RCT [+] USA, n=631, 44 weeks)
BCTs present:
3 Social support (unspecified)[C2]
9 Feedback on outcome(s) of behaviour[A2]
11 Self-monitoring of outcome(s) of behaviour[A1]
37 Information about antecedents[C1]
78 Information about health consequences[C2]

Evidence Statement 2.11 – Alcohol interventions among individuals recruited in non-primary care settings

Moderate evidence from five trials suggests that brief interventions (Chang 2011 [++], Lane 2008 [+], Feldman 2011 [++]) and multi-session interventions (Emmen 2005 [++], Gilbert 2008* [++]) are no more effective than comparators at changing alcohol consumption among risky drinkers in non-primary care settings.

This was seen among a diverse group of patients, including female risky drinkers recruited from a hospital outpatient clinic (Chang 2011 [++] SMD -0.06, 95% CI -0.23 to 0.12), risky drinkers presenting at a sexual health clinic (Lane 2008 [+] SMD 0.18, 95% CI -0.16 to 0.52) individuals being treated for opioid or cocaine dependence (Feldman 2011 [++] SMD 0.09, 95% CI -0.29 to

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0.46), and HIV positive adults (Emmen 2005 [++] SMD -0.19, 95% CI -0.54 to 0.17; Gilbert 2008* [++] SMD 0.17, 95% CI -0.15 to 0.50).

All five interventions reported use of BCT 3 Social support unspecified. Four of the five (Chang 2011 [++], Lane 2008 [+], Feldman 2011 [++], Emmen 2005 [++]) reported BCT 8 Feedback on behaviour, and three reported use of BCTs 62 Goal setting (behaviour), 78 Information about health consequences, and 80 Information about social and environmental consequences.

Chang 2011 (RCT [++] USA, n=491, 52 weeks)
BCTs present:
3 Social support (unspecified)[C2]
8 Feedback on behaviour[C2]
61 Problem solving[B]
62 Goal setting (behaviour)[C]
78 Information about health consequences[C2]
85 Social comparison[C1]

Lane 2008 (RCT [+] Australia, n=133, 12 weeks)
BCTs present:
3 Social support (unspecified)[C2]
8 Feedback on behaviour[C2] (also reported in comparator arm)
25 Behaviour substitution[A]
36 Instruction on how to perform a behaviour[C]
62 Goal setting (behaviour)[C]
64 Action planning[C1]
78 Information about health consequences[C2]
80 Information about social and environmental consequences[C]
85 Social comparison[C1]

Feldman 2011 (RCT [++] Switzerland, n=110, 33 weeks)
BCTs present:
3 Social support (unspecified)[C2]
8 Feedback on behaviour[C2]
62 Goal setting (behaviour)[C]
68 Commitment[A1]
80 Information about social and environmental consequences[C]

Emmen 2005 (RCT [++] The Netherlands, n=123, 24 weeks)

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BCTs present:
3 Social support (unspecified)[C2]
8 Feedback on behaviour[C2]
14 Biofeedback[C]
37 Information about antecedents[C1]
78 Information about health consequences[C2]
80 Information about social and environmental consequences[C]

Gilbert 2008 (RCT [++] Canada, n=182, 24 weeks)
BCTs present:
3 Social support (unspecified)[C2]
9 Feedback on outcome(s) of behaviour[A2]

Evidence Statement 2.12 – Multi-session face to face one on one alcohol behaviour change interventions among pregnant or postpartum women

Limited evidence from two studies (Fleming 2008 [++], O'Connor 2007 [+]) suggests that multi-session interventions delivered face to face and one on one may be effective at reducing alcohol consumption over the among postpartum high risk drinkers (Fleming 2008 [++] SMD 0.35, 95% CI 0.10 to 0.61) and at encouraging alcohol abstinence during the third trimester among low income pregnant women (O'Connor 2007 [+] SMD 0.93, 95% CI 0.26 to 1.60).

These trials did not report use of any common behaviour change techniques.

Fleming 2008 (RCT [++] USA, n=235, 16 weeks)
BCTs present:
3 Social support (unspecified)[C2]
8 Feedback on behaviour[C2]
10 Self-monitoring of behaviour[C1]
68 Commitment[A1]
78 Information about health consequences[C2]

O'Connor 2007 (cRCT [+] USA, n=125, 17 weeks)
BCTs present:
9 Feedback on outcome(s) of behaviour[A2]
63 Goal setting (outcome)[C2]

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Evidence Statement 2.13 – Multi-session face to face one on one alcohol interventions among incarcerated individuals

Limited evidence from a single trial (Woodall 2007 [+]) suggests that multi-session alcohol interventions delivered face to face one on one during incarceration may have a small, significant effect on lowering alcohol consumption amongst first time offenders convicted of driving while intoxicated (SMD 0.33, 95% CI 0.10 to 0.56).

Woodall 2007 (RCT [+] USA, n=305, 104 weeks)
BCTs present:
3 Social support (unspecified)[C2]
5 Reduce negative emotions[A1]
13 Monitoring outcome of behaviour by others without feedback[A1]
63 Goal setting (outcome)[C2]
64 Action planning[C1]
79 Information about emotional consequences[C1]

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4.4 Smoking

4.4.1 Included studies

Sixty-eight RCTs and cluster RCTs assessing individual level interventions targeting smoking behaviour met the population, intervention, comparator and outcome inclusion criteria after full text appraisal Study characteristics and results for these studies are summarised in the evidence tables in Appendix G.

Of these 68 studies, 66 provided outcome data for 80 interventions which could be converted into standardised mean differences (SMDs) for comparison across studies and use in the meta-analysis and meta-regression; 56 specifically addressed smoking alone, and 11 studies addressed smoking cessation or reduction as part of a wider lifestyle change programme (mainly in individuals with or at risk for cardiovascular conditions). The narrative review and analyses below include these 66 studies.

4.4.2 Quality Assessment

Among the 66 included studies, 23 studies had internal validity rated as very good [++], and 43 studies as good [+].The results of the quality appraisals for the individual studies are found in Evidence tables in Appendix G.

4.4.3 BCTs

The individual BCTs that occurred across 80 interventions described in the 67 smoking trials are summarised in Figure 7, along with the effectiveness of the interventions including each BCT.

The following BCTs were reported only in trials with positive intervention effects, more than one of which was significant (annotated A2 throughout the smoking sections). The significance of this effect varied across the trials (see Figure 7 for details of frequency and significance):

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- 1 Social support – practical
- 65 Review behaviour goal(s)
- 75 Framing/reframing

The following BCTs were reported only in trials with positive intervention effects, one of which was significant (annotated A1 throughout the smoking sections). The significance of this effect varied across the trials (see Figure 7 for details of frequency and significance):

- 11 Self-monitoring of outcome(s) of behaviour
- 25 Behaviour substitution
- 28 Generalisation of target behaviour
- 29 Graded tasks
- 30 Restructuring the physical environment
- 31 Restructuring the social environment
- 33 Distraction
- 40 Verbal persuasion about capability
- 41 Mental rehearsal of successful performance
- 42 Focus on past success
- 82 Monitoring of emotional consequences
- 84 Demonstration of the behaviour
- 86 Information about others' approval

The following BCTs were reported only in trials with positive intervention effects, none of which were significant (annotated A throughout the smoking sections). The significance of this effect varied across the trials (see Figure 7 for details of frequency of use):

- 2 Social support – emotional
- 14 Biofeedback
- 32 Avoidance/reducing exposure to cues for the behaviour
- 66 Review outcome goals
- 69 Discrepancy between current behaviour and goal
- 71 Pros and cons
- 72 Comparative imaginings of future outcomes
- 79 Information about emotional consequences
- 89 Vicarious consequences

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The following BCTs were reported in trials with inconsistent directions of effect; however, more than one of interventions had a positive, significant effect (annotated C2 throughout the smoking sections). See Figure 7 for details of frequency and significance:

- 3 Social support - unspecified
- 4 Pharmacological support
- 5 Reduce negative emotions
- 23 Behaviour practice/rehearsal
- 34 Adding objects to the environment
- 36 Instruction on how to perform a behaviour
- 61 Problem solving
- 62 Goal setting - behaviour
- 63 Goal setting - outcome
- 64 Action planning
- 68 Commitment
- 70 Persuasive source
- 78 Information about health consequences

The following BCTs were reported in trials with inconsistent directions of effect; however, one of interventions had a positive, significant effect (annotated C1 throughout the smoking sections). See Figure 7 for details of frequency and significance:

- 9 Feedback on outcome(s) of behaviour
- 10 Self-monitoring of behaviour
- 35 Body changes
- 56 Social reward
- 80 Information about social and environmental consequences

The following BCTs were reported in trials with inconsistent directions of effect; none of the interventions had a significant effect (annotated C throughout the smoking sections). See Figure 7 for details of frequency of use:

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- 8 Feedback on behaviour
- 37 Information about antecedents
- 59 Future punishment
- 76 Incompatible beliefs
- 85 Social comparison

The following BCT was reported in a single trial with a negative, non-significant effect intervention effect (annotated B throughout the smoking sections):

- 6 Conserving mental resources
- 50 Reward incompatible behaviour

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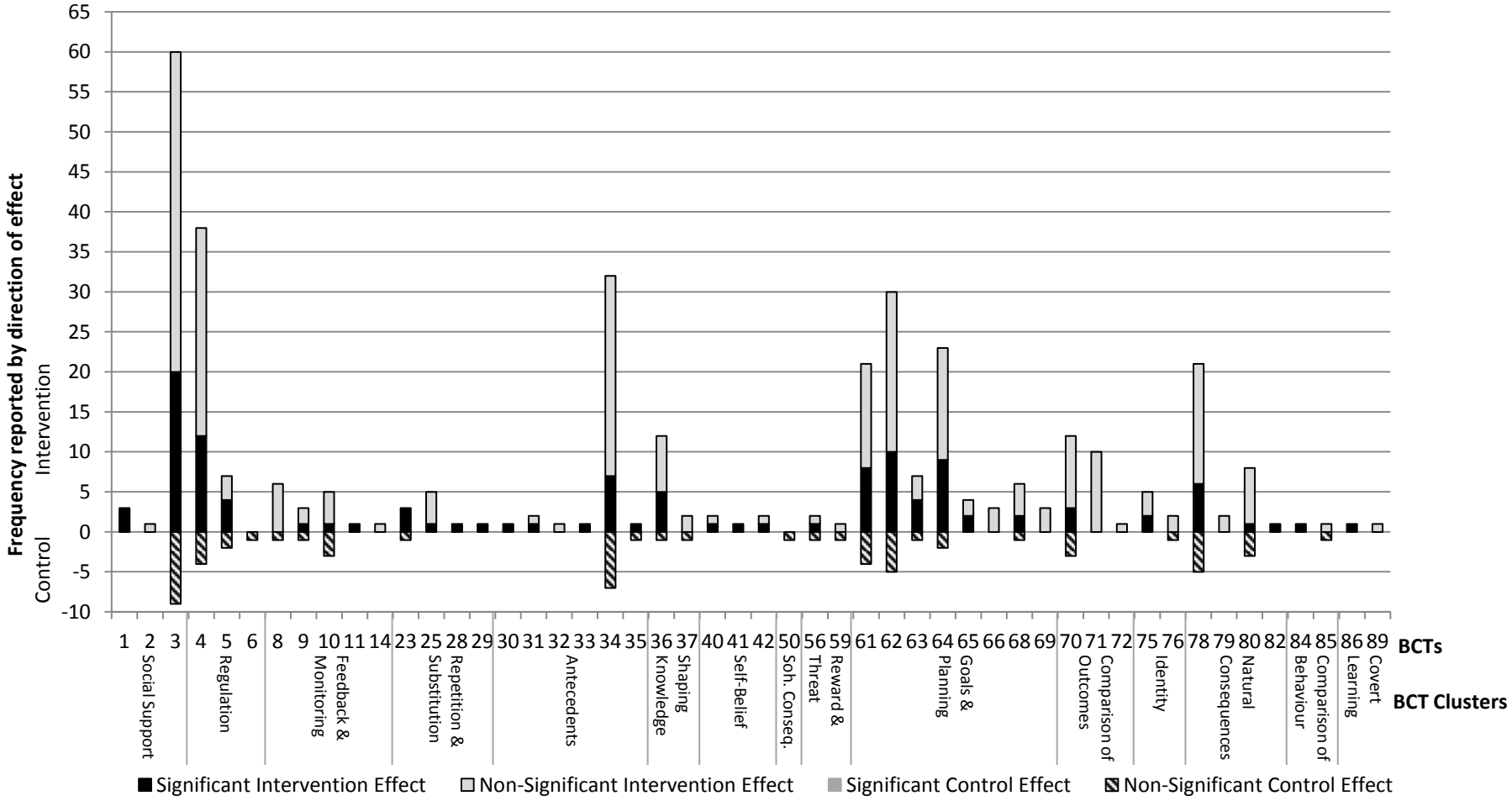
Figure 7: Distribution of BCTs in smoking trials; with direction and significance of effect



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4.4.4 Variation of effects across population groups

Tables 18 to 24 summarise the intervention type, mode of delivery, and effect size and significance, for behaviour change interventions for individuals with or at risk for cardiovascular conditions and individuals with COPD; hospital patients, pregnant women and other smokers. These tables in combination with Figure 7 were used to assess the effects of the interventions in different population subgroups and develop evidence statements relating to these effects.

Individuals with or at risk for cardiovascular conditions or COPD

Twenty-one interventions described in 18 trials (Chouinard 2005 [++], Muniz 2010* [+], Giannuzzi 2008* [+], Harting 2006* [+], Joseph 2008 [+], Hyman 2007* [++], Bock 2008 [+], Hilberink 2011 [+], Kotz 2009 [++], Koelewijn-van Loon 2010* [+], Groenveld 2011* [+], Sivarajan Froelicher 2004 [+], Wood 2008* [++], Vestfold Heartcare Study Group [VHSG] 2003 [++]*, Anthonisen 2005 [+], Mohiuddin 2007 [+], Smeulders 2009* [+], Vale 2003* [++]) assessed the effect of behaviour change interventions on smoking behaviour among individuals with COPD or people with or at risk for cardiovascular conditions. Three of these trials (Chouinard 2005 [++], Hyman 2007* [++], Kotz 2009 [++]) included two interventions.

Overall, there is strong evidence that smoking interventions delivered over multiple sessions to both groups and individuals (within one intervention) are effective at improving abstinence among individuals with cardiovascular conditions or previously undiagnosed mild or moderate airway obstruction. Additionally, strong evidence suggests that multi-session interventions delivered face to face with remote follow-up components are no more effective than usual care at encouraging cessation among smokers with or at risk for CVD or COPD.

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The evidence for other types of interventions and modes of delivery (extended face to face interventions, multi-session face to face and one on one interventions, multi-session group interventions, and multi-session remotely delivered interventions) is limited and/or inconsistent.

Figure 8 presents the frequency of use for each reported behaviour change technique across smoking interventions among individuals with or at risk for CV conditions or COPD. The x-axis is identical to that of Figure 7 to allow for comparison of reported BCTs in this population vs. smoking interventions more generally; if a BCT was reported in any smoking trial but not in the trials relevant to this population there is a gap for that BCT in Figure 8.

Extended, face to face one on one interventions

One trial (Chouinard_IC 2005 [++]) provided an extended inpatient counselling intervention delivered face to face on an individual level to smokers hospitalised with CVD. The intervention resulted in a small, non-significant effect on smoking abstinence sustained for 4 months among hospitalised CVD patients (SMD 0.44, 95% CI -0.32 to 1.20).

Multi-session, face to face one on one interventions

Two trials (Muniz 2010* [+], Giannuzzi 2008* [+]) assessed the effect of multi-session interventions delivered face to face on smoking abstinence among patients recently hospitalised for acute coronary syndrome (ACS) or myocardial infarction (MI), respectively. Muniz 2010* [+] resulted in a very small, non-significant increase in abstinence (SMD 0.12, 95% CI -0.12 to 0.36), while the intervention reported in Giannuzzi 2008* [+] resulted in a very small, significant increase in abstinence compared to the control arm after the end of the intervention (SMD 0.16, 95% CI 0.02 to 0.30).

Multi-session group interventions

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One trial (Smeulders 2009* [+]) assessed a multi-session group smoking cessation intervention among congestive heart failure patients. The trial resulted in a very small, non-significant negative effect, with intervention participants reporting smoking more cigarettes per day at follow-up than control group participants (SMD -0.01, 95% CI -0.23 to 0.21).

Multi-session interventions delivered at the individual and group level (both delivery methods present in each intervention)

Four trials (Wood 2008* [++], Vestfold Heartcare Study Group [VHSG] 2003* [++], Anthonisen 2005 [+], Mohiuddin 2007 [+]) assessed the impact of multi-session interventions delivered at both an individual and group level face to face delivered on smoking abstinence. Two of the trials (Wood 2008* [++], VHSG 2003* [++]) assessed point abstinence; Wood 2008* [++] included patients hospitalised with coronary heart disease and patients identified as at risk in GP surgeries, while VHSG 2003* [++] assessed point abstinence at the end of the two year intervention among patients hospitalised for a coronary artery bypass graft (CABG), acute myocardial infarction or unstable angina, or patients undergoing percutaneous coronary intervention (PCI) on an outpatient basis. Both trials found that the behavioural intervention had a significant effect abstinence, with Wood 2008 [++] resulting in small effect (SMD 0.24, 95% 0.05 to 0.43) and VHSG 2003* [++] resulting in a medium significant effect (SMD 0.53, 95% CI 0.03 to 1.03). Both trials reported use of BCTs 3 Social support (unspecified) and 61 Problem solving, while neither reported use of BCTs in the usual care arm.

The remaining two trials (Anthonisen 2005 [+], Mohiuddin 2007 [+]) assessed the impact of multi-session interventions delivered to individuals and groups on sustained smoking abstinence over a period of follow-up points. Anthonisen 2005 [+] included smokers with mild to moderate airway obstruction, while Mohiuddin 2007 [+] looked at sustained smoking abstinence for 3 months among hospitalised smokers with a diagnosis of acute coronary syndrome (ACS) or decompensated heart failure. Both trials resulted in large

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significant intervention effect (Anthonisen 2005 [+] SMD 0.87, 95% CI 0.76 to 0.99; Mohiuddin 2007 [+] SMD 0.89, 95% CI 0.45 to 1.32). Both trials reported use of BCTs 3 Social support (unspecified), 4 Pharmacological support, and 34 Adding objects to the environment; BCTs 3 Social support (unspecified) and 34 Adding objects to the environment were also reported in the usual care arm of Mohiuddin 2007 [+].

Multi session, face to face interventions with remote follow-up

Twelve interventions (Harting 2006* [+], Sivarajan Froelicher 2004 [+], Joseph 2008 [+], Hyman_Sic 2007* [++], Hyman_Sec 2007* [++], Bock 2008 [+], Koelewijn-van Loon 2010* [+], Hilberink 2011 [+], Kotz_CC+Nort 2009 [++], Kotz_HE+Nort 2009 [++], Chouinard_IC+FU 2005 [++], Groenveld 2011* [+]) assessed the effect of face to face, one on one interventions with remote follow-up on smoking and abstinence/cessation among individuals with or at risk for cardiovascular conditions or COPD.

One trial (Harting 2006* [+]) resulted in a small, significant intervention effect among patients at high risk for a cardiovascular event (SMD 0.31, 95% CI 0.01 to 0.61). This trial reported the use of BCTs 3 Social support (unspecified), 4 Pharmacological support, 62 Goal setting (behaviour) and 64 Action planning. All four of these BCTs were reported in other trials in this subgroup, which resulted in no significant effect.

Nine interventions (Joseph 2008 [+], Hyman_Sic 2007* [++], Hyman_Sec 2007* [++], Bock 2008 [+], Hilberink 2011 [+], Kotz_CC+Nort 2009 [++], Kotz_HE+Nort 2009 [++], Chouinard_IC+FU 2005 [++], Groenveld 2011* [+]) resulted in positive, non-significant intervention effects. These effect sizes ranged from very small among and male construction workers with elevated CVD risk (Groenveld 2011* [+] SMD 0.12, 95% CI -0.26 to 0.51) to small among smokers with COPD (Hilberink 2011 [+] SMD 0.46, 95% CI -0.06 to 0.98). Other patients enrolled in these trials included patients with heart disease (Joseph 2008 [+]), African American smokers with hypertension

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(Hyman_Sic 2007* [++], Hyman_Sec 2007* [++]), smokers presenting to the emergency department for chest pain who were admitted to the hospital for observation (Bock 2008 [+]), smokers with mild to moderate airflow limitation (Kotz_CC+Nort 2009 [++], Kotz_HE+Nort 2009 [++]), and smokers hospitalised with CVD (Chouinard_IC+FU 2005 [++]).

Two trials (Sivarajan Froelicher 2004 [+], Koelewijn-van Loon 2010* [+]) found a non-significant effect , with patients in the intervention group more likely to smoke/less likely to have quit compared to patients receiving usual care. These effects ranged in size from very small among female smokers hospitalised with CVD or peripheral vascular disease (Sivarajan Froelicher 2004 [+] SMD -0.0002, 95% CI -0.29 to 0.29) to medium among patients eligible for cardiovascular risk management (Koelewijn-van Loon 2010* [+] SMD -0.63, 95% CI -1.58 to 0.32). All of the behaviour change techniques reported in these trials were also reported in at least one other multi-session, face to face intervention with remote follow-up.

Multi-session remote interventions

One trial (Vale 2003* [++]) assessed the effectiveness of multiple telephone counselling sessions on smoking behaviours among patients hospitalised for CABG, PCI, acute MI or unstable angina, or coronary angiography with planned revascularisation. The trial resulted in a very small, non-significant effect on abstinence six weeks after the end of the intervention (SMD 0.17, 95% CI -0.13 to 0.48).

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Table 18: Smoking interventions for individuals with or at risk for cardiovascular conditions or with COPD

Author year	Intervention Type	Primary delivery mode	Outcome	SMD	95% CI lower	95% CI upper	Intervention BCTs Control BCTs
Chouinard_IC 2005 [++]	Extended	Face to face one on one	Sustained abstinence for 4 months	0.44	-0.32	1.20	3 Social support (unspecified)[C2] 4 Pharmacological support[C2] 34 Adding objects to the environment[C2] 61 Problem solving[C2] 71 Pros and cons[A] None reported
Muniz 2010* [+]	Multi-session	Face to face one on one	Abstinence	0.12	-0.12	0.36	3 Social support (unspecified)[C2] 34 Adding objects to the environment[C2] 65 Review behaviour goal[A2] 68 Commitment[C2] 70 Persuasive source[C2] 80 Information about social and environmental consequences[C1] None reported
Giannuzzi 2008* [+]	Multi-session	Face to face one on one	Abstinence	0.16	0.02	0.30	1 Social support (practical) [A2] 3 Social support (unspecified)[C2] 23 Behavioural practice/ rehearsal[C2] 34 Adding objects to the environment[C2] 36 Instruction on how to perform a behaviour[C2] 62 Goal setting (behaviour)[C2] 63 Goal setting (outcome) [C2] 64 Action planning[C2] 68 Commitment[C2] 70 Persuasive source[C2] None reported
Smeulders 2009* [+]	Multi-session	Face to face group (remote follow-up with coparticipants)	Cigarettes per day	-0.01	-0.23	0.21	3 Social support (unspecified) [C2] 62 Goal setting (behaviour)[C2] 64 Action planning[C2] None reported

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Author year	Intervention Type	Primary delivery mode	Outcome	SMD	95% CI lower	95% CI upper	Intervention BCTs Control BCTs
Wood 2008* [++]	Multi-session	Face to face, individual and group	Abstinence	0.24	0.05	0.43	3 Social support (unspecified) [C2] 28 Generalisation of a target behaviour[A1] 34 Adding objects to the environment[C2] 61 Problem solving[C2] 62 Goal setting (behaviour)[C2] 63 Goal setting (outcome) [C2] 64 Action planning[C2] 65 Review behaviour goal[A2] None reported
VHSG 2003* [++]	Multi-session	Face to face, individual and group	Abstinence at end of intervention	0.53	0.03	1.03	1 Social support (practical)[A2] 3 Social support (unspecified)[C2] 5 Reduce negative emotions[C2] 10 Self-monitoring of behaviour[C1] 23 Behavioural practice/ rehearsal[C2] 35 Body changes[C1] 36 Instruction on how to perform a behaviour[C2] 61 Problem solving[C2] 84 Demonstration of the behaviour[A1] None reported
Anthonisen 2005 [+]	Multi-session	Face to face, individual and group	Sustained abstinence for 4 years	0.87	0.76	0.99	3 Social support (unspecified)[C2] 4 Pharmacological support[C2] 34 Adding objects to the environment[C2] 78 Information about health consequences[C2] 78 Information about health consequences[C2]
Mohiuddin 2007 [+]	Multi-session	Face to face group or individual (secondary)	Sustained abstinence for 3 months	0.89	0.45	1.32	3 Social support (unspecified)[C2] 4 Pharmacological support[C2] 5 Reduce negative emotions[C2] 34 Adding objects to the environment[C2] 36 Instruction on how to perform a behaviour[C2]

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Author year	Intervention Type	Primary delivery mode	Outcome	SMD	95% CI lower	95% CI upper	Intervention BCTs Control BCTs
							3 Social support (unspecified) [C2] 34 Adding objects to the environment[C2]
Harting 2006* [+]	Multi-session	Face to face with remote follow up	Smoking	0.31	0.01	0.61	3 Social support (unspecified)[C2] 4 Pharmacological support[C2] 62 Goal setting (behaviour)[C2] 64 Action planning[C2] None reported
Joseph 2008 [+]	Multi-session	Face to face with remote follow up	Abstinence	0.01	-0.55	0.58	3 Social support (unspecified) [C2] 4 Pharmacological support[C2] 25 Behaviour substitution[A1] 62 Goal setting (behaviour)[C2] 64 Action planning[C2] 3 Social support (unspecified) [C2]
Hyman_Sic 2007* [++]	Multi-session	Face to face with remote follow up	Smoking	0.45	-0.20	1.10	3 Social support (unspecified) [C2] 4 Pharmacological support[C2] 8 Feedback on behaviour[C] 34 Adding objects to the environment[C2] 36 Instruction on how to perform a behaviour[C2] 62 Goal setting (behaviour) [C2] 69 Discrepancy between current behaviour and goal[A] None reported
Hyman_Sec 2007* [++]	Multi-session	Face to face with remote follow up	Smoking	0.32	-0.33	0.98	3 Social support (unspecified)[C2] 4 Pharmacological support[C2] 8 Feedback on behaviour[C] 34 Adding objects to the environment[C2] 36 Instruction on how to perform a behaviour[C2] 62 Goal setting (behaviour)[C2] 69 Discrepancy between current behaviour and goal[A] None reported

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Author year	Intervention Type	Primary delivery mode	Outcome	SMD	95% CI lower	95% CI upper	Intervention BCTs Control BCTs
Bock 2008 [+]	Multi-session	Face to face with remote (phone) follow up	Abstinence	0.10	-0.22	0.41	3 Social support (unspecified)[C2] 4 Pharmacological support[C2] 34 Adding objects to the environment[C2] 36 Instruction on how to perform a behaviour[C2] 62 Goal setting (behaviour)[C2] 64 Action planning[C2] 71 Pros and cons[A] 3 Social support (unspecified)[C2] 4 Pharmacological support[C2] 34 Adding objects to the environment[C2] 36 Instruction on how to perform a behaviour[C2] 62 Goal setting (behaviour)[C2]
Hilberink 2011 [+]	Multi-session	Face to face with remote follow up	Abstinence	0.46	-0.06	0.98	3 Social support (unspecified)[C2] 4 Pharmacological support[C2] None reported
Kotz_CC+Nort 2009 [++]	Multi-session	Face to face with remote follow up	Sustained abstinence for 11 months	0.39	-0.41	1.19	3 Social support (unspecified) [C2] 4 Pharmacological support[C2] 10 Self-monitoring of behaviour[C1] 14 Biofeedback[A] 34 Adding objects to the environment[C2] 71 Pros and cons[A] 76 Incompatible beliefs[C] 78 Information about health consequences[C2] None reported
Kotz_HE+Nort 2009 [++]	Multi-session	Face to face with remote follow up	Sustained abstinence for 11 months	0.41	-0.39	1.21	3 Social support (unspecified)[C2] 4 Pharmacological support[C2] 34 Adding objects to the environment[C2] 71 Pros and cons[A] None reported

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Author year	Intervention Type	Primary delivery mode	Outcome	SMD	95% CI lower	95% CI upper	Intervention BCTs Control BCTs
Chouinard_IC+ FU 2005 [++]	Multi-session	Face to face with remote follow up	Sustained abstinence for 4 months	0.44	-0.32	1.2	3 Social support (unspecified) [C2] 4 Pharmacological support[C2] 34 Adding objects to the environment[C2] 61 Problem solving[C2] 71 Pros and cons[A] None reported
Koelewijn-van Loon 2010* [+]	Multi-session	Face to face with remote follow up	Smoking	-0.63	-1.58	0.32	3 Social support (unspecified)[C2] 10 Self-monitoring of behaviour[C1] 34 Adding objects to the environment[C2] 62 Goal setting (behaviour) [C2] 63 Goal setting (outcome)[C2] 78 Information about health consequences[C2] 34 Adding objects to the environment[C2]
Groenveld 2011* [+]	Multi-session	Face to face with remote follow up	Abstinence	0.12	-0.26	0.51	3 Social support (unspecified) [C2] 63 Goal setting (outcome) [C2] 64 Action planning[C2] 71 Pros and cons[A] None reported
Sivarajan Froelicher 2004 [+]	Multi-session	Face to face with remote follow up	Abstinence	-0.0002	-0.29	0.29	3 Social support (unspecified) [C2] 4 Pharmacological support[C2] 5 Reduce negative emotions[C2] 6 Conserving mental resources[B] 8 Feedback on behaviour[C] 10 Self-monitoring of behaviour[C1] 23 Behavioural practice/ rehearsal[C2] 34 Adding objects to the environment[C2] 35 Body changes[C1] 36 Instruction on how to perform a behaviour[C2] 37 Information about antecedents[C] 56 Social reward[C1]

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Author year	Intervention Type	Primary delivery mode	Outcome	SMD	95% CI lower	95% CI upper	Intervention BCTs Control BCTs
							59 Future punishment[C] 61 Problem solving[C2] 68 Commitment[C2] 70 Persuasive source[C2] 78 Information about health consequences[C2] 80 Information about social and environmental consequences[C1] 3 Social support (unspecified) [C2] 34 Adding objects to the environment[C2] 70 Persuasive source[C2]
Vale 2003* [++]	Multi-session	Remote (phone)	Abstinence	0.17	-0.13	0.48	36 Instruction on how to perform a behaviour[C2] 61 Problem solving[C2] 63 Goal setting (outcome)[C2] 66 Review outcome goal[A] 72 Comparative imagining of future outcomes[A] 78 Information about health consequences[C2] None reported

A positive SMD represents a benefit with the intervention (i.e. favours the intervention), and a negative SMD represents a benefit with the comparator (favours comparator). A SMD of <0.2 represents a very small effect size, of ≥0.2 to <0.5 represents a small effect size, of ≥0.5 to <0.8 a medium effect size, and of ≥0.8 a large effect size.
* Intervention targeted multiple behaviour topcs

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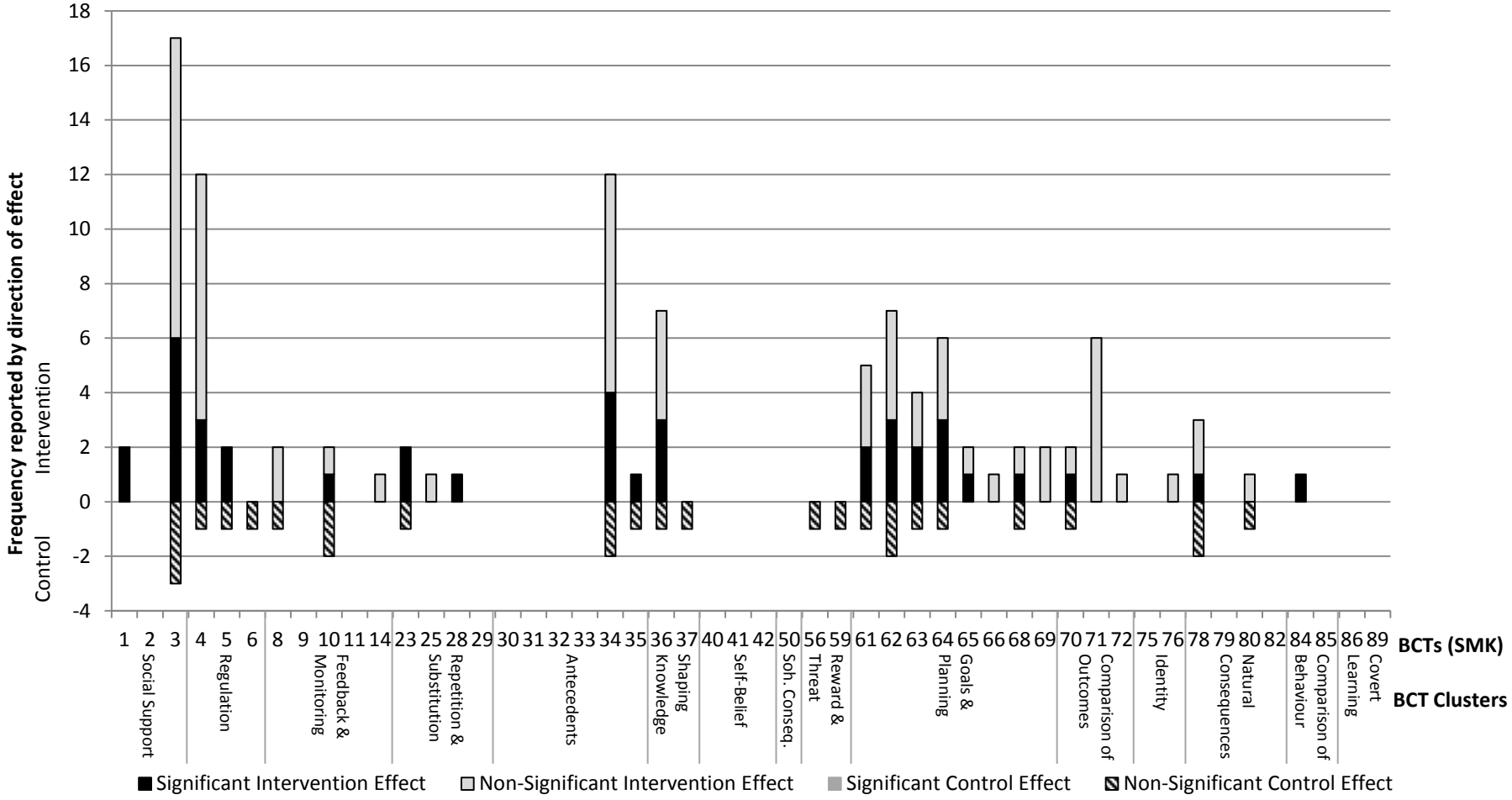
Figure 8: Distribution of BCTs in smoking trials among individuals with or at risk for COPD or CV conditions; with direction and significance of effect



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Emergency Department or hospitalised patients

Nine interventions (Molyneux_Cou 2003 [+], Molyneux_Cou+NRT 2003 [+], Lacasse 2008 [+], Thomsen 2010 [+], Sadr Azodi 2009 [++], Bernstein 2011 [++], Neuner 2009 [+], Ratner 2004 [++], Glasgow 2009 [+]) described in eight trials assessed smoking cessation trials for smokers presenting to the Emergency Department or hospitalised for non cardiovascular conditions.

Overall, the evidence suggests that opportunistic smoking interventions for Emergency Department or hospital patients are no more effective than usual care at improving abstinence, regardless of type or mode of delivery.

Brief, face to face interventions

Three interventions (Molyneux_Cou 2003 [+], Molyneux_Cou+NRT 2003 [+], Lacasse 2008 [+]) provided brief, face to face counselling or education to hospitalised smokers, and assessed the impact compared to usual care.

The brief, face to face interventions were no more effective than usual care at altering smoking behaviour. Two interventions (Molyneux_Cou 2003 [+], Lacasse 2008 [+]) resulted in a negative, non-significant effect on sustained abstinence (Molyneux_Cou 2003 [+], SMD -0.32, 95% CI -1.19 to 0.55) and point abstinence (Lacasse 2008 [+] SMD -0.10, 95% CI -0.51 to 0.32). The counselling and NRT intervention described in Molyneux_Cou+NRT 2003 [+] resulted in a small, non-significant effect (SMD 0.22, 95% CI -0.47 to 0.92). All three trials reported use of BCT 3 Social Support (unspecified), and both Molyneux_Cou+NRT 2003 [+] and Lacasse 2008 [+] reported use of BCT 4 Pharmacological support.

Extended, face to face interventions for surgical patients

One trial (Thomsen 2010 [+]) assessed the effect of an extended intervention, delivered face to face and one on one, on smoking abstinence compared to usual care among patients undergoing surgical cancer treatment. The

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intervention resulted in a small non-significant effect on abstinence (SMD 0.24, 95% CI -0.43 to 0.91).

Multi-session, face to face interventions with remote follow-up for ED or surgery patients

Four trials (Sadr Azodi 2009 [++], Bernstein 2011 [++], Neuner 2009 [+], Ratner 2004 [++]) assessed the effect of face to face interventions initially delivered in hospital or the Emergency Department, with telephone follow-up.

Overall, these interventions were no more effective than usual care at changing smoking behaviour. All four interventions reported use of BCTs 3 Social support (unspecified) and 4 Pharmacological support.

Sadr Azodi 2009 [++] provided multiple perioperative counselling sessions for surgical patients, either in person or over the phone. The intervention resulted in a medium, non-significant effect (SMD 0.51, 95% CI -0.06 to 1.07).

Two trials (Bernstein 2011 [++], Neuner 2009 [+]) assessed the effect of face to face counselling with telephone follow-up on abstinence among smokers presenting in the Emergency Department. The two interventions resulted in very small, non-significant effects (Bernstein 2011 [++] SMD 0.14, 95% CI -0.21 to 0.50; Neuner 2009 [+] SMD 0.15, 95% CI -0.05 to 0.35) compared to usual care.

Ratner 2004 [++] provided multi-session smoking cessation counselling and NRT for surgical patients, delivered face to face and over the telephone. The intervention resulted in a very small, negative and non-significant effect (SMD -0.05, 95% CI -0.41 to 0.321).

Multi-session remotely delivered interventions for surgical patients

One study (Glasgow 2009 [+]) examined a multi-session intervention delivered over the phone and in print among surgical patients. Compared to

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usual care, the intervention resulted in a small, non-significant effect on abstinence at six months follow-up (SMD 0.23, 95% CI -0.30 to 0.77).

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Table 19: Smoking interventions for Emergency Department or hospitalised patients

Author year	Intervention Type	Primary delivery mode	Outcome	SMD	95% CI lower	95% CI upper	Intervention BCTs Control BCTs
Molyneux_Cou 2003 [+]	Brief	Face to face one on one	Sustained abstinence for 1 year	-0.32	-1.19	0.55	3 Social support (unspecified)[C2] None reported
Molyneux_Cou+ NRT 2003 [+]	Brief	Face to face one on one	Sustained abstinence for 1 year	0.22	-0.47	0.92	3 Social support (unspecified)[C2] 4 Pharmacological support [C2] None reported
Lacasse 2008 [+]	Brief (follow-up session possible but not necessary)	Face to face one on one	Abstinence	-0.10	-0.51	0.32	3 Social support (unspecified)[C2] 4 Pharmacological support[C2] 10 Self-monitoring of behaviour [C1] 50 Reward incompatible behaviour [B] 61 Problem solving[C2] 70 Persuasive source[C2] None reported
Thomsen 2010 [+]	Extended	Face to face one on one	Abstinence	0.24	-0.43	0.91	3 Social support (unspecified)[C2] 4 Pharmacological support[C2] 62 Goal setting (behaviour)[C2] 64 Action planning[C2] 78 Information about health consequences[C2]
Sadr Azodi 2009 [++]	Multi-session	Face to face or remote (phone)	Abstinence	0.51	-0.06	1.07	3 Social support (unspecified)[C2] 4 Pharmacological support[C2] 34 Adding objects to the environment[C2] 62 Goal setting (behaviour)[C2] 64 Action planning[C2] None reported
Bernstein 2011 [++]	Multi-session	Face to face with remote (phone) follow up	Abstinence	0.14	-0.21	0.50	3 Social support (unspecified)[C2] 4 Pharmacological support[C2] 9 Feedback on outcome of behaviour[C1] 34 Adding objects to the environment[C2]

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Author year	Intervention Type	Primary delivery mode	Outcome	SMD	95% CI lower	95% CI upper	Intervention BCTs Control BCTs
							78 Information about health consequences[C2] 3 Social support (unspecified)[C2] 34 Adding objects to the environment[C2] 78 Information about health consequences[C2]
Neuner 2009 [+]	Multi-session	Face to face with remote (phone) follow up	Abstinence	0.15	-0.05	0.35	3 Social support (unspecified)[C2] 4 Pharmacological support[C2] 40 Verbal persuasion about capability[A1] 42 Focus on past success[A1] 62 Goal setting (behaviour)[C2] 64 Action planning[C2] None reported
Ratner 2004 [++]	Multi-session	Face to face with remote (phone) follow up	Abstinence	-0.05	-0.41	0.32	3 Social support (unspecified)[C2] 4 Pharmacological support[C2] 5 Reduce negative emotions[C2] 34 Adding objects to the environment[C2] 61 Problem solving[C2] 62 Goal setting (behaviour)[C2] 64 Action planning[C2] 78 Information about health consequences[C2] None reported
Glasgow 2009 [+]	Multi-session	Remote (phone and print)	Abstinence	0.23	-0.30	0.77	3 Social support (unspecified)[C2] 32 Avoidance/reducing exposure to cues for the behaviour[A] 61 Problem solving[C2] 62 Goal setting (behaviour)[C2] 64 Action planning[C2] 66 Review outcome goal[A] None reported
A positive SMD represents a benefit with the intervention (i.e. favours the intervention), and a negative SMD represents a benefit with the comparator (favours comparator). A SMD of <0.2 represents a very small effect size, of ≥0.2 to <0.5 represents a small effect size, of ≥0.5 to <0.8 a medium effect size, and of ≥0.8 a large effect size.							

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Pregnant or postpartum women

Nineteen interventions (Ondersma_CM-Lite 2012 [++], Ondersma_CD-5As+CM-Lite 2012 [++], Ondersma_CD-5As 2012 [++], Stotts_USF 2009 [+], Ruger_CS 2008 [++], Malchodi 2003 [+], Tappin 2005 [++], Hovell 2009 [+], Ruger_RQ 2008 [++], de Vries 2006 [+], Pbert 2004 [+], El-Mohandes 2011 [+], McBride_WOI 2004 [++], McBride_PAI 2004 [++], Stotts_MI+USF 2009 [+], Dornelas 2006 [+], Lawrence_SHM+ICI 2003 [+], Lawrence_SHM 2003 [+], Rigotti 2006 [+]) assessed the effect of smoking interventions among pregnant or postpartum women, or mothers with young children.

Overall, the evidence suggests that multi-session interventions delivered face to face and remotely no more effective than usual care at aiding pregnant women to quit smoking.

Limited evidence suggests that brief remotely delivered interventions, extended face to face interventions, and multi-session remotely delivered interventions are no more effective than usual care at changing smoking behaviour in this population.

There was inconsistent evidence regarding the effectiveness of multi-session interventions delivered face to face and one on one among pregnant smokers; while the majority of the trials (five of eight) resulted in non-significant differences in smoking behaviour between the intervention and comparators groups, three studies did result in a significant effect. The majority of studies (six of eight) in this intervention group specifically enrolled low-income pregnant smokers. The evidence in this subpopulation remained inconsistent in terms of significance of the effect.

There were inconsistent effects seen across the ten interventions, described in seven trials, that specifically recruited either low income women or women from areas of severe deprivation/poverty (Ondersma_CM-Lite 2012 [++], Ondersma_CD-5As+CM-Lite 2012 [++], Ondersma_CD-5As 2012 [++],

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Ruger_CS 2008 [++], Ruger_RQ 2008 [++], Pbert 2004 [+], Tappin 2005 [++], Hovell 2009 [+], El-Mohandes 2011 [+], Dornelas 2006 [+]).

Figure 9 presents the frequency of use for each reported behaviour change technique across smoking interventions among pregnant and postpartum. The x-axis is identical to that of Figure 7 to allow for comparison of reported BCTs in this population vs. smoking interventions more generally; if a BCT was reported in any smoking trial but not in the trials relevant to this population there is a gap for that BCT in Figure 9.

Brief interventions delivered remotely

Three interventions (Ondersma_CM-Lite 2012 [++], Ondersma_CD-5As+CM-Lite 2012 [++], Ondersma_CD-5As 2012 [++]) described in one trial assessed the effect of brief, interactive computer interventions compared to usual care on abstinence during pregnancy; participants in this trial were almost exclusively low-income Black women, and were recruited from an urban setting (Detroit, USA). Ondersma_CM-Lite 2012 [++] utilised a contingency management approach, Ondersma_CD-5As 2012 [++] employed the established 5As approach (Ask about smoking status, Advise to quit, Assess willingness to quit, Assist with cessation skills, Arrange for follow-up), and Ondersma_CD-5As+CM-Lite 2012 [++] combined the two interventions. All of the trials resulted in a non-significant effect, which was negative in one intervention (Ondersma_CM-Lite 2012 [++] SMD -0.38, 95% CI -1.82 to 1.06) and favoured the intervention in the remaining two (Ondersma_CD-5As+CM-Lite 2012 [++] SMD 0.57, 95% CI -0.64 to 1.77; Ondersma_CD-5As 2012 [++] SMD 0.96, 95% CI -0.28 to 2.20). The contingency management intervention reported use of BCTs 3 Social support (unspecified), 9 Feedback on outcome of behaviour, 62 Goal setting (behaviour), and 80 Information about social and environmental consequences. The 5A’s intervention reported use of BCT 70 Persuasive source, while the combined intervention reported the BCTs present in the two other arms. No BCTs were reported in the usual care group.

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Extended interventions delivered face to face and one on one

One intervention (Stotts_USF 2009 [+]) utilised an extended face to face intervention delivered on an individual level that aimed to improve abstinence among pregnant smokers. Some of the smokers in this trial were recruited from WIC centres (i.e., were low-income women), it is unclear, however, what proportion of the enrolled participants were deemed to be low-income. The intervention, which included an feedback following an ultrasound, resulted in a small, non-significant effect on abstinence at the end of pregnancy compared to usual care (SMD 0.17, 95% CI -0.36 to 0.70).

Multi-session interventions delivered face to face and one on one

Eight interventions (Ruger_CS 2008 [++], Ruger_RQ 2008 [++], Pbert 2004 [+], Tappin 2005 [++], Hovell 2009 [+], Malchodi 2003 [+], de Vries 2006 [+], El-Mohandes 2011 [+]) described in seven trials assessed the effect of multi-session smoking interventions delivered face to face to an individual.

Six of these interventions (Ruger_CS 2008 [++], Ruger_RQ 2008 [++], Pbert 2004 [+], Tappin 2005 [++], Hovell 2009 [+], El-Mohandes 2011 [+]) specifically enrolled low-income women, or women living in areas of severe deprivation/high poverty. There were inconsistent results in this subgroup, both in terms of direction and significance of effect.

A very small, negative, non-significant effect on abstinence six months postpartum was seen among the current low-income pregnant smokers in Ruger_CS 2008 [++] (SMD -0.14 95% CI -0.72 to 0.44). The other arm of the Ruger study (Ruger_RQ 2008 [++]) enrolled low-income women who recently quit smoking due to their pregnancy, and resulted in a medium, non-significant effect on relapse prevention at 6 months postpartum (SMD 0.68, 95% CI -0.03 to 1.40).

Two interventions (Pbert 2004, Hovell 2009 [+]) were delivered to women eligible for care under a US federal assistance programme for low-income

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pregnant women (WIC). Pbert 2004 [+] provided a 4As (Ask, Advise, Assist, Arrange) counselling intervention that resulted in a medium effect of sustained abstinence at three months postpartum, compared to usual care (SMD 0.57, 95% CI 0.23 to 0.92). Hovell 2009 [+] provided tailored counselling to reduce smoking among low-income pregnant women and mothers with small children (under the age of 4 years) receiving care through a US federal assistance programme; the intervention resulted in a small, non-significant effect on the number of cigarettes smoked each week at one year follow-up (SMD 0.26, 95% CI -0.06 to 0.58).

Tappin 2005 [++] provided home based motivational interviewing and had a very small, non-significant effect on abstinence at approximately four months follow-up among women from an area of severe deprivation (SMD 0.03, 95% CI -0.34 to 0.40). The El-Mohandes 2011 [+] intervention resulted in a medium effect on postpartum smoking among black pregnant smokers living in an urban setting with high poverty rates (SMD 0.44, 95% CI 0.12 to 0.76).

The remaining trials (Malchodi 2003 [+], de Vries 2006 [+]) included pregnant smokers, with no additional selection based on socioeconomic status. The midwife intervention described in de Vries 2006 [+] resulted in a large effect on continuous abstinence one and a half months postpartum, compared to usual care (SMD 1.01, 95% CI 0.08 to 1.94).

The peer counselling intervention used in Malchodi 2003 [+] resulted in a very small, non-significant effect on abstinence at the end of pregnancy (SMD 0.08, 95% CI -0.35 to 0.51). The intervention and usual arms of this trial were coded identically (see Table 20), with both sets of codes reflecting usual care. The additional intervention provided in addition to usual care in the peer counselling arm was not described in a manner amenable to BCT coding, as the description focused on the training provided to the peer counsellors and not the content of the additional counselling sessions. Where content was described, it reflected reinforcement of usual care content, and was not subject to additional BCT coding. See Section 6.1 for further discussion.

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Multi-session interventions delivered face to face with remote components

Six interventions (McBride_WOI 2004 [++], McBride_PAI 2004 [++], Stotts_MI+USF 2009 [+], Dornelas 2006 [+], Lawrence_SHM+ICI 2003 [+], Lawrence_SHM 2003 [+]) examined the effect of multi-session interventions delivered face to face with remote follow-up on smoking behaviours among pregnant women. All interventions resulted in small to medium, non-significant effects. The two interventions described in McBride 2004 [++] involved either the pregnant women only McBride_WOI 2004 [++], or included their partner as well (McBride_PAI 2004 [++]). The women only intervention (McBride_WOI 2004 [++]) resulted in a small, non-significant effect on sustained abstinence for eight months (SMD 0.19, 95% CI -0.29 to 0.68). McBride_PAI 2004 [++] resulted in a small, non-significant effect as well (SMD 0.22, 95% CI -0.26 to 0.70). Both of these interventions reported use of BCTs 3 Social support (unspecified), and 61 Problem solving.

The motivational interviewing and ultrasound feedback intervention described in Stotts 2009_MI+USF [+] resulted in a small, non-significant effect on abstinence at the end of pregnancy (SMD 0.34, 95% CI -0.18 to 0.85). This intervention provided the same ultrasound feedback described used in Stotts_USF 2009 [+] (See extended face to face intervention section), and added a multi-session motivational interviewing component.

Dornelas 2006 [+] provided a counselling intervention to low-income, primarily Hispanic pregnant women that resulted in a medium, non-significant effect on abstinence at six months follow-up (SMD 0.53, 95% CI -0.40 to 1.46).

Lawrence_SHM+ICI 2003 [+] provided self-help manuals and an interactive computer intervention to pregnant smokers. The intervention resulted in a small, non-significant effect on sustained abstinence at two weeks postpartum, compared to usual care (SMD 0.37, 95% CI -0.61 to 1.34). Similarly, Lawrence_SHM 2003 [+] provided a smoking intervention during antenatal care, which resulted in a small, non-significant effect on sustained

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abstinence at two weeks postpartum (SMD 0.46, 95% CI -0.49 to 1.4). No specific BCTs were codeable from the description of the interventions as the content of the manuals and computer programme were not described in sufficient detail for BCT detection; the descriptions focused on the training required for intervention delivery and the theoretical basis of the interventions. However, BCT 70 Persuasive source was reported in the comparator arm.

Overall, evidence suggests that multi-session interventions delivered face to face with remote follow-up are no more effective than usual care at encouraging smoking abstinence among pregnant women.

Multi-session interventions delivered remotely

One trial (Rigotti 2006 [+]) assessed the effect of multi-session, remotely delivered interventions on the smoking behaviours of pregnant women. The trial delivered multiple counselling sessions over the phone to pregnant smokers, and resulted in a small, non-significant effect on sustained abstinence at three months postpartum (SMD 0.21, 95% CI -0.34 to 0.75).

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Table 20: Smoking interventions for pregnant or postpartum women

Author year	Type	Primary delivery mode	Outcome	SMD	95% CI lower	95% CI upper	Intervention BCTs Control BCTs
Ondersma 2012_CM-Lite [++]	Brief	Remote (computer)	Abstinence	-0.38	-1.82	1.06	3 Social support (unspecified)[C2] 9 Feedback on outcome of behaviour[C1] 62 Goal setting (behaviour)[C2] 80 Information about social and environmental consequences[C1] None reported
Ondersma 2012_CD-5As+CM-Lite [++]	Brief	Remote (computer)	Abstinence	0.57	-0.64	1.77	3 Social support (unspecified)[C2] 9 Feedback on outcome of behaviour[C1] 62 Goal setting (behaviour)[C2] 70 Persuasive source[C2] 80 Information about social and environmental consequences[C1] None reported
Ondersma 2012_CD-5As [++]	Brief	Remote (computer)	Abstinence	0.96	-0.28	2.20	70 Persuasive source[C2] None reported
Stotts 2009_USF [+]	Extended	Face to face one on one	Abstinence at end of pregnancy	0.17	-0.36	0.70	3 Social support (unspecified)[C2] 78 Information about health consequences[C2] 3 Social support (unspecified)[C2]
Ruger 2008_CS [++]	Multi-session	Face to face one on one	Abstinence at 6 months postpartum	-0.14	-0.72	0.44	34 Adding objects to the environment[C2] 62 Goal setting (behaviour) [C2] 78 Information about health consequences[C2] 34 Adding objects to the environment[C2] 78 Information about health consequences[C2]
Malchodi 2003 [+]	Multi-session	Face to face one on one	Abstinence at end of pregnancy	0.08	-0.35	0.51	3 Social support (unspecified)[C2] 34 Adding objects to the environment[C2] 59 Future punishment[C] 70 Persuasive source[C2] 80 Information about social and environmental consequences[C1]

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Author year	Type	Primary delivery mode	Outcome	SMD	95% CI lower	95% CI upper	Intervention BCTs Control BCTs
							3 Social support (unspecified)[C2] 34 Adding objects to the environment[C2] 59 Future punishment[C] 70 Persuasive source[C2] 80 Information about social and environmental consequences[C1]
Tappin 2005 [++]	Multi-session	Face to face one on one	Abstinence	0.03	-0.34	0.40	3 Social support (unspecified)[C2] None reported
Hovell 2009 [+]	Multi-session	Face to face one on one	Cigarettes per week	0.26	-0.06	0.58	3 Social support (unspecified)[C2] 4 Pharmacological support[C2] 34 Adding objects to the environment[C2] 56 Social reward[C1] 62 Goal setting (behaviour)[C2] 64 Action planning[C2] 3 Social support (unspecified)[C2]
Ruger 2008_RQ [++]	Multi-session	Face to face one on one	Relapse prevented at 6 months postpartum	0.68	-0.03	1.40	34 Adding objects to the environment[C2] 62 Goal setting (behaviour)[C2] 78 Information about health consequences[C2] 34 Adding objects to the environment[C2] 78 Information about health consequences[C2]
de Vries 2006 [+]	Multi-session	Face to face one on one	Continuous abstinence at 1.5 months postpartum	1.01	0.08	1.94	3 Social support (unspecified)[C2] 61 Problem solving[C2] 78 Information about health consequences[C2] None reported
Pbert 2004 [+]	Multi-session	Face to face one on one	Sustained abstinence at 3 months postpartum	0.57	0.23	0.92	3 Social support (unspecified)[C2] 68 Commitment[C2] None reported
El-Mohandes 2011 [+]	Multi-session	Face to face one on one	Smoking postpartum	0.44	0.12	0.76	3 Social support (unspecified)[C2] None reported

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Author year	Type	Primary delivery mode	Outcome	SMD	95% CI lower	95% CI upper	Intervention BCTs Control BCTs
McBride 2004_WOI [++]	Multi-session	Face to face with remote (phone) follow up	Sustained abstinence for 8 months	0.19	-0.29	0.68	3 Social support (unspecified)[C2] 61 Problem solving[C2] None reported
McBride 2004_PAI [++]	Multi-session	Face to face with remote follow up	Sustained abstinence for 8 months	0.22	-0.26	0.70	2 Social support (emotional)[A] 3 Social support (unspecified)[C2] 4 Pharmacological support[C2] 25 Behaviour substitution[A1] 34 Adding objects to the environment[C2] 61 Problem solving[C2] None reported
Stotts 2009_MI+USF [+]	Multi-session	Face to face with remote follow up	Abstinence at end of pregnancy	0.34	-0.18	0.85	3 Social support (unspecified)[C2] 8 Feedback on behaviour[C] 62 Goal setting (behaviour)[C2] 66 Review outcome goal[A] 78 Information about health consequences[C2] 3 Social support (unspecified)[C2]
Dornelas 2006 [+]	Multi-session	Face to face with remote follow up	Abstinence	0.53	-0.40	1.46	3 Social support (unspecified)[C2] 5 Reduce negative emotions[C2] 62 Goal setting (behaviour)[C2] 64 Action planning[C2] None reported
Lawrence 2003_SHM+ICI [+]	Multi-session	Remote and face to face	Sustained abstinence at 2 weeks postpartum	0.37	-0.61	1.34	None reported 70 Persuasive source[C2]
Lawrence 2003_SHM [+]	Multi-session	Remote and face to face	Sustained abstinence at 2 weeks postpartum	0.46	-0.49	1.42	None reported 70 Persuasive source[C2]

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Author year	Type	Primary delivery mode	Outcome	SMD	95% CI lower	95% CI upper	Intervention BCTs Control BCTs
Rigotti 2006 [+]	Multi-session	Remote (phone)	Sustained abstinence at 3 months postpartum	0.21	-0.34	0.75	3 Social support (unspecified)[C2] 34 Adding objects to the environment[C2] 61 Problem solving[C2] 3 Social support (unspecified)[C2] 34 Adding objects to the environment[C2]
A positive SMD represents a benefit with the intervention (i.e. favours the intervention), and a negative SMD represents a benefit with the comparator (favours comparator). A SMD of <0.2 represents a very small effect size, of ≥0.2 to <0.5 represents a small effect size, of ≥0.5 to <0.8 a medium effect size, and of ≥0.8 a large effect size. * Intervention targeted multiple behaviour topcs							

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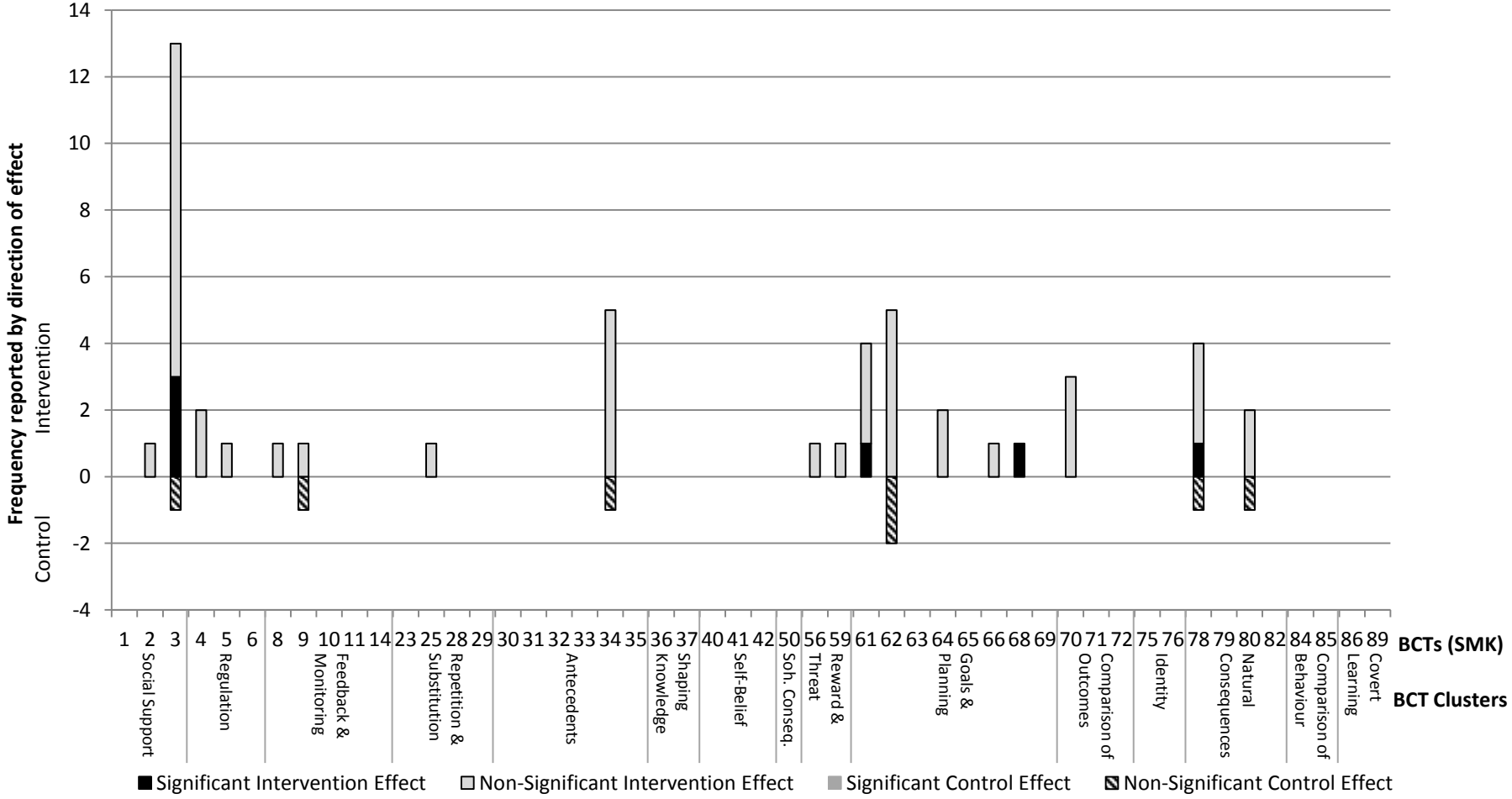
Figure 9: Distribution of BCTs in smoking trials among pregnant or postpartum women; with direction and significance of effect



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Smokers intending to quit

Ten interventions (Willemsen 2006 [+], Sutton 2007 [+], Toll 2010 [++], Rodriguez-Aralejo 2003 [++], Nollen 2007 [++], Joseph 2011[++], Rabius 2004 [+], Free 2011 [++], Swartz 2006 [+], An 2006 [+]) assessed the effectiveness of behaviour change interventions among smokers who intended or were motivated to quit.

Overall, evidence suggests that multi-session interventions delivered remotely can be effective at helping motivated smokers to quit. Other types of interventions and modes of delivery were found to be no more effective than usual care (brief remotely delivered interventions), or had limited or inconsistent evidence (multi-session interventions delivered one on one).

Brief, remotely delivered interventions

Three trials (Willemsen 2006 [+], Sutton 2007 [+], Toll 2010 [++]) examined the effect of brief interventions delivered remotely either through post (Willemsen 2006 [+], Sutton 2007 [+]) or over the phone (Toll 2010 [++]) on the smoking behaviour of individuals interested in quitting. All three trials resulted in very small, non-significant effects, one of which (Willemsen 2006 [+]) favoured the control arm of the trial.

Willemsen 2006 [+] mailed a decision aid to smokers who intended to quit within the next six months, and compared sustained abstinence for six months between the intervention and a no intervention control group. The trial resulted in a very small, non-significant negative effect (SMD -0.01, 95% CI -0.32 to 0.30).

Sutton 2007 [+] assessed the effect of a brief telephone counselling and mailed letter intervention for smokers or recent quitters (within the past two weeks) who were first time callers to a quitline. This intervention resulted in a very small, non-significant effect on sustained abstinence compared to usual quitline care (SMD 0.04, 95% CI -0.13 to 0.20).

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Toll 2010 [++] assessed the effect of a brief intervention delivered over the phone to quitline callers. The intervention resulted in a very small, non-significant effect on abstinence compared to usual quitline care (SMD 0.07, 95% CI -0.06 to 0.20).

Overall, brief interventions that are remotely delivered do not appear to effect significant change in smoking abstinence among individuals who intend to quit. Moreover, the interventions offered as adjuncts or alternatives to standard quitline care appeared to be no more effective than usual care at changing smoking behaviour among quitline callers.

Multi-session interventions delivered face to face and one on one

Two trials (Rodriguez-Aralejo 2003 [++], Nollen 2007 [++]) assessed the effect of face to face, multi-session interventions on smoking cessation among individuals who intended to quit.

Rodriquez-Aralejo 2003 [++] assessed the effect of a worksite intervention, delivered over multiple sessions in a face to face and one on one manner, and resulted in a medium, significant effect on sustained abstinence for nine months compared to usual care (SMD 0.52, 95% CI 0.06 to 0.99).

Nollen 2007 [++] assessed the effect of a multi-session intervention delivered face to face and one on one, with remote components (videotape viewing and follow-up phone calls) on abstinence among African American male smokers who were motivated to quit. The intervention resulted in a very small, non-significant effect (SMD 0.15, 95% CI -0.12 to 0.41).

The intervention that resulted in a significant effect (Rodriquez-Aralejo 2003 [++]) reported use of 3 Social support (unspecified) and 63 Goal setting (outcome), neither of which were reported in the intervention with non-significant effects (Nollen 2007 [++]).

Multi-session, remotely delivered interventions

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Five trials (Joseph 2011 [++], Rabius 2004 [+], Free 2011 [++], Swartz 2006 [+], An 2006 [+]) assessed the effectiveness of a multi-session, remotely delivered approach on abstinence among smokers who intended to quit.

Joseph 2011 [++] examined the impact of a multi-session intervention delivered over the phone on sustained abstinence for 6 months among adults interested in making a quit attempt over the next two weeks. The intervention resulted in a small, significant effect (SMD 0.31, 95% CI 0.04 to 0.57).

Rabius 2004 [+] assessed the effect of multi-session telephone counselling for quitline callers interested in making a quit attempt in the next two weeks. The intervention resulted in a small, significant effect on abstinence at 3 months post intervention (SMD 0.31, 95% CI 0.20 to 0.42).

Free 2011 [++] assessed the effect of a multiple text messages intervention on abstinence among smokers interested in quitting. The trial resulted in a small, significant effect on abstinence at the end of the intervention compared to an attention control group (SMD 0.47, 95% CI 0.35 to 0.58).

Swartz 2006 [+] assessed the effectiveness of a multi-session internet based intervention compared to a waitlist control. The intervention had a medium, significant effect on abstinence (SMD 0.54, 95% CI 0.09 to 0.99).

An 2006 [+] assessed the effect of multi-session telephone counselling intervention on sustained abstinence for 6 months among veterans. The intervention resulted in a medium, significant effect compared to usual care (SMD 0.69, 95% CI 0.38 to 1.00).

The only BCT that was reported across all five interventions was 3 Social support (unspecified). This was also reported in the comparator arm of one of the five trials (Joseph 2011 [++]). BCT 4 Pharmacological support was reported in four of the five trials, but again was reported in the comparator arms of Joseph 2011 [++] and An 2006 [+].

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Table 21: Smoking interventions for smokers intending to quit

Author year	Type	Primary delivery mode	Outcome	SMD	95% CI lower	95% CI upper	Intervention BCTs Control BCTs
Willemsen 2006 [+]	Brief	Remote (post)	Sustained abstinence for 6 months	-0.01	-0.32	0.30	3 Social support (unspecified)[C2] 4 Pharmacological support[C2] 34 Adding objects to the environment[C2] 61 Problem solving[C2] 70 Persuasive source[C2] 85 Social comparison[C] None reported
Sutton 2007 [+]	Brief	Remote (post)	Sustained abstinence for 3 months	0.04	-0.13	0.20	3 Social support (unspecified)[C2] 3 Social support (unspecified)[C2]
Toll 2010 [++]	Brief	Remote (phone)	Abstinence	0.07	-0.06	0.20	3 Social support (unspecified)[C2] 4 Pharmacological support[C2] 34 Adding objects to the environment[C2] 75 Framing/ reframing[A2] 78 Information about health consequences[C2] 79 Information about emotional consequences[A] 80 Information about social and environmental consequences[C1] 3 Social support (unspecified)[C2] 4 Pharmacological support[C2] 34 Adding objects to the environment[C2] 78 Information about health consequences[C2] 81 Salience of consequences
Rodriguez-Aralejo 2003 [++]	Multi-session	Face to face	Sustained abstinence for 9 months	0.52	0.06	0.99	3 Social support (unspecified)[C2] 4 Pharmacological support[C2] 62 Goal setting (behaviour)[C2] 63 Goal setting (outcome)[C2] None reported
Nollen 2007 [++]	Multi-session	Face to face and remote (phone,	Abstinence	0.15	-0.12	0.41	4 Pharmacological support[C2] 34 Adding objects to the environment[C2]

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Author year	Type	Primary delivery mode	Outcome	SMD	95% CI lower	95% CI upper	Intervention BCTs Control BCTs
		videotape)					36 Instruction on how to perform a behaviour[C2] 62 Goal setting (behaviour)[C2] 65 Review behaviour goal[A2] 78 Information about health consequences[C2] 4 Pharmacological support[C2] 34 Adding objects to the environment[C2] 70 Persuasive source[C2]
Joseph 2011 [++]	Multi-session	Remote (phone)	Sustained abstinence for 6 months	0.31	0.04	0.57	3 Social support (unspecified)[C2] 4 Pharmacological support[C2] 36 Instruction on how to perform a behaviour[C2] 61 Problem solving[C2] 62 Goal setting (behaviour)[C2] 64 Action planning[C2] 65 Review behaviour goal[A2] 3 Social support (unspecified)[C2] 4 Pharmacological support[C2] 36 Instruction on how to perform a behaviour[C2] 61 Problem solving[C2] 62 Goal setting (behaviour)[C2] 64 Action planning[C2]
Rabius 2004 [+]	Multi-session	Remote (phone)	Abstinence	0.31	0.20	0.42	1 Social support (practical)[A2] 3 Social support (unspecified)[C2] 4 Pharmacological support[C2] 5 Reduce negative emotions[C2] 23 Behavioural practice/ rehearsal[C2] 41 Mental rehearsal of successful performance[A1] 56 Social reward[C1] 61 Problem solving[C2] 62 Goal setting (behaviour)[C2] 64 Action planning[C2] 75 Framing/ reframing[A2]

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Author year	Type	Primary delivery mode	Outcome	SMD	95% CI lower	95% CI upper	Intervention BCTs Control BCTs
							None reported
Free 2011 [++]	Multi-session	Remote (text message)	Abstinence	0.47	0.35	0.58	3 Social support (unspecified)[C2] 4 Pharmacological support[C2] 9 Feedback on outcome of behaviour[C1] 25 Behaviour substitution[A1] 30 Restructuring the physical environment[A1] 31 Restructuring the social environment[A1] 33 Distraction[A1] 34 Adding objects to the environment[C2] 40 Verbal persuasion about capability[A1] 42 Focus on past success[A1] 61 Problem solving[C2] 62 Goal setting (behaviour)[C2] 64 Action planning[C2] 78 Information about health consequences[C2] 80 Information about social and environmental consequences 82 Monitoring of emotional consequences[A1] 86 Information about others' approval [A1] None reported
Swartz 2006 [+]	Multi-session	Remote (computer)	Abstinence	0.54	0.09	0.99	3 Social support (unspecified)[C2] 36 Instruction on how to perform a behaviour[C2] 78 Information about health consequences[C2] None reported
An 2006 [+]	Multi-session	Remote (phone)	Sustained abstinence for 6 months	0.69	0.38	1.00	3 Social support (unspecified)[C2] 4 Pharmacological support[C2] 4 Pharmacological support[C2] 34 Adding objects to the environment[C2]

A positive SMD represents a benefit with the intervention (i.e. favours the intervention), and a negative SMD represents a benefit with the comparator (favours comparator). A SMD of <0.2 represents a very small effect size, of ≥0.2 to <0.5 represents a small effect size, of ≥0.5 to <0.8 a medium effect size, and of ≥0.8 a large effect size.
* Intervention targeted multiple behaviour topcs

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Primary healthcare patients

Five interventions (Unrod 2007 [+], Borrelli 2005 [+], Pisinger_GC 2010 [+], Pisinger_GC 2010 [+], Katz 2004 [+]) recruited smokers identified in primary care settings.

Overall, these interventions were no more effective than usual care at altering smoking behaviour among these patients.

Brief face to face interventions for primary healthcare patients

One trial (Unrod 2007 [+]) assessed the effectiveness of a brief intervention delivered face to face during a primary care appointment. This intervention resulted in a small, non-significant increase in abstinence at 6 months compared to the usual care group (SMD 0.31, 95% CI -0.03 to 0.66).

Multi-session delivered face to face in an individual or group setting for primary healthcare patients

Two interventions (Borrelli 2005 [+], Pisinger_GC 2010 [+]) examined multi-session interventions delivered face to face. Borrelli 2005 [+] assessed the effectiveness of an intervention delivered on an individual level to smokers who were unable to visit a primary care physician or who required frequent daily home based care. This intervention had a small, non-significant effect on sustained abstinence (SMD 0.43, 95% CI -0.49 to 1.36).

A multi-session, group counselling intervention for smokers registered with a general practice was described in Pisinger_GC 2010 [+]. This intervention had a very small, non-significant effect (SMD 0.14, 95% CI -0.93 to 1.22) on abstinence at 6 months.

Both trials reported use of BCTs 3 Social support (unspecified) and 78 Information about health consequences.

Multi-session interventions delivered remotely for primary healthcare patients

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Two trials (Pisinger_IC 2010 [+], Katz 2004 [+]) assessed the effect of multi-session, remotely delivered interventions on smoking cessation among primary care patients. Pisinger_IC 2010 [+] utilised an internet based multi-session intervention for smokers identified through their GP practice. The trial resulted in a very small, non-significant negative effect on abstinence at 6 months (SMD -0.04, 95% CI -1.19 to 1.11).

The remaining trial (Katz 2004 [+]) assessed the effect of a multiple session intervention delivered over the phone to smokers identified through community clinics. This intervention resulted in a very small, non-significant effect on abstinence (SMD 0.19, 95% CI -0.13 to 0.50).

Both interventions reported use of BCT 3 Social support (unspecified), although this BCT was also reported in the comparator arm of Katz 2004 [+].

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Table 22: Smoking interventions for primary healthcare patients

Author year	Type	Primary delivery mode	Outcome	SMD	95% CI lower	95% CI upper	Intervention BCTs Control BCTs
Unrod 2007 [+]	Brief	Face to face one on one	Abstinence at 6 months	0.31	-0.03	0.66	25 Behaviour substitution[A1] 31 Restructuring the social environment[A1] 34 Adding objects to the environment[C2] 70 Persuasive source[C2] 71 Pros and cons[A] 78 Information about health consequences[C2] 80 Information about social and environmental consequences[C1] None reported
Borrelli 2005 [+]	Multi-session	Face to face one on one	Sustained abstinence at 1 year	0.43	-0.49	1.36	3 Social support (unspecified)[C2] 62 Goal setting (behaviour)[C2] 71 Pros and cons[A] 75 Framing/ reframing[A2] 76 Incompatible beliefs[C] 78 Information about health consequences[C2] 79 Information about emotional consequences[A] 85 Social comparison[C] 89 Vicarious consequences[A] 3 Social support (unspecified)[C2]
Pisinger_GC 2010 [+]	Multi-session	Face to face group	Abstinence at 6 months	0.14	-0.93	1.22	3 Social support (unspecified)[C2] 4 Pharmacological support[C2] 70 Persuasive source[C2] 78 Information about health consequences[C2] None reported
Pisinger_IC 2010 [+]	Multi-session	Remote (computer)	Abstinence at 6 months	-0.04	-1.19	1.11	3 Social support (unspecified)[C2] None reported
Katz 2004 [+]	Multi-session	Remote (phone)	Abstinence at 4 months	0.19	-0.13	0.50	3 Social support (unspecified)[C2] 4 Pharmacological support[C2] 8 Feedback on behaviour[C]

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							10 Self-monitoring of behaviour [C1] 34 Adding objects to the environment[C2] 61 Problem solving[C2] 62 Goal setting (behaviour)[C2] 64 Action planning[C2] 68 Commitment[C2] 70 Persuasive source[C2] 3 Social support (unspecified)[C2]
A positive SMD represents a benefit with the intervention (i.e. favours the intervention), and a negative SMD represents a benefit with the comparator (favours comparator). A SMD of <0.2 represents a very small effect size, of ≥0.2 to <0.5 represents a small effect size, of ≥0.5 to <0.8 a medium effect size, and of ≥0.8 a large effect size. * Intervention targeted multiple behaviour topcs							

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Dentistry patients

Three interventions from two trials (Gordon_5As 2010a [+], Gordon_3As 2010a [+], Gordon 2010b [++]) assessed the effect of smoking interventions during a routine dental visit on smoking cessation. All three interventions were brief and delivered face to face and one on one. Overall, there was limited and inconsistent evidence regarding the effectiveness of these interventions at changing smoking behaviour among dental patients.

Brief face to face interventions for dentistry patients

Two interventions (Gordon_5As 2010a [+], Gordon_3As 2010a [+]) resulted in small, non-significant effects. Gordon_5As 2010a [+] used a brief 5As (Ask, Advise, Assess, Assist, Arrange) smoking cessation counselling approach (SMD 0.463, 95% CI -0.203 to 1.129), while Gordon_3As 2010a [+] utilised a modified version which included three of the five components (Ask, Advise, Arrange) and had no significant effect in terms of abstinence sustained for 9 months (SMD 0.413, 95% CI -0.260). The third intervention (Gordon 2010b [++]) used the same 5A's approach reported in Gordon_5As 2010a [+], but resulted in a medium, significant effect on abstinence sustained for 6 months (SMD 0.585, 95% CI 0.319 to 0.851). Gordon 2010b [++] included nearly twice as many participants as the similar intervention described in Gordon_5As 2010a [+] and assessed sustained abstinence over a shorter period (six months compared to nine months), which may account for the difference in intervention significance. All three interventions reported use of BCTs 3 Social support (unspecified), 34 adding objects to the environment, 70 Persuasive source and 78 Information about health consequences; both Gordon_5As 2010a [+] and Gordon 2010b [++] reported use of BCT 4 Pharmacological support. No BCTs were reported in the usual care arms.

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Table 23: Smoking interventions for dentistry patients

Author year	Type	Primary delivery mode	Outcome	SMD	95% CI lower	95% CI upper	Intervention BCTs Control BCTs
Gordon 2010a_3As [+]	Brief	Face to face	Sustained abstinence for 9 months	0.41	-0.26	1.09	3 Social support (unspecified)[C2] 34 Adding objects to the environment[C2] 70 Persuasive source[C2] 78 Information about health consequences[C2] None reported
Gordon 2010a_5As [+]	Brief	Face to face	Sustained abstinence for 9 months	0.46	-0.20	1.13	3 Social support (unspecified)[C2] 4 Pharmacological support[C2] 34 Adding objects to the environment[C2] 62 Goal setting (behaviour)[C2] 64 Action planning[C2] 70 Persuasive source[C2] 78 Information about health consequences[C2] None reported
Gordon 2010b [++]	Brief	Face to face	Sustained abstinence for 6 months	0.58	0.32	0.85	3 Social support (unspecified)[C2] 4 Pharmacological support[C2] 34 Adding objects to the environment[C2] 70 Persuasive source[C2] 78 Information about health consequences[C2] None reported

A positive SMD represents a benefit with the intervention (i.e. favours the intervention), and a negative SMD represents a benefit with the comparator (favours comparator). A SMD of <0.2 represents a very small effect size, of ≥0.2 to <0.5 represents a small effect size, of ≥0.5 to <0.8 a medium effect size, and of ≥0.8 a large effect size.
* Intervention targeted multiple behaviour topcs

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Other smokers

This category refers to individuals who were identified based only on smoking habits, with no other overarching eligibility criteria, or in cases where the additional eligibility criteria were not present in other trials, precluding narrative synthesis in that subgroup.

Brief, remotely delivered interventions among other smokers

One study (Armitage 2008 [++]) assessed the effect of a brief paper based smoking intervention provided to employed smokers. The intervention resulted in large effect on abstinence at 2 months compared to an assessment only control (SMD 1.52, 95% CI 0.39 to 2.65).

Extended group interventions with university students

One study (Simmons 2007 [+]) assessed the effect of an extended intervention on abstinence at 1 month among University student smokers. The intervention resulted in a very small, negative, non-significant effect (SMD -0.14, 95% CI -0.72 to 0.43).

Multi-session face to face, one on one interventions for weight concerned females

One trial (Sallit 2009* [+]) assessed the effect of multiple face to face sessions on smoking behaviour. The trial used a multi-target approach to address smoking among weight concerned females (smoking, diet and physical activity). The intervention resulted in a small, significant effect (SMD 0.37, 95% CI 0.02 to 0.72) on the number of cigarettes smoked after 9 months, compared to no intervention.

Multi-session face to face, one on one intervention for patients with non-acute psychotic disorders

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One trial (Baker 2006 [+]) assessed the effect of multiple face to face sessions on sustained abstinence among smokers with non-acute psychotic disorders. The intervention resulted in a large but non-significant improvement in sustained abstinence compared to usual care (SMD 0.92, 95% CI -0.65 to 2.48). No BCTs were reported in the control arm.

Multi-session group interventions in older smokers

Two interventions (Hall_ECBT 2009 [+], Hall_ENRT+CBT 2009 [+]) described in one trial assessed the impact of multi-session group interventions on smoking behaviour.

Hall_ECBT 2009 [+] and Hall_ENRT+CBT 2009 [+] provided multiple group counselling sessions to older smokers. The extended cognitive behavioural therapy (CBT) (Hall_ECBT 2009 [+]) intervention resulted in a small, non-significant effect on abstinence one year after the conclusion of the intervention (SMD 0.41, 95% CI -0.01 to 0.83), while the extended NRT plus CBT intervention (Hall_ENRT+CBT 2009 [+]) resulted in a very small, non-significant effect (SMD 0.19, 95% CI -0.22 to 0.61).

Both interventions included BCTs and included BCTs 3, Social support (unspecified) , 4 Pharmacological support , 8 Feedback on behaviour, 10 Self-monitoring of behaviour, 34 Adding objects to the environment, 37 Information about antecedents, 61 Problem solving, 62 Goal setting (behaviour) , 64 Action planning, 68 Commitment, 71 Pros and cons, and 80 Information about social and environmental consequences.

Multi-session group interventions alcohol or drug dependent smokers

One study (Reid 2008 [++]) assessed the effect of a multi-session group based smoking intervention among smokers in treatment for alcohol or drug dependence compared to no intervention. The study resulted in a very small non-significant effect on abstinence four months after the end of the intervention (SMD 0.03, 95% CI -0.64 to 0.71).

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Multi-session remotely delivered interventions among other smokers

Six interventions (Segan 2011[++], McClure 2005 [++], Schumann 2008 [+], Vidrine 2012 [+], Carpenter SR+NRT 2004 [+], Carpenter MA+NRT 2004 [+]) assessed the effect of multi-session remotely delivered interventions on smoking behaviour among other smokers.

Segan 2011 [++] assessed the effect of multiple telephone counselling sessions on relapse prevention among recent ex-smokers. The intervention resulted in a very small, non-significant effect on relapse prevention (sustained abstinence) for nine months (SMD 0.02, 95% CI -0.19 to 0.23).

McClure 2005 [++] examined a multi-session motivational counselling intervention delivered over the phone to female smokers with a high risk of cervical cancer. The intervention resulted in a very small, non-significant effect on abstinence at 6 months compared to usual care (SMD 0.04, 95% CI -0.40 to 0.47).

Schumann 2008 [+] provide a mailed multi-session intervention to rural smokers. The trial resulted in a very small, negative, non-significant effect on abstinence after a year and a half (SMD -0.02, 95% CI -0.25 to 0.20).

Vidrine 2011 [+] provided multiple telephone counselling session delivered using a prepaid cell phone to HIV-positive smokers. The trial resulted in a large, significant effect on abstinence at the end of the intervention compared to usual care (SMD 0.80, 95% CI 0.42 to 1.17).

Two interventions (Carpenter SR+NRT 2004 [+], Carpenter MA+NRT 2004 [+]) assessed the effect of multi-session programmes delivered over the phone for smokers currently not motivated to quit, but who expressed interest in a non-cessation study; while the participants expressed willingness to participate in a smoking reduction study, the primary outcome measured in the trial was smoking cessation. Carpenter SR+NRT 2004 [+] assessed the impact of smoking reduction (SR) counselling and nicotine replacement

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therapy (NRT) along with brief advice, while Carpenter MA+NRT 2004 [+] assessed the impact of motivational advice (MA) and NRT plus brief advice on abstinence at the end of the intervention. Carpenter SR+NRT 2004 [+] resulted in a large, significant intervention effect (SMD 0.83, 95% CI 0.31 to 1.35). Carpenter MA+NRT 2004 [+] also resulted in a large, significant effect (SMD 1.01, 95% CI 0.50 to 1.53). Both interventions reported use of BCTs 3 Social support (unspecified), 4 Pharmacological support, 61 Problem solving, 62 Goal setting (behaviour), and 64 Action planning.

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Table 24: Smoking interventions for other smokers

Author year	Type	Primary delivery mode	Outcome	SMD	95% CI lower	95% CI upper	Intervention BCTs Control BCTs
Armitage 2008 [++]	Brief	Remote (paper)	Abstinence at 2 months	1.52	0.39	2.65	62 Goal setting (behaviour)[C2] 64 Action planning[C2] None reported
Simmons 2007 [+]	Extended	Face to face group	Abstinence at 1 month	-0.14	-0.72	0.43	34 Adding objects to the environment[C2] 76 Incompatible beliefs[C] 78 Information about health consequences[C2] 80 Information about social and environmental consequences[C1] 34 Adding objects to the environment[C2]
Sallit 2009* [+]	Multi-session	Face to face one on one	Cigarettes per day at 9 months	0.37	0.02	0.72	3 Social support (unspecified)[C2] 5 Reduce negative emotions[C2] 11 Self-monitoring of outcome of behaviour[A1] 63 Goal setting (outcome)[C2] 75 Framing/ reframing[A2] None reported
Baker 2006 [+]	Multi-session	Face to face one on one	Sustained abstinence at 1 year	0.92	-0.65	2.48	3 Social support (unspecified)[C2] 4 Pharmacological support[C2] 5 Reduce negative emotions[C2] 36 Instruction on how to perform a behaviour[C2] 61 Problem solving[C2] 63 Goal setting (outcome)[C2] 64 Action planning[C2] 75 Framing/ reframing[A2] 78 Information about health consequences[C2] None reported
Hall 2009_ECBT [+]	Multi-session	Face to face combined one on one and group	Abstinence at 1 year	0.41	-0.01	0.83	3 Social support (unspecified)[C2] 4 Pharmacological support[C2] 8 Feedback on behaviour[C] 10 Self-monitoring of behaviour[C1]

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Author year	Type	Primary delivery mode	Outcome	SMD	95% CI lower	95% CI upper	Intervention BCTs Control BCTs
							34 Adding objects to the environment[C2] 37 Information about antecedents[C] 61 Problem solving[C2] 62 Goal setting (behaviour)[C2] 64 Action planning[C2] 68 Commitment[C2] 71 Pros and cons[A] 80 Information about social and environmental consequences[C1] 3 Social support (unspecified)[C2] 4 Pharmacological support[C2] 34 Adding objects to the environment[C2]
Hall 2009_ENRT+CBT [+]	Multi-session	Face to face combined one on one and group	Abstinence at 1 year	0.19	-0.22	0.61	3 Social support (unspecified)[C2] 4 Pharmacological support[C2] 8 Feedback on behaviour[C] 10 Self-monitoring of behaviour[C1] 25 Behaviour substitution[A2] 34 Adding objects to the environment[C2] 36 Instruction on how to perform a behaviour[C2] 37 Information about antecedents[C] 61 Problem solving[C2] 62 Goal setting (behaviour)[C2] 64 Action planning[C2] 68 Commitment[C2] 71 Pros and cons[A] 80 Information about social and environmental consequences[C1] 3 Social support (unspecified)[C2] 4 Pharmacological support[C2] 34 Adding objects to the environment[C2]
Reid 2008 [+]	Multi-session	Face to face group	Abstinence at 4 months	0.03	-0.64	0.71	3 Social support (unspecified)[C2] 4 Pharmacological support[C2] 34 Adding objects to the environment[C2]

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Author year	Type	Primary delivery mode	Outcome	SMD	95% CI lower	95% CI upper	Intervention BCTs Control BCTs
							None reported
Segan 2011 [++]	Multi-session	Remote (phone)	Sustained abstinence for 9 months	0.02	-0.19	0.23	3 Social support (unspecified)[C2] 5 Reduce negative emotions[C2] 61 Problem solving[C2] None reported
McClure 2005 [++]	Multi-session	Remote (phone)	Abstinence at 6 months	0.04	-0.40	0.47	3 Social support (unspecified)[C2] 4 Pharmacological support[C2] 34 Adding objects to the environment[C2] 61 Problem solving[C2] 62 Goal setting (behaviour)[C2] 69 Discrepancy between current behaviour and goal[A] 78 Information about health consequences[C2] 3 Social support (unspecified)[C2] 34 Adding objects to the environment[C2] 78 Information about health consequences[C2]
Schumann 2008 [+]	Multi-session	Remote (post)	Abstinence at 18 months	-0.02	-0.25	0.20	34 Adding objects to the environment[C2] None reported
Vidrine 2012 [+]	Multi-session	Remote (phone)	Abstinence over 24 hours	0.80	0.42	1.17	3 Social support (unspecified)[C2] 4 Pharmacological support[C2] 34 Adding objects to the environment[C2] 70 Persuasive source[C2] 78 Information about health consequences[C2] 4 Pharmacological support[C2] 34 Adding objects to the environment[C2] 70 Persuasive source[C2]
Carpenter 2004_SR+NRT [+]	Multi-session	Remote (phone)	Abstinence	0.83	0.31	1.35	3 Social support (unspecified)[C2] 4 Pharmacological support[C2] 29 Graded tasks[A1] 61 Problem solving[C2] 62 Goal setting (behaviour)[C2]

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Author year	Type	Primary delivery mode	Outcome	SMD	95% CI lower	95% CI upper	Intervention BCTs Control BCTs
							64 Action planning[C2] None reported
Carpenter 2004_MA+NRT [+]	Multi-session	Remote (phone)	Abstinence	1.01	0.50	1.53	3 Social support (unspecified)[C2] 4 Pharmacological support[C2] 61 Problem solving[C2] 62 Goal setting (behaviour)[C2] 64 Action planning[C2] None reported
A positive SMD represents a benefit with the intervention (i.e. favours the intervention), and a negative SMD represents a benefit with the comparator (favours comparator). A SMD of <0.2 represents a very small effect size, of ≥0.2 to <0.5 represents a small effect size, of ≥0.5 to <0.8 a medium effect size, and of ≥0.8 a large effect size. * Intervention targeted multiple behaviour topcs							

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A overview of smoking interventions according to the reviewed parameters of type, mode of delivery and population is provided in Table 25.

Table 25: Summary of smoking interventions according to type, mode of delivery, population and significant of effect

Category	Number of interventions	Number significant	% of 80 total SMK interventions (category interventions /topic total)	% of 21 total significant SMK interventions (category significant/ topic significant)	% of category resulting in significant effect (category significant/ category total)
Intervention Type					
Brief	14	2	17.50%	9.52%	14.29%
Extended	4	0	5.00%	0.00%	0.00%
Multi-session	62	19	77.50%	90.48%	30.65%
Mode of Delivery					
Face to face, one on one	23	6	28.75%	28.57%	26.09%
Face to face, group	4	1	5.00%	4.76%	25.00%
Face to face combined	5	3	6.25%	14.29%	60.00%
Face to face with remote	25	2	31.25%	9.52%	8.00%
Remote	23	9	28.75%	42.86%	39.13%
Population					
CV conditions or COPD	17	5	21.25%	23.81%	29.41%
CV risk	4	1	5.00%	4.76%	25.00%
Pregnant or postpartum	19	3	23.75%	14.29%	15.79%
Motivated to quit	10	6	12.50%	28.57%	60.00%
ED or Hospital	9	0	11.25%	0.00%	0.00%
Primary care	5	0	6.25%	0.00%	0.00%

4.4.5 BCT clusters

BCT clusters used in the smoking interventions are summarised in Table 7.

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The most commonly used BCT clusters in the smoking health interventions were BCT cluster (BCT-C) 1 ‘Social support’ (86.3%) followed by BCT-C 11 ‘Goals and Planning’ (65.0%). BCT-C 4 ‘Associations’ was not used in any of the interventions.

The association between BCT clusters and intervention effectiveness was assessed in the meta-regression, and results are described in Section 4.4.8.

4.4.6 Intervention functions

Interventions functions used in the smoking interventions are summarised in Table 8.

The most commonly used intervention functions (IFs) were IF9 ‘Enablement’ (96.3%) and IF1 ‘Education’ (63.8%). IF6 ‘Restriction’ was not used in any of the interventions.

The association between intervention function and intervention effectiveness was assessed in the meta-regression, and results are described in Section 4.4.8.

4.4.7 Theory use

Twenty-one comparisons included an intervention explicitly linked to a theory or model. These were:

- Transtheoretical Model (Hyman 2007* [++] Sec and Sic interventions; Chouinard 2005 [++] IC and IC+FU interventions; Schunmann 2008 [+]; Stotts 2009 [+] MI+USF intervention; Lawrence 2003 [+] SHM and SHM+ICI interventions)
- Transtheoretical Model and Motivational Interviewing Theory (Bernstein 2011 [++])
- Transtheoretical Model and the Theory of Planned Behaviour (Armitage 2008 [++])

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- Transtheoretical Model, Social Learning Theory and the Health Belief Model (Rigotti 2006 [+])
- Cognitive Behavioural Model (Sivarajan Froelicher 2004 [+]; Hall 2009 ENRT+CBT and ECBT [+])
- Self-Efficacy Theory (Smeulders 2009 [+], Lacasse 2008 [+])
- Social Ecological Theory (Glasgow 2009 [+])
- Cognitive Dissonance Theory (Simmons 2007 [+])
- Social Cognitive Theory (Sutton 2007 [+])
- Behavioural Ecological Model and Learning Theory (Hovell 2009 [+])
- I-Change model (de Vries 2006 [+])

The most commonly used theory or model was the Transtheoretical Model (also known as the Stages of Change model), which was used in eleven interventions. In three of these interventions the Transtheoretical Model was combined with another theory or model.

The presence of a theory was controlled for in the meta-regression, and results are described in Section 4.4.8.

4.4.8 Effects of behaviour change interventions, BCT clusters and intervention functions using meta-regression

Results from 80 comparisons (66 studies) were included in the meta-regression models. As shown in Figure 10, overall the studies found a small significant effect of the individual level behaviour change interventions (SMD 0.28, 95% CI 0.21 to 0.36). The analysis had substantial levels of heterogeneity (I^2=68.1%, 95% CI 59.2% to 74.2%, p<0.001). No studies were found to be outliers.

There was no evidence of publication bias using Egger's test for small study effects (p=0.728). Using a filled funnel plot approach, addition of hypothetical results from potential missing studies led to very little change in the pooled effect size, and the effect remained statistically significant (SMD 0.26, 95% CI

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0.19 to 0.34; p<0.001). This suggests that publication bias is not having an effect on the meta-analysis.

Full meta-regression results are provided in Appendix H. In adjusted univariate analyses controlled for the presence of each BCT/intervention function in the control group, the following factors contributed to the between study variance (see Table 26):

- BCT cluster 1 – Social support (12.2%)
- Theory use (10.4%)
- BCT cluster 2 – Regulation (6.1%)
- Intervention function 7 – Environmental restructuring (4.6%)
- BCT cluster 11 – Goals and planning (2.6%)

The final multivariate model included all of these variables and adjusted for use of each BCT/intervention function in the control group as well as theory use accounted for 34.3% of between study variability in results (see Table 26).

The only factor which showed a statistically significant association with effectiveness was BCT cluster 11 Goals and planning. The use of techniques in this BCT cluster was associated with reduced effectiveness of the intervention (regression coefficient -0.14, 95% CI -0.27 to -0.004; p=0.044). Among the other factors, which did not show a significant association with effectiveness, BCT clusters 1 Social support and 2 Regulation and intervention function 7 Environmental restructuring showed a positive direction of effect (see Table 26).

A sensitivity analysis including only studies with long term follow up (30 comparisons) showed similar results, with the multivariate model explaining 41.1% of the between study variance. The effect associated with BCT cluster 11 Goals and planning became just non-significant in this analysis, and the direction of effect of BCT cluster 1 became negative rather than positive (See

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Table 26). This change in direction of effect of BCT cluster 1 suggests that its effects are not maintained in the long term.

These results suggest that some, but not most, variance between studies may be explained by BCT clusters, intervention function, and theory use.

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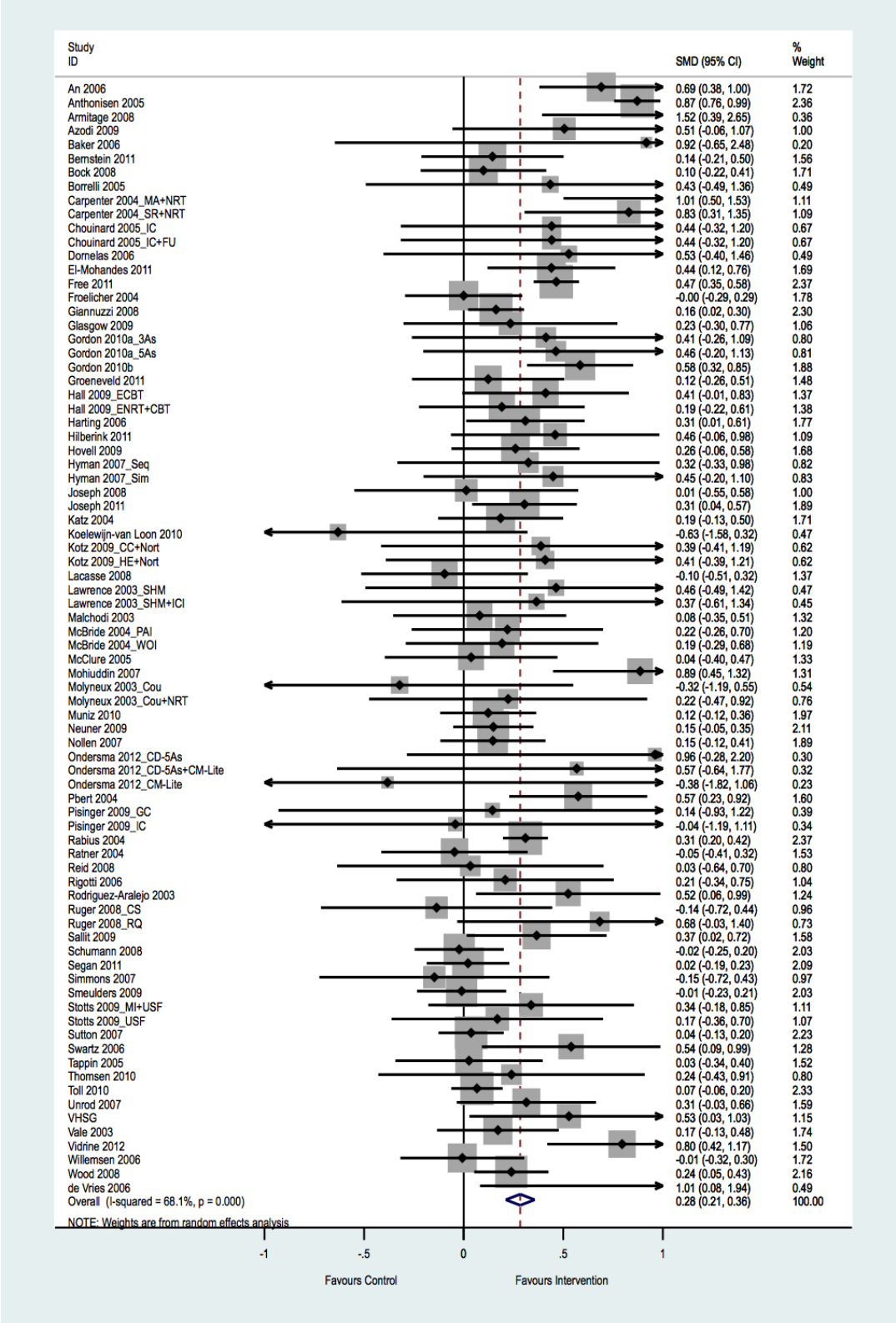
Figure 10: Overall effect of individual-level behaviour change interventions on smoking



CI confidence interval; SMD standardised mean difference.
Sadr Azodi 2009 shortened to Azodi 2009, Sivarajan Froelicher 2004 shortened to Froelicher 2004

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Table 26: Meta-regression of BCT clusters and intervention functions in smoking

Covariate	β	95% CI	P value	Adjusted R^2
Adjusted univariate analysis				
BCT-C 1 – Social support	0.14	0.01 to 0.28	0.037	12.2%
BCT-C 2 – Regulation	0.10	-0.03 to 0.23	0.126	6.1%
IF 7 – Environmental restructuring	0.09	-0.07 to 0.26	0.274	4.6%
BCT-C 11 – Goals and planning	-0.07	-0.21 to 0.07	0.305	2.6%
Theory use	-0.13	-0.29 to 0.02	0.085	10.4%
Primary multivariate analysis				
BCT-C 1 – Social support	0.11	-0.03 to 0.26	0.108	34.3%
BCT-C 2 – Regulation	0.09	-0.04 to 0.22	0.163	
IF7 – Environmental restructuring	0.06	-0.10 to 0.21	0.471	
BCT-C 11 – Goals and planning	-0.14	-0.27 to -0.004	0.044	
Theory use	-0.07	-0.22 to 0.08	0.364	
Multivariate analysis – long term follow up only (sensitivity analysis)				
BCT-C 1 – Social support	-0.13	-0.51 to 0.25	0.494	41.1%
BCT-C 2 – Regulation	0.10	-0.14 to 0.35	0.387	
IF7 – Environmental restructuring	0.13	-0.11 to 0.38	0.267	
BCT-C 11 – Goals and planning	-0.23	-0.47 to 0.01	0.059	
Theory use	-0.22	-0.59 to 0.16	0.242	

β = regression coefficient; BCT-C = BCT Cluster; CI = confidence interval; IF = intervention function

Adjusted R^2 = the proportion of between study variance explained by a variable(s). A positive regression coefficient indicates that the presence of the cluster or intervention function is associated with increased effectiveness of the intervention; a negative regression coefficient indicates that the presence of the cluster or intervention function is associated with decreased effectiveness of the intervention. BCT-clusters and intervention function in the comparator group were controlled for in the univariate analyses, the multivariate analyses also controlled for theory use.

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4.4.9 Evidence statements

Direction of effect across all interventions in the specified behaviour area	
A	BCT found in interventions with a positive direction of effect only (i.e. effect favours intervention)
B	BCT found in interventions with a negative direction of effect only (i.e. effect favours control)
C	BCT found in interventions with positive and negative directions of effect (i.e. inconsistent direction of effect – some favouring intervention, some favouring control)
Significance and consistency of effect across all interventions in the specified behaviour area	
1	BCT found in one intervention with a significant positive effect
2	BCT found in more than one intervention with a significant positive effect

Applicability and transferability of evidence to the UK

This applicability statement applies to all of the smoking evidence statements for Review 2. These 80 interventions have partial to direct applicability to the UK. Seven trials, describing nine interventions (Molyneux_Cou 2003 [+], Molyneux_Cou+NRT 2003 [+], Tappin 2005 [++], Lawrence_SHM+ICI 2003 [+], Lawrence_SHM 2003 [+], Rigotti 2006 [+], Sutton 2007 [+], Free 2011 [+], Armitage 2008 [++]) were carried out in the UK. Of the remaining 71 interventions, 19 were conducted in in other European countries, five in Canada, three in Australia, and 43 in the USA. Therefore caution is required when interpreting findings regarding the interventions carried out in populations that may have different access to services, as well as the interventions having different delivery methods and provided in different settings from those found in the UK. The individual evidence statements provide further information on the country in which each study was conducted.

In terms of transferability to clinical or public health practice, it should be remembered that the behaviour change interventions in the randomised controlled trials in this review varied in the number of sessions provided (ranging from one to over 30) and the types of interventions (brief, extended and multi-session). Twenty-three studies included individuals selectively

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recruited based on characteristics in addition to smoking behaviours. This may reduce their direct applicability to general UK public health practice. These characteristics include gender (male: Groenveld 2011 [+]; female: Froelicher 2004 [+],Thomsen 2010 [+],Sallit 2007 [+], McClure 2005 [++], Ondersma 2012 [++],Rigotti 2006 [+], Stotts 2009 [+], Ruger 2008 [++], Malchodi 2003 [+], Tappin 2005 [++], Hovell 2009 [+], de Vries 2006 [+], El-Mohandes 2001 [+], Pbert 2004 [++], McBride 2004 [++], Dornelas 2006 [+], Lawrence 2003 [+]); ethnicity (black: Hyman_Sic 2007* [++], Hyman_Sec 2007* [++], Nollen 2007 [++], El-Mohandes 2001 [+]); concurrent drug or alcohol treatment (Reid 2008 [++]); health status (HIV positive: Vidrine 2012 [+]); and setting (university students: Simmons 2007 [+]).

Evidence Statement 3.1 – Overall Effectiveness of smoking behaviour change interventions, BCT clusters and intervention functions

Strong evidence from a body of 66 studies, describing 80 interventions (Chouinard_IC 2005 [++], Muniz 2010* [+], Giannuzzi 2008* [+], Harting 2006* [+], Joseph 2008 [+], Hyman_Sic 2007* [++], Hyman_Sec 2007* [++], Bock 2008 [+], Hilberink 2011 [+], Kotz_CC+Nort 2009 [++], Kotz_HE+Nort 2009 [++], Chouinard_IC+FU 2005 [++], Koelewijn-van Loon 2010* [+], Groenveld 2011* [+], Sivarajan Froelicher 2004 [+], Wood 2008* [++], Vestfold Heartcare Study Group [VHSG] 2003* [++], Anthonisen 2005 [+], Mohiuddin 2007 [+], Smeulders 2009* [+], Vale 2003* [++], Molyneux_Cou 2003 [+], Molyneux_Cou+NRT 2003 [+], Lacasse 2008 [+], Thomsen 2010 [+], Sadr Azodi 2009 [++], Bernstein 2011 [++], Neuner 2009 [+], Ratner 2004 [++], Glasgow 2009 [+], Ondersma_CM-Lite 2012 [++], Ondersma_CD-5As+CM-Lite 2012 [++], Ondersma_CD-5As 2012 [++], Stotts_USF 2009 [+], Ruger_CS 2008 [++], Malchodi 2003 [+], Tappin 2005 [++], Hovell 2009 [+], Ruger_RQ 2008 [++], Lawrence_SHM+ICI 2003 [+], Lawrence_SHM 2003 [+], de Vries 2006 [+], Pbert 2004 [+], El-Mohandes 2011 [+], McBride_WOI 2004 [++], McBride_PAI 2004 [++], Stotts_MI+USF 2009 [+], Dornelas 2006 [+], Rigotti 2006 [+], Willemsen 2006 [+], Sutton 2007 [+], Toll 2010 [++],

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Rodriguez-Aralejo 2003 [++], Nollen 2007 [++], Joseph 2011[++], Rabius 2004 [+], Free 2011 [++], Swartz 2006 [+], An 2006 [+], Gordon_5As 2010a [+], Gordon_3As 2010a [+], Gordon 2010b [++], Unrod 2007 [+], Borrelli 2005 [+], Pisinger_GC 2010 [+], Pisinger_IC 2010 [+], Katz 2004 [+], Sallit 2009* [+], Baker 2006 [+], Simmons 2007 [+], Hall_ECBT 2009 [+], Hall_ENRT+CBT 2009 [+], Reid 2008 [++], Armitage 2008 [++], Segan 2011[++], McClure 2005 [++], Vidrine 2012 [+], Schumann 2008 [+], Carpenter SR+NRT 2004 [+], Carpenter MA+NRT 2004 [+]) suggests that individual level behaviour change interventions can have a small, significant effect on smoking behaviour. These RCTs found that behaviour change interventions have an effect size of 0.28 (95% CI 0.21 to 0.36).

Meta-regression of the results of these RCTs suggested that the following variables explain 34.3% of between study variance:

- BCT-C 1 – Social support (regression coefficient 0.11, 95% CI -0.03 to 0.26; p=0.108)
- BCT-C 2 – Regulation (regression coefficient 0.09, 95% CI -0.04 to 0.22, p=0.163)
- IF7 – Environmental restructuring (regression coefficient 0.06, 95% CI -0.10 to 0.21, p=0.471)
- BCT-C 11 – Goals and planning (regression coefficient -0.14, 95% CI -0.27 to -0.004, p=0.044)

BCT Cluster ‘Goals and planning’ is be associated with reduced effectiveness of interventions (regression coefficient -0.14, 95% CI -0.28 to -0.004; p=0.044), while BCT-Clusters 1 and 2 and Intervention function 7 showed non-significant associations with increased intervention effectiveness.

The effects of BCT clusters 2 and 11 and intervention function 7 appear to be maintained in the long term. The direction of effect of BCT cluster 1 is not stable in the long term, becoming negative.

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Evidence statement 3.2 – BCTs reported in interventions with a positive effect across smoking trials

Strong evidence from a body of 66 studies, describing 80 interventions (See Evidence Statement 3.1 for references) suggests that the following three BCTs are consistently associated with a significant intervention effect in smoking trials (reported in more than one smoking intervention with a positive and significant direction of effect): 1 Social support – practical[A2], 65 Review behaviour goal[A2], and 75 Framing/reframing[A2].

The following BCTs were reported in one trial with a significant intervention effect: 11 Self-monitoring of outcome of behaviour[A1], 25 Behaviour substitution[A1], 28 Generalisation of target behaviour[A1], 29 Graded tasks[A1], 30 Restructuring the physical environment[A1], 31 Restructuring the social environment[A1], 33 Distraction[A1], 40 Verbal persuasion about capability[A1], 41 Mental rehearsal of successful performance [A1], 42 Focus on past success[A1], 82 Monitoring of emotional consequences[A1], 84 Demonstration of the behaviour[A1], 86 Information about others' approval[A1]. Nine BCTs were reported only in trials that resulted in a positive direction of effect, however, the effect was non-significant: 2 Social support – emotional[A], 14 Biofeedback[A], 32 Avoidance/reducing exposure to cues for the behaviour[A], 66 Review outcome goals[A], 69 Discrepancy between current behaviour and goal[A], 71 Pros and Cons[A], 72 Comparative imaginings of future outcomes[A], 79 Information about emotional consequences[A], 89 Vicarious consequences[A].

Evidence statement 3.3 – BCTs reported in interventions with inconsistent effects across smoking trials

Strong evidence from a body of 67 studies, describing 80 interventions (See ES3.1 for references) suggests that the following BCTs are associated with inconsistent effects, both in terms of direction and significance of effect: 3 Social support – unspecified[C2], 4 Pharmacological support[C2], 5 Reduce negative emotions[C2], 8 Feedback on behaviour[C], 9 Feedback on outcome(s)

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of behaviour[C1], 10 Self-monitoring of behaviour[C1], 23 Behaviour practice/rehersal[C2], 34 Adding objects to the environment[C2], 35 Body changes[C1], 36 Instruction on how to perform a behaviour[C2], 37 Information about antecedents[C], 56 Social reward[C1], 59 Future punishment[C], 61 Problem solving[C2], 62 Goal setting - behaviour[C2], 63 Goal setting - outcome[C2], 64 Action planning[C2], 68 Commitment[C2], 70 Persuasive source[C2], 76 Incompatible beliefs[C], 78 Information about health consequences[C2], 80 Information about social and environmental consequences[C1], 85 Social comparison[C].

Evidence statement 3.4 – BCTs reported in trials with an effect favouring the comparator arms across smoking trials

Strong evidence from a body of 67 studies, describing 80 interventions (See ES3.1 for references) suggests that BCTs 6 Conserving mental resources[B] and 50 Reward incompatible behaviour[B] are associated only with an intervention with non-significant effects favouring the comparator.

Evidence statement 3.5 – Face to face (one on one or group) smoking behaviour change interventions for individuals with cardiovascular conditions

Inconsistent evidence was identified from four trials regarding the effectiveness of face to face interventions delivered one on one over a single extended session (Chouinard 2005_IC 2005 [++]), one on one over multiple sessions (Muniz 2010* [+], Giannuzzi 2008* [+]), and to a group over multiple session (Smeulders 2009* [+]).

Three trials resulted in a non-significant difference in smoking abstinence compared to usual care: an extended intervention among hospitalised CVD patients (Chouinard 2005_IC 2005 [++] SMD 0.44, 95% CI -0.32 to 1.20), a one on one multi-session intervention for patients recently hospitalised for acute coronary syndrome (Muniz 2010* [+] SMD 0.12, 95% CI -0.12 to 0.36),

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and a multi-session group intervention among congestive heart failure patients (Smeulders 2009* [+] SMD -0.01, 95% CI -0.23 to 0.21). Another multi-session intervention among patients hospitalised for MI resulted in a significant effect (Giannuzzi 2008* [+] SMD 0.16, 95% CI 0.02 to 0.30).

The single face to face intervention among this population that resulted in significant effects (Giannuzzi 2008* [+]) reported use of several BCTs that did not appear in the other three, non-significant trials, including: 1 Social support (practical), 23 Behavioural practice/rehearsal, 36 Instruction on how to perform a behaviour, and 63 Goal setting (outcome). One of these (BCT 1) were reported only in smoking trials with a consistently positive and significant effect.

Chouinard_IC 2005 (cRCT [++], Canada, n=108, 24 weeks)
BCTs present:
3 Social support (unspecified)[C2]
4 Pharmacological support[C2]
34 Adding objects to the environment[C2]
61 Problem solving[C2]
71 Pros and cons[A]

Muniz 2010* (RCT [+], Spain, n=200, 16 weeks)
BCTs present:
3 Social support (unspecified)[C2]
34 Adding objects to the environment[C2]
65 Review behaviour goal[A2]
68 Commitment[C2]
70 Persuasive source[C2]
80 Information about social and environmental consequences[C1]

Smeulders 2009* (RCT [+], The Netherlands, n=317, 44 weeks); BCTs present:
3 Social support (unspecified) [C2]
62 Goal setting (behaviour)[C2]
64 Action planning[C2]

Giannuzzi 2008* (RCT [+], Italy, n=692, 0 weeks)
BCTs present:
1 Social support (practical)[A2]
3 Social support (unspecified)[C2]
23 Behavioural practice/ rehearsal[C2]

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34 Adding objects to the environment[C2]
36 Instruction on how to perform a behaviour[C2]
62 Goal setting (behaviour)[C2]
63 Goal setting (outcome)[C2]
64 Action planning[C2]
65 Review behaviour goal[A2]
68 Commitment[C2]
70 Persuasive source[C2]

Evidence statement 3.6 – Multi-session smoking behaviour change interventions delivered face to face at both an individual and group level to patients with cardiovascular conditions or obstructed airways

There is strong evidence from four trials (Wood 2008* [++], Vestfold Heartcare Study Group [VHSG] 2003* [++], Anthonisen 2005 [+], Mohiuddin 2007 [+]) that multiple session smoking cessation interventions delivered at both an individual and group level are effective at increasing smoking abstinence among patients with cardiovascular conditions or previously undetected mild to moderate airway obstruction. The effect was significant on point abstinence (Wood 2008* [+] SMD 0.24, 95% 0.05 to 0.43; VHSG 2003* [++] SMD 0.53, 95% CI 0.03 to 1.03). The effect on abstinence sustained overtime was especially pronounced, with large effect sizes seen in cessation sustained for several years in Anthonisen 2005 [+] (SMD 0.87, 95% CI 0.76 to 0.99) and for three months in Mohiuddin 2007 [+] (SMD 0.89, 95% CI 0.45 to 1.32).

No BCTs were common across all four interventions.

Wood 2008* (cluster RCT [++], France, n=562, 36 weeks)
BCTs present:
3 Social support (unspecified) [C2]
28 Generalisation of a target behaviour[A1]
34 Adding objects to the environment[C2]
61 Problem solving[C2]
62 Goal setting (behaviour)[C2]
63 Goal setting (outcome) [C2]
64 Action planning[C2]
65 Review behaviour goal[A2]

VHSG 2003* (RCT [++], Norway, n=91, 0 weeks)
BCTs present:

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1 Social support (practical)[A2]
3 Social support (unspecified)[C2]
5 Reduce negative emotions[C2]
10 Self-monitoring of behaviour[C1]
23 Behavioural practice/ rehearsal[C2]
35 Body changes[C1]
36 Instruction on how to perform a behaviour[C2]
61 Problem solving[C2]
84 Demonstration of the behaviour[A1]

Anthonisen 2005 (RCT [+], USA, n=5,887, 250 weeks)
BCTs present:
3 Social support (unspecified)[C2]
4 Pharmacological support[C2]
34 Adding objects to the environment[C2]
78 Information about health consequences[C2] (also reported in control arm)

Mohiuddin 2007 (RCT [+], USA, n=209, 21 weeks)
BCTs present:
3 Social support (unspecified)[C2] (also reported in control arm)
4 Pharmacological support[C2]
5 Reduce negative emotions[C2]
34 Adding objects to the environment[C2] (also reported in control arm)
36 Instruction on how to perform a behaviour[C2]

Evidence statement 3.7 – Smoking behaviour change interventions delivered remotely or with remote follow-up for individuals with cardiovascular conditions

Strong evidence from 13 interventions in 11 studies suggests that multi-session smoking interventions delivered remotely (Vale 2003* [++]) or face to face with remote follow-up (Harting 2006* [+], Joseph 2008 [+], Hyman_Sic 2007* [++], Hyman_Sec 2007* [++], Bock 2008 [+], Hilberink 2011 [+], Kotz_CC+Nort 2009 [++], Kotz_HE+Nort 2009 [++], Chouinard_IC+FU 2005 [++], Koelewijn-van Loon 2010* [+], Groenveld 2011* [+], Sivarajan Froelicher 2004 [+]) are no more effective than usual care at encouraging smokers with cardiovascular conditions or COPD to quit.

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The remotely delivered intervention (Vale 2003* [++]) was found to be no more effective than usual in terms of improving abstinence among patients hospitalised for CVD (SMD 0.17, 95% CI -0.13 to 0.48).

Eleven of the face to face interventions with remote follow-up resulted in no significant difference in smoking behaviour between the intervention and usual care arms at follow up (Joseph 2008 [+], Groenveld 2011* [+], Hyman_Sic 2007* [++], Hyman_Sec 2007* [++], Bock 2008 [+], Hilberink 2011 [+], Kotz_CC+Nort 2009 [++], Kotz_HE+Nort 2009 [++], Chouinard_IC+FU 2005 [++], Koelewijn-van Loon 2010* [+], Sivarajan Froelicher 2004 [+]), SMD range: -0.63 to 0.46; all non-significant.

Only one trial (Harting 2006* [+]) resulted in a significant intervention effect (SMD 0.31, 95% CI 0.01 to 0.61). All of the BCTs reported in Harting 2006* [+] were also reported in other trials in this subgroup that found non-significant intervention effects.

The intervention resulting in significant effects on the smoking behaviour did not report any BCTs which didn't also appear in at least three of the interventions reporting non-significant effects, and also did not report use of any BCTs consistently found in smoking interventions with positive effects.

Harting 2006* (RCT [+], Netherlands, n=320, 0 weeks)
BCTs reported:
3 Social support (unspecified)[C2]
4 Pharmacological support[C2]
62 Goal setting (behaviour)[C2]
64 Action planning[C2]

Vale 2003* (RCT [+], Australia, n=203, 6 weeks); BCTs present:
36 Instruction on how to perform a behaviour[C2]
61 Problem solving[C2]
63 Goal setting (outcome)[C2]
66 Review outcome goal[A]
72 Comparative imagining of future outcomes[A]
78 Information about health consequences[C2]

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Joseph 2008 (RCT [+], USA, n=101, 0 weeks)
BCTs present:
3 Social support (unspecified)[C2] (reported in control arm as well)
4 Pharmacological support[C2]
25 Behaviour substitution[A1]
62 Goal setting (behaviour)[C2]
64 Action planning[C2]

Hyman_Sic 2007* (RCT [++], USA, n=185, 0 weeks)
BCTs present:
3 Social support (unspecified) [C2]
4 Pharmacological support[C2]
8 Feedback on behaviour[C]
34 Adding objects to the environment[C2]
36 Instruction on how to perform a behaviour[C2]
62 Goal setting (behaviour) [C2]
69 Discrepancy between current behaviour and goal[A]

Hyman_Sec 2007* (RCT [++], USA, n=189, 0 weeks)
BCTs present:
3 Social support (unspecified)[C2]
4 Pharmacological support[C2]
8 Feedback on behaviour[C]
34 Adding objects to the environment[C2]
36 Instruction on how to perform a behaviour[C2]
62 Goal setting (behaviour)[C2]
69 Discrepancy between current behaviour and goal[A]

Bock 2008 (RCT [+], USA, n=292, 16 weeks)
BCTs present:
3 Social support (unspecified)[C2] (also reported in control arm)
4 Pharmacological support[C2] (also reported in control arm)
34 Adding objects to the environment[C2] (also reported in control arm)
36 Instruction on how to perform a behaviour[C2] (also reported in control arm)
62 Goal setting (behaviour)[C2] (also reported in control arm)
64 Action planning[C2]
71 Pros and cons[A]

Hilberink 2011 (cluster RCT [+], Netherlands, n=667, 0 weeks)
BCTs present:

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3 Social support (unspecified)[C2]
4 Pharmacological support[C2]

Kotz_CC+Nort 2009(RCT [++], Netherlands, n=184, 47 weeks)
BCTs present:
3 Social support (unspecified) [C2]
4 Pharmacological support[C2]
10 Self-monitoring of behaviour[C1]
14 Biofeedback[A]
34 Adding objects to the environment[C2]
71 Pros and cons[A]
76 Incompatible beliefs[C]
78 Information about health consequences[C2]

Kotz_HE+Nort 2009 (RCT [++], Netherlands, n=180, 47 weeks)
BCTs present:
3 Social support (unspecified)[C2]
4 Pharmacological support[C2]
34 Adding objects to the environment[C2]
71 Pros and cons[A]

Chouinard_IC+FU 2005 (RCT [++], Canada, n=108, 16 weeks)
BCTs present:
3 Social support (unspecified) [C2]
4 Pharmacological support[C2]
34 Adding objects to the environment[C2]
61 Problem solving[C2]
71 Pros and cons[A]

Koelewijn-van Loon 2010* (cluster RCT [+], Netherlands, n=153, 40 weeks)
BCTs present:
3 Social support (unspecified)[C2]
10 Self-monitoring of behaviour[C1]
34 Adding objects to the environment[C2] (also reported in control arm)
62 Goal setting (behaviour) [C2]
63 Goal setting (outcome)[C2]
78 Information about health consequences[C2]

Groenveld 2011* (RCT [+], Netherlands, n=162, 24 weeks)
BCTs present:
3 Social support (unspecified) [C2]

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63 Goal setting (outcome) [C2]
64 Action planning[C2]
71 Pros and cons[A]

Sivarajan Froelicher 2004 (RCT [+], USA, n=216, 108 weeks)
BCTs present:
3 Social support (unspecified) [C2] (reported in control arm as well)
4 Pharmacological support[C2]
5 Reduce negative emotions[C2]
6 Conserving mental resources[A]
8 Feedback on behaviour[C]
10 Self-monitoring of behaviour[C1]
23 Behavioural practice/ rehearsal[C2]
34 Adding objects to the environment[C2] (reported in control arm as well)
35 Body changes[C1]
36 Instruction on how to perform a behaviour[C2]
37 Information about antecedents[C]
56 Social reward[C1]
59 Future punishment[C]
61 Problem solving[C2]
68 Commitment[C2]
70 Persuasive source[C2] (reported in control arm as well)
78 Information about health consequences[C2]
80 Information about social and environmental consequences[C1]

Evidence statement 3.8 – Smoking interventions for ED or hospitalised patients

Strong evidence from nine interventions described in eight trials suggests that brief (Molyneux_Cou 2003 [+], Molyneux_Cou+NRT 2003 [+], Lacasse 2008 [+]), extended (Thomsen 2010 [+]) and multi-session (Sadr Azodi 2009 [++], Bernstein 2011 [++], Neuner 2009 [+], Ratner 2004 [++], Glasgow 2009 [+]) interventions are no more effective than usual care at encouraging cessation among ED or hospitalised patients. This non-significant effect was seen across intervention types, modes of delivery, and patient groups.

Emergency Department patients

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Multi-session face to face interventions with remote follow-up appointments were not effective at altering the smoking behaviour of patients presenting in the Emergency Department (Bernstein 2011 [++] SMD 0.14, 95% CI -0.21 to 0.50; Neuner 2009 [+] SMD 0.15, 95% CI -0.05 to 0.35).

Hospitalised Medical or Surgical patients

No significant effects on smoking cessation were seen across the interventions delivered to hospitalised patients, regardless of intervention types and mode of delivery, and reason for hospitalisation. Among patients hospitalised for non-surgical reasons, the size and direction of effect varied, although all effects remained non-significant compared to usual care (Molyneux_Cou 2003 [+], SMD -0.32, 95% CI -1.19 to 0.55; Molyneux_Cou+NRT 2003 [+] SMD 0.22, 95% CI -0.47 to 0.92; Lacasse 2008 [+] SMD -0.10, 95% CI -0.51 to 0.32)

This variation in size and direction of effect was seen among surgical patients as well (Sadr Azodi 2009 [++], SMD 0.51, 95% CI -0.06 to 1.07; Ratner 2004 [++] SMD -0.05, 95% CI -0.41 to 0.32; Thomsen 2010 [+] SMD 0.24, 95% CI -0.43 to 0.91; Glasgow 2009 [+] SMD 0.23, 95% CI -0.30 to 0.77).

The only technique common to all nine interventions is BCT 3 Social support (unspecified). Seven interventions (Molyneux_Cou+NRT 2003 [+], Lacasse 2008 [+]), Thomsen 2010 [+], Sadr Azodi 2009 [++], Bernstein 2011 [++], Neuner 2009 [+], Ratner 2004 [++]) also reported use of BCT 4 Pharmacological support.

Molyneux_Cou 2003 (RCT [+], UK, n=183, 52 weeks)
BCTs present:
3 Social support (unspecified)[C2]

Molyneux_Cou+NRT 2003 (RCT [+], UK, n=183, 52 weeks)
BCTs present:
3 Social support (unspecified)[C2]
4 Pharmacological support[C2]

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Lacasse 2008 (RCT [+], Canada, n=196, 46 weeks)
BCTs present:
3 Social support (unspecified)[C2]
4 Pharmacological support[C2]
10 Self-monitoring of behaviour [C1]
50 Reward incompatible behaviour [B]
61 Problem solving[C2]
70 Persuasive source[C2]

Extended intervention:
Thomsen 2010 (RCT [+], Denmark, n=113, 52 weeks)
BCTs present:
3 Social support (unspecified)[C2]
4 Pharmacological support[C2]
62 Goal setting (behaviour)[C2]
64 Action planning[C2]

Multi-session interventions:
Sadr Azodi 2009 (RCT [++], Sweden, n=117, 48 weeks)
BCTs present:
3 Social support (unspecified)[C2]
4 Pharmacological support[C2]
34 Adding objects to the environment[C2]
62 Goal setting (behaviour)[C2]
64 Action planning[C2]

Bernstein 2011 (RCT [++], USA, n=337, 12 weeks)
BCTs present:
3 Social support (unspecified)[C2] (also reported in control arm)
4 Pharmacological support[C2] (also reported in control arm)
9 Feedback on outcome of behaviour[C1]
34 Adding objects to the environment[C2] (also reported in control arm)
78 Information about health consequences[C2]

Neuner 2009 (RCT [+], Germany, n=1,044, 44 weeks)
BCTs present:
3 Social support (unspecified)[C2]
4 Pharmacological support[C2]
40 Verbal persuasion about capability[A1]
42 Focus on past success[A1]

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62 Goal setting (behaviour)[C2]
64 Action planning[C2]

Ratner 2004 (RCT [++], Canada, n=237, 42 weeks)
BCTs present:
3 Social support (unspecified)[C2]
4 Pharmacological support[C2]
5 Reduce negative emotions[C2]
34 Adding objects to the environment[C2]
61 Problem solving[C2]
62 Goal setting (behaviour)[C2]
64 Action planning[C2]
78 Information about health consequences[C2]

Glasgow 2009 (RCT [+], USA, n=320, 24 weeks)
BCTs present:
3 Social support (unspecified)[C2]
32 Avoidance/reducing exposure to cues for the behaviour[A]
61 Problem solving[C2]
62 Goal setting (behaviour)[C2]
64 Action planning[C2]
66 Review outcome goal[A]

Evidence statement 3.9 – Single session smoking interventions for pregnant smokers

Moderate evidence from four interventions described in two trials suggests that brief (Ondersma_CM-Lite 2012 [++], Ondersma_CD-5As+CM-Lite 2012 [++], Ondersma_CD-5As 2012 [++]) and extended (Stotts_USF 2009 [+]) smoking interventions are no more effective than usual care at aiding pregnant smokers to quit.

There was an inconsistent direction of and size of effect across the three brief remotely delivered interventions, however, all effects were non-significant (Ondersma_CM-Lite 2012 [++] SMD -0.38, 95% CI -1.82 to 1.06; Ondersma_CD-5As+CM-Lite 2012 [++] SMD 0.57, 95% CI -0.64 to 1.77; Ondersma_CD-5As 2012 [++] SMD 0.96, 95% CI -0.28 to 2.20).

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An extended smoking intervention delivered face to face and one on one (Stotts_USF 2009 [+]) was no more effective than usual care at aiding smokers in quitting during pregnancy (SMD 0.17, 95% CI -0.36 to 0.70).

These interventions reported no common BCTs, and no use of BCTs consistently reported in interventions with positive effects.

Ondersma_CM-Lite 2012 (RCT [++], USA, n=49, 10 weeks)
BCTs present:
3 Social support (unspecified)[C2]
9 Feedback on outcome of behaviour[C1]
62 Goal setting (behaviour)[C2]
80 Information about social and environmental consequences[C1]

Ondersma_CD-5As+CM-Lite 2012 (RCT [++], USA, n=45, 10 weeks)
BCTs present:
3 Social support (unspecified)[C2]
9 Feedback on outcome of behaviour[C1]
62 Goal setting (behaviour)[C2]
70 Persuasive source[C2]
80 Information about social and environmental consequences[C1]

Ondersma_CD-5As 2012 (RCT [++], USA, n=46, 10 weeks)
BCTs present:
70 Persuasive source[C2]

Stotts_USF 2009 (RCT [+], USA, n=240, 18 weeks)
BCTs present:
3 Social support (unspecified)[C2] (also reported in control arm)
78 Information about health consequences[C2]

Evidence statement 3.10 – Multi-session smoking interventions delivered face to face for pregnant or postpartum women or those with young children

Inconsistent evidence was identified from eight interventions (Ruger_CS 2008 [++], Ruger_RQ 2008 [++],Malchodi 2003 [+], Tappin 2005 [++], Hovell 2009 [+], Pbert 2004 [+], de Vries 2006 [+], El-Mohandes 2011 [+]) concerning the

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effectiveness of multi-session interventions delivered face to face and one on one among pregnant women or mothers with young children. One intervention resulted in a direction of effect that favoured the control arm (Ruger_CS 2008 [++] SMD -0.14 95% CI -0.72 to 0.44). Four interventions (Ruger_RQ 2008 [++], Malchodi 2003 [+], Tappin 2005 [++], Hovell 2009 [+]) resulted in very small to medium, but non-significant effects (Ruger_RQ 2008 [++] SMD 0.68, 95% CI -0.03 to 1.40; Malchodi 2003 [+] SMD 0.08, 95% CI -0.35 to 0.51; Tappin 2005 [++] SMD 0.03, 95% CI -0.34 to 0.40; Hovell 2009 [+] SMD 0.26, 95% CI -0.06 to 0.58).

Finally, three trials (Pbert 2004 [+], de Vries 2006 [+], El-Mohandes 2011 [+]) resulted in small to large significant effects on postpartum smoking behaviour (Pbert 2004 [+] SMD 0.57, 95% CI 0.23 to 0.92; de Vries 2006 [+] SMD 1.01, 95% CI 0.08 to 1.94; El-Mohandes 2011 [+] SMD 0.44, 95% CI 0.12 to 0.76). These three trials all reported use of BCT 3 Social support unspecified in the intervention; this BCT was also reported in studies with non-significant effects (Tappin 2005 [+], Malchodi 2003 [+] and Hovell 2009 [+]), as well as in the usual care arms of Malchodi 2003 [+] and Hovell 2009 [+].

Ruger_CS 2008 (RCT [++], USA, n=210, 24 weeks)
BCTs present:
34 Adding objects to the environment[C2] (also reported in control arm)
62 Goal setting (behaviour) [C2]
78 Information about health consequences[C2] (also reported in control arm)

Ruger_RQ 2008 (RCT [++], USA, n=49, 24 weeks)
BCTs present:
34 Adding objects to the environment[C2] (also reported in control arm)
62 Goal setting (behaviour)[C2]
78 Information about health consequences[C2] (also reported in control arm)

Malchodi 2003 (RCT [+], USA, n=142, 0 weeks)
BCTs present:
3 Social support (unspecified)[C2] (also reported in control arm)
34 Adding objects to the environment[C2] (also reported in control arm)
59 Future punishment[C] (also reported in control arm)

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70 Persuasive source[C2] (also reported in control arm)
80 Information about social and environmental consequences[C1] (also reported in control arm)

Tappin 2005 (RCT [++], UK, n=762, 18 weeks)
BCTs present:
3 Social support (unspecified)[C2]

Hovell 2009 (RCT [+], USA, n=150, 52 weeks)
BCTs present:
3 Social support (unspecified)[C2] (also reported in control arm)
4 Pharmacological support[C2]
34 Adding objects to the environment[C2]
56 Social reward[C1]
62 Goal setting (behaviour)[C2]
64 Action planning[C2]

Pbert 2004 (cRCT [+], Netherlands, n=291, 0 weeks)
BCTs present:
3 Social support (unspecified)[C2]
68 Commitment[C2]

de Vries 2006 (cRCT [+], USA, n=277, 10 weeks)
BCTs present:
3 Social support (unspecified)[C2]
61 Problem solving[C2]
78 Information about health consequences[C2]

El-Mohandes 2011 (RCT [+], USA, n=384, 0 weeks)
BCTs present:
3 Social support (unspecified)[C2]

Evidence statement 3.11 – Multi-session smoking interventions with remote components for pregnant women

Strong evidence from seven interventions suggests that multi-session remotely delivered interventions (Rigotti 2006 [+]) and face to face interventions with remote follow-up (McBride_WOI 2004 [++], McBride_PAI 2004 [++], Stotts_MI+USF 2009 [+], Dornelas 2006 [+],Lawrence_SHM 2003

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[+], Lawrence_SHM+ICI 2003 [+]) are no more effective than usual care at getting women to quit smoking during their pregnancy.

The six face to face trials with a remote component resulted in small to medium, non-significant effects (McBride_WOI 2004 [++] SMD 0.19, 95% CI -0.29 to 0.68; McBride_PAI 2004 [++] SMD 0.22, 95% CI -0.26 to 0.70; Stotts_MI+USF 2009 [+] SMD 0.34, 95% CI -0.18 to 0.85; Dornelas 2006 [+] SMD 0.53, 95% CI -0.40 to 1.46; Lawrence_SHM+ICI 2003 [+] SMD 0.37, 95% CI -0.61 to 1.34; Lawrence_SHM 2003 [+] SMD 0.46, 95% CI -0.49 to 1.42). The multi-session remotely delivered intervention (Rigotti 2006 [+]) resulted in a small, non-significant effect on postpartum smoking (SMD 0.21, 95% CI -0.34 to 0.75).

The majority of these trials reported use of BCT 3 Social support (unspecified), which was also reported in the comparator arm of two of the interventions. BCT 61 Problem solving was reported in three of the seven interventions.

McBride_WOI 2004 (RCT [++], USA, n=390, 32 weeks)
BCTs present:
3 Social support (unspecified)[C2]
61 Problem solving[C2]

McBride_PAI 2004 (RCT [++], USA, n=391, 32 weeks)
BCTs present:
2 Social support (emotional)[A]
3 Social support (unspecified)[C2]
4 Pharmacological support[C2]
25 Behaviour substitution[A1]
34 Adding objects to the environment[C2]
61 Problem solving[C2]

Stotts_MI+USF 2009 (RCT [+], USA, n=240, 18 weeks)
BCTs present:
3 Social support (unspecified)[C2] (also reported in control arm)
8 Feedback on behaviour[C]
62 Goal setting (behaviour)[C2]

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66 Review outcome goal[A]
78 Information about health consequences[C2]

Dornelas 2006 Rigotti 2006 (RCT [+], USA, n=105, 24 weeks)
BCTs present:
3 Social support (unspecified)[C2]
5 Reduce negative emotions[C2]
62 Goal setting (behaviour)[C2]
64 Action planning[C2]

Lawrence_SHM+ICI 2003 (cRCT [+], UK, n=613, 52 weeks)
BCTs present:
None reported

Lawrence_SHM 2003 (cRCT [+], UK, n=594, 52 weeks)
BCTs present:
None reported

Rigotti 2006 (RCT [+], UK, n=421, 4 weeks)
BCTs present:
3 Social support (unspecified)[C2] (also reported in control arm)
34 Adding objects to the environment[C2] (also reported in control arm)
61 Problem solving[C2]

Evidence statement 3.12 – Brief interventions for smokers who intend to quit

Moderate evidence from three trials (Willemsen 2006 [+], Sutton 2007 [+], Toll 2010 [++]) suggests that brief, remotely delivered interventions are no more effective than the comparator in terms smoking abstinence among individuals who are motivated to quit. All three trials resulted in very small, non-significant effects; two of these trials (Sutton 2007 [+], Toll 2010 [++]) offered adjunct or alternative quitline counselling, and had a direction of effect in favour of the intervention arm (Sutton 2007 [+] SMD 0.04, 95% CI -0.13 to 0.20, Toll 2010 [++] SMD 0.07, 95% CI -0.06 to 0.20), which suggests that the addition of brief interventions to established quitline counselling offers no significant

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benefit. The remaining trial (Willemsen 2006 [+]) resulted in a very small, negative, non-significant effect (SMD -0.01, 95% CI -0.32 to 0.30).

The only BCT common across all three interventions is BCT 3 Social support (unspecified). Two trials (Willemsen 2006 [+], Toll 2010 [++]) also reported use of BCTs 4 Pharmacological support and 34 Adding objects to the environment; these two BCTs also were sued in the comparator arm of Toll 2010 [++].

Willemsen 2006 (RCT [+], Netherlands, n=1,273, 23 weeks)
3 Social support (unspecified)[C2]
4 Pharmacological support[C2]
34 Adding objects to the environment[C2]
61 Problem solving[C2]
70 Persuasive source[C2]
85 Social comparison[C]

Sutton 2007 (RCT [+], UK, n=1,508, 24 weeks)
3 Social support (unspecified)[C2] (also reported in control arm)

Toll 2010 (RCT [++], USA, n=439, 10 weeks)
3 Social support (unspecified)[C2] (also reported in control arm)
4 Pharmacological support[C2] (also reported in control arm)
34 Adding objects to the environment[C2] (also reported in control arm)
75 Framing/ reframing[A2]
78 Information about health consequences[C2] (also reported in control arm)
79 Information about emotional consequences[A]
80 Information about social and environmental consequences[C1]

Evidence statement 3.13 – Multi-session smoking intervention for smokers who intend to quit

Strong evidence from seven trials (Rodriguez-Aralejo 2003 [++], Nollen 2007 [++], Joseph 2011 [++], Rabius 2004 [+], Free 2011 [++], Swartz 2006 [+], An 2006 [+]) suggests that multi-session smoking interventions can be effective at aiding cessation attempts among smokers who are motivated to quit or report intending to quit within six months. One trial (Rodriguez-Aralejo 2003

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[++]) of a workplace based intervention, delivered face to face and one on one, resulted in a medium effect sustained abstinence among smokers motivated to quit (Nollen 2007 [++] SMD 0.52, 95% CI 0.06 to 0.99), while a multi-session intervention with face to face and remote components was no more effective than usual care among African American males who wanted to quit smoking (SMD 0.15, 95% CI -0.12 to 0.41).

Five interventions used a remote delivery; all resulted in significant effects. Medium effect sizes were seen in both an internet based intervention (Swartz 2006 [+] SMD 0.54, 95% CI 0.09 to 0.99) and a multiple text message programme (Free 2011 [++] SMD 0.47, 95% CI 0.35 to 0.58). Telephone counselling resulted in small to medium effect sizes across three trials (Joseph 2011 SMD 0.31, 95% CI 0.04 to 0.57, Rabius 2004 [+] SMD 0.31, 95% CI 0.20 to 0.42; An 2006 [+] SMD 0.69, 95% CI 0.38 to 1.00).

The majority of these interventions reported use of BCT 4 Pharmacological support; this technique was also reported in both the intervention and control arms of the single non-significant intervention (Nollen 2007 [++]).

Rodriquez-Aralejo 2003 (RCT [++], Spain, n=217, 36 weeks)
3 Social support (unspecified)[C2]
4 Pharmacological support[C2]
62 Goal setting (behaviour)[C2]
63 Goal setting (outcome)[C2]

Nollen 2007 (RCT [++], USA, n=500, 16 weeks)
4 Pharmacological support[C2] (also reported in the control arm)
34 Adding objects to the environment[C2] (also reported in the control arm)
36 Instruction on how to perform a behaviour[C2]
62 Goal setting (behaviour)[C2]
65 Review behaviour goal[A2]
78 Information about health consequences[C2]

Joseph 2011 (RCT [++], USA, n=443, 24 weeks)
BCTs present:
3 Social support (unspecified)[C2] (also reported in control arm)

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4 Pharmacological support[C2] (also reported in control arm)
36 Instruction on how to perform a behaviour[C2] (also reported in control arm)
61 Problem solving[C2] (also reported in control arm)
62 Goal setting (behaviour)[C2] (also reported in control arm)
64 Action planning[C2] (also reported in control arm)
65 Review behaviour goal[A2]

Rabius 2009 (RCT [+], USA, n=3,522, 10 weeks)
BCTs present:
1 Social support (practical)[A2]
3 Social support (unspecified)[C2]
4 Pharmacological support[C2]
5 Reduce negative emotions[C2]
23 Behavioural practice/ rehearsal[C2]
41 Mental rehearsal of successful performance[A1]
56 Social reward[C1]
61 Problem solving[C2]
62 Goal setting (behaviour)[C2]
64 Action planning[C2]
75 Framing/ reframing[A2]

Swartz 2006 (RCT [+], USA, n=351, 12 weeks)
BCTs present:
3 Social support (unspecified)[C2]
36 Instruction on how to perform a behaviour[C2]
78 Information about health consequences[C2]

Free 2011 (RCT [+], UK, n=5,792, 0 weeks)
3 Social support (unspecified)[C2]
4 Pharmacological support[C2]
9 Feedback on outcome of behaviour[C1]
25 Behaviour substitution[A1]
30 Restructuring the physical environment[A1]
31 Restructuring the social environment[A1]
33 Distraction[A1]
34 Adding objects to the environment[C2]
40 Verbal persuasion about capability[A1]
42 Focus on past success[A1]
61 Problem solving[C2]
62 Goal setting (behaviour)[C2]
64 Action planning[C2]

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78 Information about health consequences[C2]
80 Information about social and environmental consequences
82 Monitoring of emotional consequences[A1]
86 Information about others' approval [A1]

An 2006 (RCT [+], USA, n=830, 24 weeks)
3 Social support (unspecified)[C2]
4 Pharmacological support[C2] (also reported in control arm)

Evidence statement 3.14 – Smoking behaviour change interventions among smokers identified in primary care

Strong evidence from four trials describing five interventions suggests brief (Unrod 2007 [+]) and multi-session (Borrelli 2005 [+], Pisinger_GC 2010 [+]) and remotely delivered (Pisinger_IC 2010 [+], Katz 2004 [+]) interventions are no more effective than usual care at improving abstinence among smokers identified in primary care settings.

A brief intervention (Unrod 2007 [+]) delivered face to face and one on one during primary care appointments is no more effective than usual care at improving abstinence (SMD 0.31, 95% CI -0.03 to 0.66). Multi-session interventions were no more effective than usual care across several delivery mechanisms, including those delivered face to face one on one (Borrelli 2005 [+] SMD 0.43, 95% CI -0.49 to 1.36), within a group (Pisinger_GC 2010 [+] SMD 0.14, 95% CI -0.93 to 1.22), or remotely (Pisinger_IC 2010 [+] SMD -0.04, 95% CI -1.19 to 1.11; Katz 2004 [+] SMD 0.19, 95% CI -0.13 to 0.50).

No BCTs occurred in all five interventions; BCTs 70 Persuasive source and 78 Information about health consequences were reported in three interventions.

Unrod 2007 (cRCT [+], USA, n=465, 24 weeks)
BCTs present:
25 Behaviour substitution[A1]
31 Restructuring the social environment[A1]
34 Adding objects to the environment[C2]

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70 Persuasive source[C2]
71 Pros and cons[A]
78 Information about health consequences[C2]
80 Information about social and environmental consequences[C1]

Borrelli 2005 (cRCT [+], USA, n=273, 32 weeks)
BCTs present:
3 Social support (unspecified)[C2] (also reported in the control arm)
62 Goal setting (behaviour)[C2]
71 Pros and cons[A]
75 Framing/ reframing[A2]
76 Incompatible beliefs[C]
78 Information about health consequences[C2]
79 Information about emotional consequences[A]
85 Social comparison[C]
89 Vicarious consequences[A]

Pisinger_GC 2010 (cRCT [+], Denmark, n=1,042, 24 weeks)
BCTs present:
3 Social support (unspecified)[C2]
4 Pharmacological support[C2]
70 Persuasive source[C2]
78 Information about health consequences[C2]

Pisinger_IC 2010 (cRCT [+], USA, n=918, 24 weeks)
BCTs present:
3 Social support (unspecified)[C2] (also reported in control arm)

Katz 2004 (cRCT [+], USA, n=1,069, 16 weeks)
3 Social support (unspecified)[C2]
4 Pharmacological support[C2]
8 Feedback on behaviour[C]
10 Self-monitoring of behaviour [C1]
34 Adding objects to the environment[C2]
61 Problem solving[C2]
62 Goal setting (behaviour)[C2]
64 Action planning[C2]
68 Commitment[C2]
70 Persuasive source[C2]

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Evidence statement 3.15 – Smoking behaviour change interventions delivered during routine dental visits

Limited, inconsistent evidence from three interventions (Gordon_5As 2010a [+], Gordon_3As 2010a [+], Gordon 2010b [++]) described in two trials was identified regarding the effectiveness of brief smoking interventions delivered during dental visits. Similar effect sizes were seen across the three interventions (SMD range 0.41 to 0.58), however, the effect was only significant in one (Gordon_5As 2010a [+] SMD 0.46, 95% CI -0.20 to 1.13; Gordon_3As 2010a [+] SMD 0.41, 95% CI -0.26 to 1.09; Gordon 2010b [++] SMD 0.58, 95% CI 0.32 to 0.85). The same BCTs were reported in the trials with significant vs. non-significant results; the effective trial (Gordon 2010b [++]) had a larger sample size, which may account for the significance of effect.

This limited evidence suggests that brief interventions following a 5As counselling approach (Ask about smoking status, Advise to quit, Assess willingness to quit, Assist with cessation skills, Arrange for follow-up) may be effective at encouraging smokers to quit.

Gordon_5As 2010a (cRCT [+], USA, n=1,367, 52 weeks)
BCTs present:
3 Social support (unspecified)[C2]
4 Pharmacological support [C2]
34 Adding objects to the environment[C2]
70 Persuasive source[C2]
78 Information about health consequences[C2]

Gordon_3As 2010a (cRCT [+], USA, n=1,343, 52 weeks)
BCTs present:
3 Social support (unspecified)[C2]
34 Adding objects to the environment[C2]
70 Persuasive source[C2]
78 Information about health consequences[C2]

Gordon 2010b (cRCT [+], USA, n=2,549, 30 weeks)

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BCTs present:
3 Social support (unspecified)[C2]
4 Pharmacological support [C2]
34 Adding objects to the environment[C2]
70 Persuasive source[C2]
78 Information about health consequences[C2]

Evidence statement 3.16 – Face to face smoking interventions among other smokers

Limited evidence was identified regarding the effectiveness of smoking interventions among highly variable populations of smokers.

Single session interventions

A brief paper-based intervention (Armitage 2008 [++]) was effective at improving abstinence among employed smokers, compared to an assessment only control (SMD 1.52, 95% CI 0.39 to 2.65). This intervention reported no BCTs that were consistently found in smoking interventions with positive effects.

An extended face to face group intervention (Simmons 2007 [+]) is no more effective than usual care at improving abstinence among university students (SMD -0.14, 95% CI -0.72 to 0.43).

Armitage 2008 (RCT [++], UK, n=230, 8 weeks)
62 Goal setting (behaviour)[C2]
64 Action planning[C2]

Simmons 2007 (RCT [+], USA, n=143, 4 weeks)
BCTs present:
34 Adding objects to the environment[C2] (also reported in control arm)
76 Incompatible beliefs[C]
78 Information about health consequences[C2]
80 Information about social and environmental consequences[C1]

Multi-session face to face one on one interventions

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A multi-session face to face intervention (Sallit 2009* [+]) that targets smoking, diet and physical activity is effective at reducing the number of cigarettes smoked among females concerned with their weight (SMD 0.37, 95% CI 0.02 to 0.72). This trial reported use of BCTs 11 Self-monitoring of outcome of behaviour, and 75 framing/reframing, both of which were reported in smoking trials with a consistently positive effect.

A multi-session intervention (Baker 2006 [+]) delivered face to face and one on one for smokers with a non-acute psychotic disorder is no more effective than usual care on sustained abstinence (SMD 0.92, 95% CI -0.65 to 2.48).

Sallit 2009* (RCT [+], USA, n=128, 36 weeks)

3 Social support (unspecified)[C2]
5 Reduce negative emotions[C2]
11 Self-monitoring of outcome of behaviour[A1]
63 Goal setting (outcome)[C2]
75 Framing/ reframing[A2]

Baker 2006 (RCT [+], Australia, n=298, 42 weeks)

3 Social support (unspecified)[C2]
4 Pharmacological support[C2]
5 Reduce negative emotions[C2]
36 Instruction on how to perform a behaviour[C2]
61 Problem solving[C2]
63 Goal setting (outcome)[C2]
64 Action planning[C2]
75 Framing/ reframing[A2]
78 Information about health consequences[C2]

Multi-session face to face group interventions

Evidence from three interventions (Hall_ECBT 2009 [+], Hall_ENRT+CBT 2009 [+], Reid 2008 [+]) described in two trials suggests that multi-session group interventions are no more effective than usual care at improving abstinence among older smokers (Hall_ECBT 2009 [+] SMD 0.41, 95% CI -0.01 to 0.83; Hall_ENRT+CBT 2009 [+] SMD 0.19, 95% CI -0.22 to 0.61), or

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abstinence among treatment seeking alcohol or drug dependent smokers (Reid 2008 [+] SMD 0.03, 95% CI -0.64 to 0.71).

Hall_ECBT 2009 (RCT [+], USA, n=169, 52 weeks)
BCTs present:
3 Social support (unspecified)[C2] (also reported in control arm)
4 Pharmacological support[C2] (also reported in control arm)
8 Feedback on behaviour[C]
10 Self-monitoring of behaviour[C1]
34 Adding objects to the environment[C2] (also reported in control arm)
37 Information about antecedents[C]
61 Problem solving[C2]
62 Goal setting (behaviour)[C2]
64 Action planning[C2]
68 Commitment[C2]
71 Pros and cons[A]
80 Information about social and environmental consequences[C1]

Hall_ENRT+CBT 2009 (RCT [+], USA, n=172, 52 weeks)
BCTs present:
3 Social support (unspecified)[C2] (also reported in control arm)
4 Pharmacological support[C2] (also reported in control arm)
8 Feedback on behaviour[C]
10 Self-monitoring of behaviour[C1]
25 Behaviour substitution[A2]
34 Adding objects to the environment[C2] (also reported in control arm)
36 Instruction on how to perform a behaviour[C2]
37 Information about antecedents[C]
61 Problem solving[C2]
62 Goal setting (behaviour)[C2]
64 Action planning[C2]
68 Commitment[C2]
71 Pros and cons[A]
80 Information about social and environmental consequences[C1]

Reid 2008 (RCT [++], USA, n=225, 17 weeks)
BCTs present:
3 Social support (unspecified)[C2]
4 Pharmacological support[C2]
34 Adding objects to the environment[C2]

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Evidence statement 3.17 – Remotely delivered smoking interventions among other smokers

Six interventions (Segan 2011[++], McClure 2005 [++], Vidrine 2012 [+], Schumann 2008 [+], Carpenter SR+NRT 2004 [+],Carpenter MA+NRT 2004 [+]) assessed the effectiveness of multi-session, remotely delivered interventions. No significant difference was seen in terms of relapse prevention among recent ex-smokers (Segan 2011 [++] SMD 0.02, 95% CI -0.19 to 0.23), long term abstinence among women with an elevated cervical cancer risk (McClure 2005 [++] SMD 0.04, 95% CI -0.40 to 0.47), or among rural smokers (Schumann 2008 [+] SMD -0.02, 95% CI -0.25 to 0.20).

Multiple telephone counselling sessions had large, significant effects on abstinence among HIV-positive smokers (Vidrine 2012 [+] SMD 0.80, 95% CI 0.42 to 1.17) and smokers not motivated to quit (Carpenter SR+NRT 2004 [+] SMD 0.83, 95% CI 0.31 to 1.35; Carpenter MA+NRT 2004 [+] SMD 1.01, 95% CI 0.50 to 1.53). These three interventions all reported use of BCTs 3 Social support (unspecified) and 4 Pharmacological support, although both were reported in the comparator arm of Vidrine 2012 [+] as well.

Segan 2011 (RCT [++], Australia, n=698, 36 weeks)
BCTs present:
3 Social support (unspecified)[C2]
5 Reduce negative emotions[C2]
61 Problem solving[C2]

McClure 2005 (RCT [++], USA, n=275, 24 weeks)
BCTs present:
3 Social support (unspecified)[C2] (also reported in control arm)
4 Pharmacological support[C2] (also reported in control arm)
34 Adding objects to the environment[C2] (also reported in control arm)
61 Problem solving[C2]
62 Goal setting (behaviour)[C2]
69 Discrepancy between current behaviour and goal[A]
78 Information about health consequences[C2]

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Schumann 2008 (RCT [+], Germany, n=847, 72 weeks)
BCTs present:
34 Adding objects to the environment[C2]

Vidrine 2012 (RCT [+], USA, n=474, 0 weeks)
BCTs present:
3 Social support (unspecified)[C2] (also reported in control arm)
4 Pharmacological support[C2] (also reported in control arm)
34 Adding objects to the environment[C2]
70 Persuasive source[C2] (also reported in control arm)
78 Information about health consequences[C2]

Carpenter_SR+NRT 2004 (RCT [+], USA, n=419, 0 weeks)
BCTs present:
3 Social support (unspecified)[C2]
4 Pharmacological support[C2]
29 Graded tasks[A1]
61 Problem solving[C2]
62 Goal setting (behaviour)[C2]
64 Action planning[C2]

Carpenter_MA+NRT 2004 (RCT [+], USA, n=404, 0 weeks)
BCTs present:
3 Social support (unspecified)[C2]
4 Pharmacological support[C2]
61 Problem solving[C2]
62 Goal setting (behaviour)[C2]
64 Action planning[C2]

4.5 Diet

4.5.1 Included studies

Twenty-four RCTs and cluster RCTs, which included 27 interventions, assessing individual level interventions targeting dietary behaviour met the population, intervention, comparator and outcome inclusion criteria after full

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text appraisal. Study characteristics and results for these studies are summarised in the evidence tables in Appendix G.

All of these 24 trials provided outcome data which could be converted into standardised mean differences (SMDs) for comparison across studies and used in the meta-analysis and meta-regression; 2 trials addressed dietary behaviour alone, and 22 studies examined diet as part of a wider lifestyle change programme. The narrative review and analyses below include these 24 studies.

4.5.2 Quality assessment

Among the 24 trials which provided useable outcome data, three studies had internal validity rated as very good [++], and 21 studies as good [+].

4.5.3 BCTs

The individual BCTs that occurred across 27 interventions described in the 24 diet trials are summarised in Figure 11, along with the effectiveness of the interventions including each BCT.

The following BCTs were reported only in trials with positive intervention effects, more than one of which was significant (annotated A2). The significance of this effect varied across the trials (see Figure 11 for details of frequency and significance):

- 1 Social support – practical
- 8 Feedback on behaviour
- 25 Behaviour substitution
- 28 Generalisation of target behaviour
- 34 Adding objects to the environment
- 35 Body changes
- 61 Problem solving
- 62 Goal setting - behaviour
- 65 Review behaviour goal(s)

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- 67 Behavioural contract
- 69 Discrepancy between current behaviour and goal
- 71 Pros and cons
- 85 Social comparison

The following BCTs were reported only in trials with positive intervention effects, one of which was significant (annotated A1). The significance of this effect varied across the trials (see Figure 11 for details of frequency and significance):

- 5 Reduce negative emotions
- 11 Self-monitoring of outcome(s) of behaviour
- 15 Prompts/cues
- 23 Behavioural practice/rehearsal
- 29 Graded tasks
- 32 Avoidance/reducing exposure to cues for the behaviour
- 43 Self talk
- 56 Social reward
- 68 Commitment
- 70 Persuasive source
- 75 Framing/reframing
- 78 Information about health consequences

The following BCTs were reported only in trials with positive intervention effects, none of which was significant (annotated A). The significance of this effect varied across the trials (see Figure 11 for details of frequency and significance):

- 9 Feedback on outcome(s) of behaviour
- 14 Biofeedback
- 30 Restructuring the physical environment

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- 31 Restructuring the social environment
- 37 Information about antecedents
- 54 Material reward
- 57 Non-specific reward
- 76 Incompatible beliefs
- 80 Information about social and environmental consequences
- 84 Demonstration of the behaviour

The following BCTs were reported in trials with positive both and negative directions of effect; more than one of the interventions with a positive effect was found to be significant (annotated C2). The significance of this effect varied across the trials (see Figure 11 for details of frequency and significance):

- 3 Social support - unspecified
- 10 Self-monitoring of behaviour
- 36 Instruction on how to perform a behaviour
- 63 Goal setting - outcome
- 64 Action planning

No dietary behaviour change trials resulted in negative effects.

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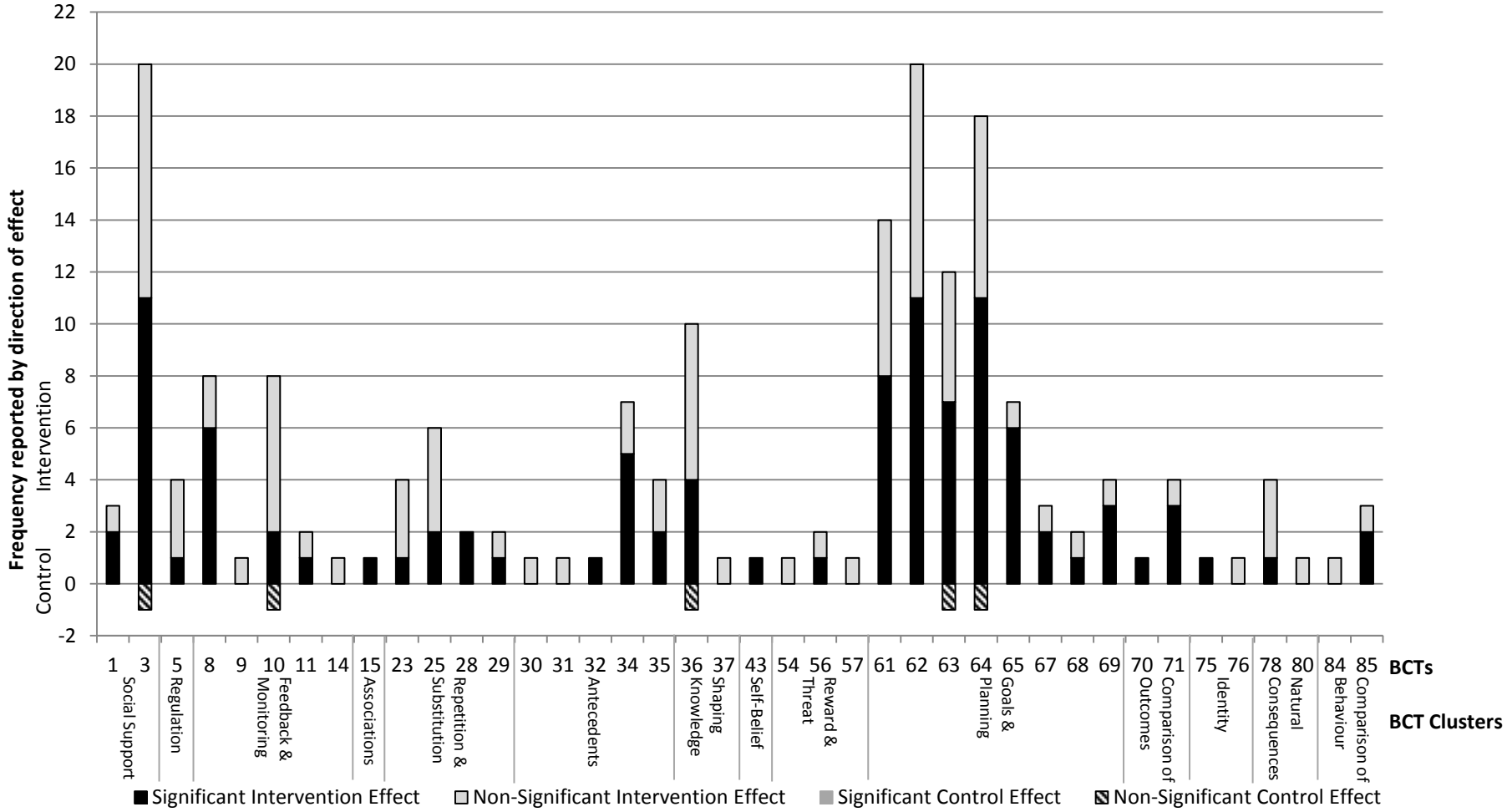
Figure 11: Distribution of behaviour change techniques in diet trials; direction and significance of effect



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4.5.4 Variation of effects across population groups

Tables 27 to 32 summarise the intervention type, mode of delivery, and effect size and significance, for dietary behaviour change interventions among overweight/obese individuals, or people with varying levels of clinical illness or risk for such illness. The subgroups covered by Tables 27 to 32 include: individuals with cardiovascular conditions, individuals with Type 2 Diabetes Mellitus (T2DM), those at risk for cardiovascular conditions, individuals at risk for T2DM, overweight or obese, and others in need of dietary intervention. These tables in combination with Figure 11 were used to assess the effects of the interventions in different population subgroups and develop evidence statements relating to these effects.

Individuals with cardiovascular conditions

Three interventions (Giannuzzi 2008* [+], Wood_CP 2008* [++], White_TB 2012* [+]) assessed the effect of dietary behaviour change interventions among people with cardiovascular conditions.

Overall, these trials used multi-session interventions and resulted in small, significant effects across the utilised modes of delivery (face to face interventions delivered on an individual or group basis). All three interventions reported use of BCTs 3 Social support (unspecified), 62 Goal setting (behaviour), and 64 Action planning. Two of the interventions (Wood_CP 2008* [++], White_TB 2012* [+]) also reported use of BCT 61 Problem solving.

Multi-session face to face interventions

One trial (Giannuzzi 2008* [+]) assessed the impact of a multi-session dietary intervention delivered face to face and one on one to recent MI patients who had completed a cardiac rehabilitation programme. The intervention resulted in a small, significant effect on adherence to a Mediterranean diet compared to usual care (SMD 0.22, 95% CI 0.15 to 0.29).

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Two interventions (Wood_CP 2008* [++], White_TB 2012* [+]) assessed the impact of a multi-session dietary intervention (which also addressed physical activity) delivered face to face to groups of patients hospitalised with coronary heart disease (CHD). Wood_CP 2008* [++] resulted in a small, significant effect on the percentage of patients consuming oily fish at least three times per week, compared to usual care (SMD 0.44, 95% CI 0.29 to 0.60). White_TB 2012* [+] resulted in a small, significant effect on healthy, low-fat eating compared to a wait list control group (SMD 0.46, 95% CI 0.05 to 0.88).

All three interventions reported use of BCTs 3 Social support (unspecified), 62 Goal setting (behaviour), and 64 Action planning. Two of the interventions (Wood_CP 2008* [++], White_TB 2012* [+]) also reported use of BCT 61 Problem solving; no BCTs were reported in the usual care arms.

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Table 27: Dietary interventions for individuals with cardiovascular conditions

Author year	Intervention Type	Primary delivery mode	Outcome	SMD	95% CI lower	95% CI upper	Intervention BCTs Control BCTs
Giannuzzi 2008* [+]	Multi-session	Face to face individual	Mediterranean diet compliance	0.22	0.15	0.29	1 Social support (practical)[A2] 3 Social support (unspecified)[C2] 23 Behavioural practice/rehearsal[A1] 34 Adding objects to the environment[A2] 36 Instruction on how to perform a behaviour[C2] 62 Goal setting (behaviour)[A2] 63 Goal setting (outcome)[C2] 64 Action planning[C2] 68 Commitment[A1] 70 Persuasive source[A1] None reported
Wood_CP 2008* [++]	Multi-session	Face to face individual and group	Oily fish at least 3 times per week	0.44	0.29	0.60	3 Social support (unspecified)[C2] 28 Generalisation of a target behaviour[A2] 34 Adding objects to the environment[A2] 61 Problem solving[A2] 62 Goal setting (behaviour)[A2] 63 Goal setting (outcome)[C2] 64 Action planning[C2] 65 Review behaviour goal[A2] None reported
White_TB 2012* [+]	Multi-session	Face to face group	Healthy eating (low fat)	0.46	0.05	0.88	3 Social support (unspecified)[C2] 29 Graded tasks[A1] 61 Problem solving[A2] 62 Goal setting (behaviour)[A2] 64 Action planning[C2] 71 Pros and cons[A2] None reported
A positive SMD represents a benefit with the intervention (i.e. favours the intervention), and a negative SMD represents a benefit with the comparator (favours comparator). A SMD of <0.2 represents a very small effect size, of ≥0.2 to <0.5 represents a small effect size, of ≥0.5 to <0.8 a medium effect size, and of ≥0.8 a large effect size.							

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Individuals with Type 2 Diabetes Mellitus

Seven trials (Osborn 2010* [+], Keogh 2011* [+], Clark 2004* [+], Glasgow 2006 [+], Thoolen 2009* [+], Toobert 2010* [+], Eakin 2010* [+]) assessed the impact of dietary interventions among individuals with Type 2 Diabetes.

Overall, these studies found very small to medium intervention effects on dietary behaviour, however, the significance of these effects was inconsistent across the trials.

Extended face to face interventions with remote components

One trial (Osborn 2010* [+]) assessed the effect of an extended face to face dietary and physical activity intervention with printed feedback on diet adherence among Puerto Rican patients with Type 2 Diabetes. The trial resulted in a small, non-significant effect on diet compliance (SMD 0.41, 95% CI -0.005 to 0.83).

Multi-session group interventions (with or without individual components)

Two interventions (Thoolen 2009* [+], Toobert 2010* [+]) assessed the impact of diet and physical activity behaviour change interventions delivered over multiple sessions primarily to groups.

Thoolen 2009* [+] included individuals with recently screening detected T2DM in a diabetes self-management intervention with diet and physical activity components. The trial resulted in a small, non-significant effect on fatty food consumption (SMD 0.15, 95% CI -0.09 to 0.39).

Toobert 2010* [+] enrolled postmenopausal women who had T2DM in a multi-session group based diet and physical activity intervention. The trial included a three day retreat and weekly group meetings thereafter, and resulted in a small, non-significant effect on healthy eating (SMD 0.152, 95% CI -0.086 to 0.391).

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Both interventions reported use of BCTs 64 Action planning in the intervention arms, and reported no BCTs in the usual care arm.

Multi-session individual face to face interventions with remote follow-up

Three interventions (Keogh 2011* [+], Clark 2004* [+], Glasgow 2006 [+]) assessed the effect of a multi-session dietary intervention delivered in person with remote follow-up on fatty food consumption among patients with Type 2 Diabetes.

Keogh 2011* [+] employed a multi-session diet and physical activity intervention involving both the patient and a family member. The intervention resulted in a very small, non-significant effect on fat consumption compared to usual care (SMD 0.07, 95% CI -0.29 to 0.42).

Clark 2004* [+] enrolled overweight and obese individuals with T2DM for a multi-session intervention delivered face to face with telephone follow-up. The trial resulted in a medium, significant effect on fatty food intake at six months follow-up (SMD 0.55, 95% CI 0.15 to 0.95).

Glasgow 2006 [+] assessed the effect of a tailored self-management intervention (delivered over multiple sessions face to face and via computer with follow-up phone calls) among T2DM patients. The trial resulted in a small, significant effect on fat consumption at 4 weeks' follow-up (SMD 0.37, 95% CI 0.14 to 0.60).

The two effective trials (Clark 2004* [+], Glasgow 2006 [+]) reported use of BCTs 8 Feedback on behaviour, and 65 Review behaviour goal; none of these BCTs were reported in the ineffective trial in this subgroup, and were consistently reported in trials with positive, significant effects across all the dietary trials included in the review.

Multi-session remotely delivered interventions

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One trial (Eakin 2010* [+]) assessed the effect of multiple diet and physical activity telephone counselling calls on vegetable consumption at six months' follow-up among patients with T2DM or hypertension in a socioeconomically disadvantaged community. The intervention resulted in a small, significant effect (SMD 0.20, 95% CI 0.01 to 0.39).

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Table 28: Dietary interventions for individuals with Type 2 Diabetes Mellitus

Author year	Intervention Type	Primary delivery mode	Outcome	SMD	95% CI lower	95% CI upper	Intervention BCTs Control BCTs
Osborn 2010* [+]	Extended	Face to face with remote (print) feedback	Diet adherence	0.41	-0.005	0.83	9 Feedback on outcome of behaviour[A] 23 Behavioural practice/rehearsal[A1] 25 Behaviour substitution[A2] 34 Adding objects to the environment[A2] 36 Instruction on how to perform a behaviour[C2] 37 Information about antecedents[A] 56 Social reward[A1] 61 Problem solving[A2] 63 Goal setting (outcome)[C2] 64 Action planning[C2] 78 Information about health consequences[A1] 80 Information about social and environmental consequences[A] None reported
Thoolen 2009* [+]	Multi-session	Face to face with individual and group	Fatty food intake	0.19	-0.10	0.49	11 Self-monitoring of outcome of behaviour[A1] 23 Behavioural practice/rehearsal[A1] 61 Problem solving[A2] 63 Goal setting (outcome)[C2] 64 Action planning[C2] 65 Review behaviour goal[A2] None reported
Toobert 2010* [+]	Multi-session	Face to face with individual and group	Healthy eating habits	0.15	-0.09	0.39	3 Social support (unspecified)[C2] 5 Reduce negative emotions[A1] 10 Self-monitoring of behaviour[C2] 25 Behaviour substitution[A2] 29 Graded tasks[A1] 35 Body changes[A2] 36 Instruction on how to perform a behaviour[C2] 54 Material reward for behaviour[A] 62 Goal setting (behaviour)[A2] 64 Action planning[C2]

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Author year	Intervention Type	Primary delivery mode	Outcome	SMD	95% CI lower	95% CI upper	Intervention BCTs Control BCTs
							None reported
Keogh 2011* [+]	Multi-session	Face to face (with family member) with remote (phone) follow-up	Fatty food intake	0.07	-0.29	0.42	3 Social support (unspecified)[C2] 61 Problem solving[A2] 62 Goal setting (behaviour)[A2] 64 Action planning[C2] 67 Behavioural contract[A2] 68 Commitment[A1] 78 Information about health consequences[A1] None reported
Clark 2004* [+]	Multi-session	Face to face with remote (phone) follow up	Fatty food intake	0.55	0.15	0.95	8 Feedback on behaviour[A2] 43 Self-talk[A1] 61 Problem solving[A2] 62 Goal setting (behaviour)[A2] 63 Goal setting (outcome)[C2] 65 Review behaviour goal[A2] 69 Discrepancy between current behaviour and goal[A2] 71 Pros and cons[A2] None reported
Glasgow 2006 [+]	Multi-session	Face to face with remote follow up	Fatty food intake	0.37	0.14	0.60	3 Social support (unspecified)[C2] 8 Feedback on behaviour[A2] 25 Behaviour substitution[A2] 32 Avoidance/reducing exposure to cues for the behaviour[A1] 36 Instruction on how to perform a behaviour[C2] 61 Problem solving[A2] 62 Goal setting (behaviour)[A2] 64 Action planning[C2] 65 Review behaviour goal[A2] 67 Behavioural contract[A2] 78 Information about health consequences[A1]

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Author year	Intervention Type	Primary delivery mode	Outcome	SMD	95% CI lower	95% CI upper	Intervention BCTs Control BCTs
							None reported
Eakin 2010* [+]	Multi-session	Remote (phone)	Servings of vegetables	0.20	0.01	0.39	1 Social support (practical)[A2] 3 Social support (unspecified)[C2] 8 Feedback on behaviour[A2] 10 Self-monitoring of behaviour[C2] 34 Adding objects to the environment[A2] 35 Body changes[A2] 61 Problem solving[A2] 62 Goal setting (behaviour)[A2] 64 Action planning[C2] 65 Review behaviour goal[A2] 69 Discrepancy between current behaviour and goal[A2] 85 Social comparison[A2] 8 Feedback on behaviour[A2]
A positive SMD represents a benefit with the intervention (i.e. favours the intervention), and a negative SMD represents a benefit with the comparator (favours comparator). A SMD of <0.2 represents a very small effect size, of ≥0.2 to <0.5 represents a small effect size, of ≥0.5 to <0.8 a medium effect size, and of ≥0.8 a large effect size. * Intervention targeted multiple behaviour topcs							

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Individuals at risk for cardiovascular conditions

Eight interventions (Burke 2008* [+], Hardcastle 2008* [+], Groeneveld 2011* [+], Koelewijn-van Loon 2003* [++], Ellingsen 2005* [+], Wright_NE 2011[+], Wright_TDF 2011 [+], Wood_HR 2008* [++]) assessed dietary behaviour change interventions in individuals at risk for cardiovascular conditions.

Overall, these interventions resulted in a wide range of effects, both in terms of size (very small to large) and significance. Limited evidence suggests that multi-session face to face interventions delivered on a combined one on one and group level may be effective at encouraging dietary changes among individuals at risk for cardiovascular conditions. Similarly, there is limited evidence that multi-session interventions delivered face to face and one on one, face to face in a group or remotely delivered interventions are no more effective than usual care in this population. The evidence surrounding multi-session interventions delivered face to face with a remote component is limited and inconsistent.

Multi-session face to face one on one intervention

One trial (Hardcastle 2008* [+]) provided lifestyle counselling (which involved both diet and physical activity) face to face and one on one over multiple sessions to overweight and obese patients at risk for coronary artery disease. The trial found a very small, non-significant difference in fat consumption compared to usual care (SMD 0.07, 95% CI -0.15 to 0.29).

Multi-session face to face one on one interventions with remote component

Two trials (Groeneveld 2011* [+], Koelewijn-van Loon 2003* [+]) assessed the impact of face to face interventions with a remote component on dietary behaviour change among individuals at risk for various cardiovascular conditions.

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Groeneveld 2011* [+] assessed the effect of a multi-component lifestyle intervention (including diet, physical activity and smoking) delivered face to face one on one as well as over the phone to male construction workers screened as at risk for CVD. At six months' follow-up, the intervention had a large, significant effect on the amount of vegetables eaten per week compared to usual care (SMD 1.11, 95% CI 0.91 to 1.32).

Koelewijn-van Loon 2003* [+] assessed the impact of a multi-session face to face individual and telephone lifestyle intervention (addressing diet, physical activity and smoking) on the dietary behaviours of patients deemed eligible for cardiovascular risk management. The intervention resulted in a very small, non-significant effect on fat consumption at 10 months follow-up compared to usual care (SMD 0.19, 95% CI -0.07 to 0.44).

All of the BCTs reported in the intervention with a significant effect (Groeneveld 2011* [+]) were also reported in the intervention with a non-significant effect (Koelewijn-van Loon 2003* [+]), except BCT 71 Pros and cons.

Multi-session face to face interventions, one on one and group

Two interventions (Ellingsen 2005* [+], Wood_HR 2008* [++]) provided face to face interventions delivered on an individual and group level to patients with elevated CV risk. Both of these trials resulted in small, significant effects on dietary behaviour.

Ellingsen 2005* [+] enrolled men in their 40's with elevated total cholesterol or a high coronary risk score for a face to face intervention that had both group and one-on-one delivery components. The trial resulted in a small, significant difference in fat consumption over approximately 20 years compared to no intervention (SMD 0.34, 95% CI 0.17 to 0.51).

Wood_HR 2008* [++] assessed the effect of a multi-session dietary intervention (which also addressed physical activity) delivered face to face to

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primary care patients with elevated CV risk; patients' partners joined the patients for the intervention. The trial resulted in a small, significant effect on the proportion of patients consuming oily fish at least three times a week (SMD 0.37, 95% CI 0.19 to 0.55).

Both interventions reported use of BCTs 3 Social support (unspecified), 62 Goal setting (behaviour), and 64 Action planning; no BCTs were reported in the usual care arms.

Multi-session group interventions

Two trials (Wright_NE 2011 [+], Burke 2008* [+]) provided face to face interventions delivered primarily in a group setting to individuals with elevated CV risk.

Wright_NE 2011 [+] enrolled patients at risk for CVD into either group counselling with remote (posted) feedback or usual care. The intervention resulted in a small, non-significant effect on vegetable consumption SMD 0.26, 95% CI -0.18 to 0.70).

Burke 2008* [+] provided a multi-session CV risk and lifestyle intervention (that addressed diet, physical activity and alcohol) delivered face to face primarily on a group basis to overweight and obese individuals being treated with antihypertensive medication. The trial resulted in a small, non-significant effect on the proportion of people consuming at least five servings of fruit and vegetables each day, compared usual care (SMD 0.21, 95% CI -0.08 to 0.49).

Both interventions reported use of BCTs 62 Goal setting (behaviour).

Multi-session remotely delivered interventions

One trial (Wright_TDF 2011 [+]) assessed the effectiveness of a multi-session remotely delivered tailored feedback intervention on dietary behaviours among people with elevated CV risk. The intervention mailed feedback materials to participants, and resulted in a small, non-significant difference in

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vegetable consumption two weeks after the end of the intervention (SMD 0.26, 95% CI -0.18 to 0.70).

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Table 29: Dietary interventions for individuals at risk for cardiovascular conditions

Author year	Type	Primary delivery mode	Outcome	SMD	95% CI lower	95% CI upper	Intervention BCTs Control BCTs
Hardcastle 2008* [+]	Multi-session	Face to face one on one	Fruit and vegetable intake	0.07	-0.15	0.29	3 Social support (unspecified)[C2] None reported
Groeneveld 2011* [+]	Multi-session	Face to face one on one with remote (phone)	Vegetable intake	1.11	0.91	1.32	3 Social support (unspecified)[C2] 63 Goal setting (outcome)[C2] 64 Action planning[C2] 71 Pros and cons[A2] None reported
Koelewijn-van Loon 2003* [+]	Multi-session	Face to face one on one with remote component	Fatty food intake	0.19	-0.07	0.44	3 Social support (unspecified)[C2] 10 Self-monitoring of behaviour[C2] 34 Adding objects to the environment[A2] 62 Goal setting (behaviour)[A2] 63 Goal setting (outcome)[C2] 78 Information about health consequences[A1] 34 Adding objects to the environment[A2]
Ellingsen 2005* [+]	Multi-session	Face to face combined one on one and group	Fatty food intake	0.34	0.17	0.51	3 Social support (unspecified)[C2] 36 Instruction on how to perform a behaviour[C2] 62 Goal setting (behaviour)[A2] 64 Action planning[C2] None reported
Wood_HR 2008* [++]	Multi-session	Face to face combined one on one and group	Oily fish at least 3 times per week	0.37	0.19	0.55	3 Social support (unspecified)[C2] 28 Generalisation of a target behaviour[A2] 34 Adding objects to the environment[A2] 61 Problem solving[A2] 62 Goal setting (behaviour)[A2] 63 Goal setting (outcome)[C2] 64 Action planning[C2] 65 Review behaviour goal[A2]

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Author year	Type	Primary delivery mode	Outcome	SMD	95% CI lower	95% CI upper	Intervention BCTs Control BCTs
							None reported
Wright_NE 2011 [+]	Multi-session	Face to face group	Vegetable intake	0.26	-0.18	0.70	36 Instruction on how to perform a behaviour[C2] 62 Goal setting (behaviour)[A2] None reported
Burke 2008* [+]	Multi-session	Face to face group	5 a day	0.21	-0.08	0.49	1 Social support (practical)[A2] 3 Social support (unspecified)[C2] 8 Feedback on behaviour[A2] 10 Self-monitoring of behaviour[C2] 14 Biofeedback[A] 62 Goal setting (behaviour)[A2] 63 Goal setting (outcome)[C2] 64 Action planning[C2] 14 Biofeedback[A]
Wright_TDF 2011 [+]	Multi-session	Remote (post)	Vegetable intake	0.26	-0.18	0.70	8 Feedback on behaviour[A2] 10 Self-monitoring of behaviour[C2] 57 Non-specific reward[A1] 62 Goal setting (behaviour)[A2] 69 Discrepancy between current behaviour and goal[A2] 71 Pros and cons[A2] 76 Incompatible beliefs[A1] 85 Social comparison[A2] None reported

A positive SMD represents a benefit with the intervention (i.e. favours the intervention), and a negative SMD represents a benefit with the comparator (favours comparator). A SMD of <0.2 represents a very small effect size, of ≥0.2 to <0.5 represents a small effect size, of ≥0.5 to <0.8 a medium effect size, and of ≥0.8 a large effect size.
* Intervention targeted multiple behaviour topcs

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Individuals at risk for Type 2 Diabetes Mellitus

Multi-session face to face (group and individual) interventions with remote follow-up

One trial (Lindahl 2009* [+]) assessed the effect of residential lifestyle intervention (delivered over multiple face to face sessions, with telephone follow-up) on dietary behaviour among overweight and obese individuals with impaired glucose tolerance. The trial resulted in a small, non-significant effect on vegetable consumption (SMD 0.35, 95% CI -0.05 to 0.75).

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Table 30: Dietary interventions for individuals at risk for Type 2 Diabetes Mellitus

Author year	Type	Primary delivery mode	Outcome	SMD	95% CI lower	95% CI upper	Intervention BCTs Control BCTs
Lindahl 2009* [+]	Multi-session	Face to face individual	Vegetable intake	0.35	-0.05	0.75	3 Social support (unspecified)[C2] 5 Reduce negative emotions[A1] 10 Self-monitoring of behaviour[C2] 30 Restructuring the physical environment[A] 31 Restructuring the social environment[A] 61 Problem solving[A2] 62 Goal setting (behaviour)[A2] 3 Social support (unspecified)[C2]
A positive SMD represents a benefit with the intervention (i.e. favours the intervention), and a negative SMD represents a benefit with the comparator (favours comparator). A SMD of <0.2 represents a very small effect size, of ≥0.2 to <0.5 represents a small effect size, of ≥0.5 to <0.8 a medium effect size, and of ≥0.8 a large effect size. * Intervention targeted multiple behaviour topcs							

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Overweight or obese individuals

Five interventions (Stolley 2009* [+], van Wier_I 2009* [+], van Wier_T 2009* [+], Morey 2009* [++], Patrick 2011* [+]) assessed the effect of dietary interventions among overweight or obese individuals.

Overall, all five interventions were delivered over multiple sessions. The evidence in this population was either limited (in the cases of multi-session group interventions) or inconsistent (multi-session remotely delivered interventions).

Multi-session face to face group interventions

One trial (Stolley 2009* [+]) assessed the effectiveness of a multi-session lifestyle intervention delivered primarily at the group level and targeting diet and physical activity among obese African American women. The trial resulted in a very small, non-significant difference in vegetable consumption compared to an information only control (SMD 0.19, 95% CI -0.12 to 0.48).

Multi-session remotely delivered interventions

Four interventions (van Wier_I 2009* [+], van Wier_T 2009* [+], Morey 2009* [++], Patrick 2011* [+]) assessed the effect of multi-session remotely delivered dietary interventions on fruit and vegetable consumption among overweight and obese individuals.

van Wier_I 2009* [+] compared usual care to a multi-session internet based counselling intervention (targeting diet and physical activity) among overweight and obese employees. The intervention resulted in a very small, negative, non-significant difference in the proportion of participants consuming at least two portions of fruit per day at the end of the intervention (SMD -0.06, 95% CI -0.35 to 0.23).

van Wier_T 2009* [+] compared usual care to a multi-session telephone counselling intervention (targeting diet and physical activity) among

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overweight and obese employees. The trial resulted in a very small, non-significant difference in the proportion of participants consuming at least two portions of fruit per day at the end of the intervention (SMD 0.05, 95% CI -0.23 to 0.34).

Morey 2009* [++] compared a multi-session counselling intervention delivered over the phone and via post among overweight or obese long term colorectal, breast and prostate cancer survivors (over the age of 65 years). The intervention resulted in a small, significant difference in daily servings of fruit and vegetables at the end of the trial (SMD 0.49, 95% CI 0.34 to 0.65).

Patrick 2011* [+] compared a web based multi-session intervention to a wait list control, among overweight or obese men aged 25 to 55 years. The intervention resulted in a small, significant difference in fruit and vegetable intake (SMD 0.31, 95% CI 0.08 to 0.53)

No BCTs appeared in both of the interventions with significant effects (Morey 2009* [++], Patrick 2011* [+]) that didn’t also appear in at least one of the non-significant interventions (van Wier_I 2009* [+], van Wier_T 2009* [+]).

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Table 31: Dietary interventions for overweight or obese individuals

Author year	Type	Primary delivery mode	Outcome	SMD	95% CI lower	95% CI upper	Intervention BCTs Control BCTs
Stolley 2009* [+]	Multi-session	Face to face primarily group	Vegetable intake	0.19	-0.12	0.48	3 Social support (unspecified)[C2] 23 Behavioural practice/rehearsal[A1] 25 Behaviour substitution[A2] 35 Body changes[A2] 36 Instruction on how to perform a behaviour[C2] 61 Problem solving[A2] 62 Goal setting (behaviour)[A2] 64 Action planning[C2] 84 Demonstration of the behaviour[A] None reported
van Wier_I 2009* [+]	Multi-session	Remote (internet based)	Fruit intake	-0.06	-0.35	0.23	3 Social support (unspecified)[C2] 10 Self-monitoring of behaviour[C2] 36 Instruction on how to perform a behaviour[C2] 63 Goal setting (outcome)[C2] 64 Action planning[C2] None reported
van Wier_T 2009* [+]	Multi-session	Remote (Phone)	Fruit intake	0.05	-0.23	0.34	3 Social support (unspecified)[C2] 10 Self-monitoring of behaviour[C2] 36 Instruction on how to perform a behaviour[C2] 63 Goal setting (outcome)[C2] 64 Action planning[C2] None reported

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Morey 2009* [++]	Multi-session	Remote (phone and post)	Fruit and vegetable intake	0.49	0.34	0.65	3 Social support (unspecified)[C2] 8 Feedback on behaviour[A2] 10 Self-monitoring of behaviour[C2] 15 Prompts/cues[A1] 34 Adding objects to the environment[A2] 35 Body changes[A2] 36 Instruction on how to perform a behaviour[C2] 56 Social reward[A1] 61 Problem solving[A2] 62 Goal setting (behaviour)[A2] 63 Goal setting (outcome)[C2] 64 Action planning[C2] 85 Social comparison[A2] None reported
Patrick 2011* [+]	Multi-session	Remote (internet based)	Fruit and vegetable intake	0.31	0.08	0.53	8 Feedback on behaviour[A2] 25 Behaviour substitution[A2] 62 Goal setting (behaviour)[A2] 64 Action planning[C2] 65 Review behaviour goal[A2] 69 Discrepancy between current behaviour and goal[A2] None reported

A positive SMD represents a benefit with the intervention (i.e. favours the intervention), and a negative SMD represents a benefit with the comparator (favours comparator). A SMD of <0.2 represents a very small effect size, of ≥0.2 to <0.5 represents a small effect size, of ≥0.5 to <0.8 a medium effect size, and of ≥0.8 a large effect size.
* Intervention targeted multiple behaviour topcs

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Others in need of dietary interventions

Three trials (Eakin 2007* [+], Guelinckx_B+LI 2010* [+], Sallit 2009* [+]) assessed the impact of dietary behaviour change intervention among other individuals in need of dietary interventions. This included individuals with chronic conditions (Eakin 2007* [+]), women at risk for gestational diabetes (Guelinckx_B+LI 2010* [+]) and female weight concerned smokers (Sallit 2009* [+]).

Multi-session face to face interventions with remote components for people with chronic conditions

One trial (Eakin 2007* [+]) assessed the effect of a multi-session, face to face behavioural intervention on fat and fibre intake among individuals with one or more of the following chronic conditions: hypertension, chronic pain, hypercholesterolemia, depression, type 2 diabetes, osteoarthritis, obesity, chronic lung disease, heart disease, osteoporosis, hepatitis, history of cancer, previous stroke, multiple sclerosis. The intervention took place over multiple sessions and employed both face to face (individual level) and remote components (telephone and print materials). The trial resulted in a small, significant difference in fat and fibre consumption at 3 months follow up compared to usual care (SMD 0.38, 95% CI 0.10 to 0.66),

Multi-session face to face interventions for pregnant women at risk for Gestational Diabetes

One trial (Guelinckx_B+LI 2010* [+]) examined the effectiveness of multi-session interventions on the dietary habits of pregnant women at risk for gestational diabetes. The study enrolled obese white pregnant women into a trial that aimed to reduce gestational weight gain and lower the risk of associated conditions including gestational diabetes. The multi-session group counselling intervention resulted in a small, non-significant difference in fruit consumption compared to usual care (SMD 0.40, 95% CI -0.03 to 0.83).

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Multi-session face to face interventions for weight concerned female smokers

Sallit 2009* [+] recruited weight concerned female smokers, and provided a multi-session face to face intervention addressing diet, physical activity and smoking. Compared to usual care, the trial resulted in a large, significant difference in healthy eating nine months after the conclusion of the intervention (SMD 0.89, 95% CI 0.53 to 1.26).

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Table 32: Dietary interventions for other individuals in need of intervention

Author year	Type	Primary delivery mode	Outcome	SMD	95% CI lower	95% CI upper	Intervention BCTs Control BCTs
Eakin 2007* [+]	Multi-session	Face to face one on one with remote (phone and post) component	Fatty food and fibre intake	0.38	0.10	0.66	3 Social support (unspecified)[C2] 8 Feedback on behaviour[A2] 61 Problem solving[A2] 62 Goal setting (behaviour)[A2] 64 Action planning[C2] 67 Behavioural contract[A2] 3 Social support (unspecified)[C2]
Guelinckx_B+LI 2010* [+]	Multi-session	Face to face group with remote (print) component	Fruit intake	0.40	-0.03	0.83	3 Social support (unspecified)[C2] 5 Reduce negative emotions[A1] 25 Behaviour substitution[A2] 36 Instruction on how to perform a behaviour[C2] 61 Problem solving[A2] 62 Goal setting (behaviour)[A2] None reported
Sallit 2009* [+]	Multi-session	Face to face one on one	Healthy eating	0.89	0.53	1.26	3 Social support (unspecified)[C2] 5 Reduce negative emotions[A1] 11 Self-monitoring of outcome of behaviour[A1] 63 Goal setting (outcome)[C2] 75 Framing/reframing[A1] None reported

A positive SMD represents a benefit with the intervention (i.e. favours the intervention), and a negative SMD represents a benefit with the comparator (favours comparator). A SMD of <0.2 represents a very small effect size, of ≥0.2 to <0.5 represents a small effect size, of ≥0.5 to <0.8 a medium effect size, and of ≥0.8 a large effect size.
* Intervention targeted multiple behaviour topcs

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A overview of dietary interventions according to the reviewed parameters of type, mode of delivery and population is provided in Table 33.

Table 33: Summary of dietary interventions according to type, mode of delivery, population and significant of effect

Category	Number of interventions	Number significant	% of 27 total DIE interventions (category interventions /topic total)	% of 13 total significant DIE interventions (category significant/ topic significant)	% of resulting in significant effect (category significant/ category total)
Intervention Type					
Brief	0	0	0.00%	0.00%	NA
Extended	1	0	3.70%	0.00%	0.00%
Multi-session	26	13	96.30%	100.00%	50.00%
Mode of Delivery					
Face to face, one on one	4	2	14.81%	15.38%	50.00%
Face to face, group	4	1	14.81%	7.69%	25.00%
Face to face combined	5	3	18.52%	23.08%	60.00%
Face to face with remote	8	4	29.63%	30.77%	50.00%
Remote	6	3	22.22%	23.08%	50.00%
Population					
CV conditions	3	3	11.11%	23.08%	100.00%
CV risk	8	3	29.63%	23.08%	37.50%
T2DM	7	3	25.93%	23.08%	42.86%
T2DM risk	1	0	3.70%	0.00%	0.00%
Overweight or obese	5	2	18.52%	15.38%	40.00%

4.5.5 BCT clusters

BCT clusters used in the diet interventions are summarised in Table 7.

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The most commonly used BCT clusters in the diet interventions were BCT cluster (BCT-C) 11 ‘Goals and planning (96.3%) followed by BCT-C 1 ‘Social support (77.8%). BCT-C 9 ‘Scheduled consequences’, and BCT-C 16 ‘Covert learning were not used in any of the interventions.

The association between BCT clusters and intervention effectiveness was assessed in the meta-regression, and results are described in Section 4.5.8.

4.5.6 Intervention functions

Interventions functions used in the diet interventions are summarised in Table 8.

The most commonly used intervention functions (IFs) were IF9 ‘Enablement’ (100%) and IF1 ‘Education’ (70.4%). IF6 ‘Restriction’ and IF4 ‘Coercion’ were not used in any of the interventions.

The association between intervention function and intervention effectiveness was assessed in the meta-regression, and results are described in Section 4.5.8.

4.5.7 Theory use

Twelve comparisons included an intervention explicitly linked to a theory or model. These were:

- Social Cognitive Theory (Patrick 2011* [+], Morey 2009* [++], Stolley 2009* [+], Glasgow 2006 [+])
- Social Cognitive Theory and Social Ecological Theory (Eakin 2010* [+])
- Social Cognitive Theory, Social Ecological Theory and Goal Systems Theory (Toobert 2010* [+])
- Transtheoretical Model (Wright 2011_TDF [+], Clark 2004* [+])
- Theory of Planned Behaviour (White 2012* [+])
- Social Ecological Theory (Eakin 2007* [+])
- Self-Regulatory Model (Keogh 2011* [+])

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- Information Motivation Behavioural Skills Model (Osborn 2010* [+])

The most commonly used theory or model was Social Cognitive Theory, which was used in six interventions. In two of these interventions it was combined with other theories (Social Ecological Theory and Goal Systems Theory).

The presence of a theory use was controlled for in the meta-regression, and results are described in Section 4.5.8.

4.5.8 Effects of behaviour change interventions, BCT clusters and intervention functions using meta-regression

Results from 27 comparisons (24 studies) were included in the meta-regression models. As shown in Figure 12, overall the studies found a small significant effect of the individual level behaviour change interventions (SMD 0.33, 95% CI 0.24 to 0.42; random effects analysis). The analysis had substantial levels of heterogeneity (I^2=76.1%, 95% CI 64.4% to 82.6%; p<0.001). No studies were found to be outliers.

There was no evidence of publication bias using Egger's test for small study effects (p=0.527) or from the filled funnel plot approach, which did not change the effect size or confidence interval.

Full meta-regression results are provided in Appendix H. In adjusted univariate analyses controlled for the presence of each BCT/intervention function in the control group, the following factors contributed to the between study variance (see Table 34):

- BCT cluster 12 – Comparison of outcomes (14.9%)
- Intervention function 5 – Training (8.4%)
- BCT cluster 7 – Shaping knowledge (2.1%)

The final multivariate model did not include BCT cluster 7 'Shaping knowledge' as it did not increase the amount of between study variance

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explained (the adjusted R^2 value) when it was added to the model. The multivariate model including the other two variables and controlling for BCT/intervention function in the control group and theory use explained 18.0% of the between study variance (see Table 34).

In this primary multivariate model neither of the individual variables showed a significant association with effectiveness. BCT cluster 12 Comparison of outcomes showed a positive direction of effect which approached significance (regression coefficient 0.24, 95% CI -0.01 to 0.49, p=0.061). Intervention function 5 ‘Training’ showed a negative direction of effect (regression coefficient -0.14, 95% CI -0.33 to 0.05, p=0.142).

A sensitivity multivariate analysis including only studies with long term follow up (9 comparisons) could not include the BCT cluster 12 ‘Comparison of outcomes’ variable as it was not used in the studies with long term follow-up. The multivariate model including the intervention function 5 ‘Training’ and controlling for this in the control group, as well as theory use, explained 98.1% of between study variance. Intervention function 5 ‘Training’ showed a non-significant trend towards being associated with reduced effectiveness (see Table 34). However, as the model included only a few comparisons and could not assess all of the variables it should be treated with caution.

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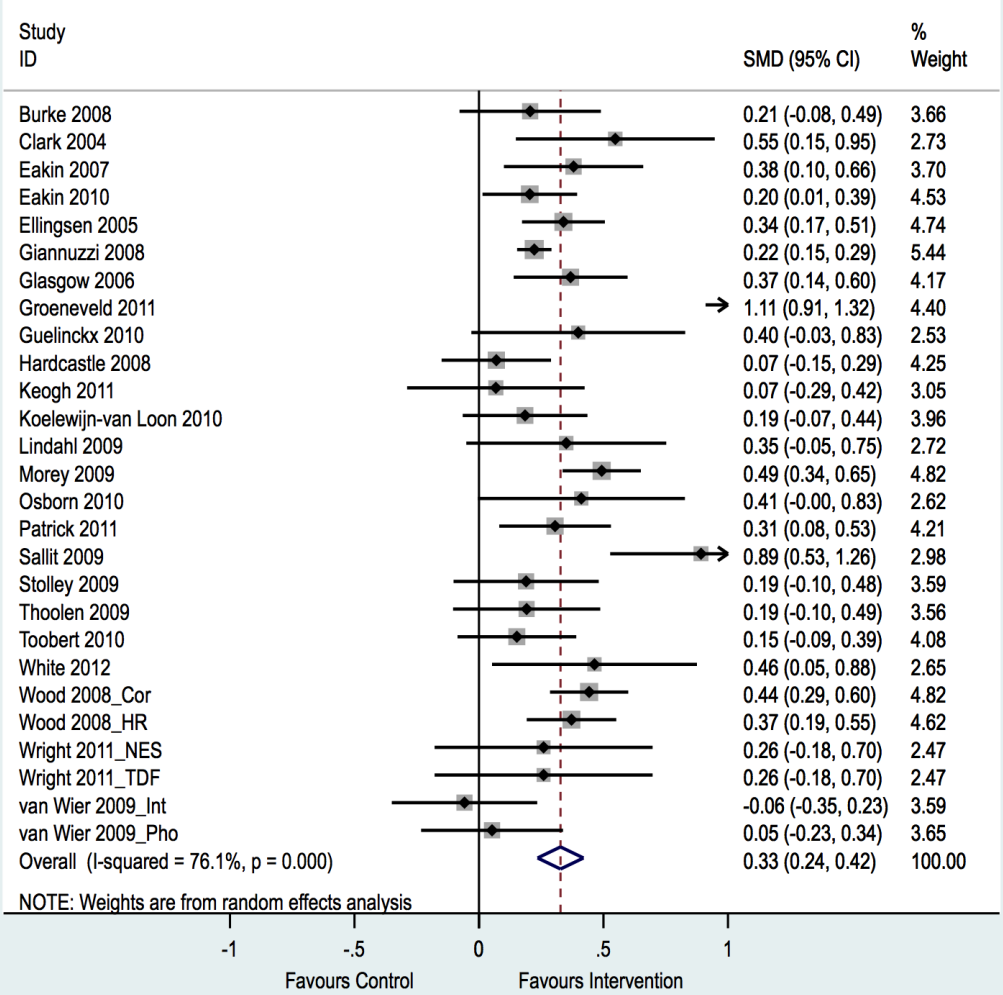
Figure 12: Overall effect of individual-level behaviour change interventions on diet behaviour



CI confidence interval; SMD standardised mean difference.
An SMD of 0 indicates no difference between intervention and control comparator. A positive SMD indicates that the intervention was more effective than control, and a negative SMD indicates that the intervention was less effective than control. If the 95% confidence interval spans 0, this indicates that the difference between the groups was not statistically significant.

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Table 34: Meta-regression results for the effect of BCT clusters and intervention functions in individual-level interventions for diet

Covariate	β	95% CI	P value	Adjusted R^2
Adjusted univariate analysis				
BCT-C 12 – Comparison of outcomes	0.25	0.002 to 0.50	0.048	14.9%
IF 5 - Training	-0.15	-0.35 to 0.04	0.12	8.4%
BCT-C 7 – Shaping knowledge	-0.12	-0.32 to 0.09	0.24	2.1%
Theory use	-0.02	-0.22 to 0.19	0.85	0%
Primary multivariate analysis				
BCT-C 7 – Shaping knowledge	Dropped because adjusted R^2 did not improve if when added to the model			
BCT-C 12 – Comparison of outcomes	0.24	-0.01 to 0.49	0.06	18.0%
IF 5 - Training	-0.14	-0.33 to 0.05	0.14	
Theory use	-0.03	-0.22 to 0.16	0.74	
Sensitivity analysis: multivariate analysis - long term follow up only				
BCT-C 12 – Comparison of outcomes	No long term studies used BCT cluster 12			
IF 5 - Training	-0.19	-0.42 to 0.04	0.09	98.1%
Theory use	-0.11	-0.50 to 0.28	0.51	

β = Regression coefficient; CI = Confidence interval; IF = intervention function

Adjusted R^2 = the proportion of between study variance explained by a variable(s). A positive regression coefficient indicates that the presence of the cluster or intervention function is associated with increased effectiveness of the intervention; a negative regression coefficient indicates that the presence of the cluster or intervention function is associated with decreased effectiveness of the intervention. Intervention function in the comparator group and theory use were controlled for in the analysis.

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4.5.9 Evidence statements

Direction of effect across all interventions in the specified behaviour area	
A	BCT found in interventions with a positive direction of effect only (i.e. effect favours intervention)
B	BCT found in interventions with a negative direction of effect only (i.e. effect favours control)
C	BCT found in interventions with positive and negative directions of effect (i.e. inconsistent direction of effect – some favouring intervention, some favouring control)
Significance and consistency of effect across all interventions in the specified behaviour area	
1	BCT found in one intervention with a significant positive effect
2	BCT found in more than one intervention with a significant positive effect

Applicability and transferability of evidence to the UK

This applicability statement applies to all of the diet activity evidence statements for Review 2. These 27 interventions have partial to direct applicability to the UK. Two trials (Hardcastle 2008 [+], Clark 2004 [+]) were carried out in the UK. Of the remaining 25 interventions, 12 were conducted in in other European countries, five in Australia, and eight in the USA. Therefore caution is required when interpreting findings regarding the interventions carried out in populations that may have different access to services, as well as the interventions having different delivery methods and are provided in different settings from those found in the UK. The individual evidence statements provide further information on the country each study was conducted in.

In terms of transferability to clinical or public health practice, it should be remembered that the behaviour change interventions in the randomised controlled trials in this review varied in the number of sessions provided (ranging from one to over 30). Nine studies included individuals selectively recruited based on characteristics in addition to dietary behaviours or those population characteristics that form the basis of the Evidence Statements. This may reduce their direct applicability to general UK public health practice.

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These characteristics include: gender (male: Groenveld 2011 [+], Patrick 2011 [+], Ellingsen 2006 [+]; female: Guelinckx 2010 [+], Toobert 2010 [+], Stolley 2009 [+]); age (White 2012 [+]); ethnicity (black: Stolley 2009 [+]; Hispanic/Latino: Osborn 2010 [+], Eakin 2007 [+], Toobert 2010 [+]); health status other than cardiovascular or T2DM (other chronic conditions: Eakin 2007 [+]).

Evidence Statement 4.1 – Overall Effectiveness of diet behaviour change interventions, BCT clusters and intervention functions

There is strong evidence from 27 interventions (Giannuzzi 2008* [+], Wood_CP 2008* [++], White_TB 2012* [+], Osborn 2010* [+], Keogh 2011* [+], Clark 2004* [+], Glasgow 2006 [+], Thoolen 2009* [+], Toobert 2010* [+], Eakin 2010* [+], Burke 2008* [+], Hardcastle 2008* [+], Groeneveld 2011* [+], Koelewijn-van Loon 2003* [++], Ellingsen 2005* [+], Wright_NE 2011 [+], Wright_TDF 2011 [+], Wood_HR 2008* [++], Lindahl 2009* [+],Stolley 2009* [+], van Wier_I 2009* [+], van Wier_T 2009* [+], Morey 2009* [++], Patrick 2011* [+],Eakin 2007* [+], Guelinckx_B+LI 2010* [+], Sallit 2009* [+]) to suggest that individual level behaviour change interventions can have a small effect on dietary behaviour (SMD 0.33, 95% CI 0.24 to 0.42).

Meta-regression of the results of these RCTs suggested that following variables explain 18% of between study variance:

- BCT cluster 12 Comparison of outcomes (regression coefficient 0.24, 95% CI -0.01 to 0.49, p=0.061)
- Intervention function 5 ‘Training’ (regression coefficient -0.14, 95% CI -0.33 to 0.05; p=0.142)

Use of the BCT cluster 12 ‘Comparison of outcomes’ is associated with increased intervention effectiveness, while intervention function 5 ‘Training’ may be associated with reduced effectiveness of interventions. The evidence about the long term effects of these variables is not conclusive.

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Evidence Statement 4.2 –BCTs reported in interventions with a positive effect across diet trials

Strong evidence from a body of 27 interventions (see Evidence Statement 4.1 for references) suggests that the following BCTs are consistently associated with a significant intervention effect in dietary trials (reported in more than one diet change intervention with a positive and significant direction of effect): 1 Social support – practical[A2], 8 Feedback on behaviour[A2], 25 Behaviour substitution[A2], 28 Generalisation of target behaviour[A2], 34 Adding objects to the environment[A2], 35 Body changes[A2], 61 Problem solving[A2], 62 Goal setting - behaviour[A2], 65 Review behaviour goal(s)[A2], 67 Behavioural contract[A2], 69 Discrepancy between current behaviour and goal[A2], 71 Pros and cons[A2] and 85 Social comparison[A2].

The following BCTs were reported in one trial with a significant intervention effect: 5 Reduce negative emotions[A1], 11Self-monitoring of outcome(s) of behaviour[A1], 15 Prompts/cues[A1], 23 Behavioural practice/rehersal[A1], 29 Graded tasks[A1], 32 Avoidance/reducing exposure to cues for the behaviour[A1] , 43 Self talk[A1], 56 Social reward[A1], 68 Commitment[A1], 70 Persuasive source[A1], 75 Framing/reframing[A1] and 78 Information about health consequences[A1],

Ten BCTs were reported only in trials that resulted in a positive direction of effect, however, the effect was non-significant: 9 Feedback on outcome(s) of behaviour[A], 14 Biofeedback[A], 30 Restructuring the physical environment[A], 31 Restructuring the social environment[A], 37 Information about antecedents[A], 54 Material reward[A], 57 Non-specific reward[A], 76 Incompatible beliefs[A], 80 Information about social and environmental consequences[A] and 84 Demonstration of the behaviour[A].

Evidence Statement 4.3 – Individual BCTs reported in interventions with inconsistent effects across diet trials

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There is inconsistent evidence from 27 interventions (See Evidence Statement 4.1 for references) suggests that the following BCTs may be associated with interventions that have either a positive and negative direction of effect, although the size and significance of this effect varied: 3 Social support – unspecified[C2], 10 Self-monitoring of behaviour[C2], 36 Instruction on how to perform a behaviour[C2], 63 Goal setting – outcome[C2] and 64 Action planning[C2].

Evidence statement 4.4 – Multi-session, face to face dietary interventions for individuals with cardiovascular conditions

Moderate evidence from three interventions (Giannuzzi 2008* [+], Wood_CP 2008* [++], White_TB 2012* [+]) suggests that multi-session dietary interventions that also address physical activity have a small, significant impact on eating habits among individuals with cardiovascular conditions. This effect was seen across several face to face delivery methods (individual: Giannuzzi 2008* [+] SMD 0.22, 95% CI 0.15 to 0.29; group: White_TB 2012* [+] SMD 0.46, 95% CI 0.05 to 0.88; combined: Wood_CP 2008* [++] SMD 0.44, 95% CI 0.29 to 0.60). All of the interventions reported use of BCTs 3 Social support (unspecified), 62 Goal setting (behaviour), and 64 Action planning. Two of the interventions (White_TB 2012* [+], Wood_CP 2008* [++]) also reported use of BCT 61 Problem solving.

Giannuzzi 2008* (RCT [+], Italy, n=3,241, 0 weeks)
BCTs present:
1 Social support (practical)[A2]
3 Social support (unspecified)[C2]
23 Behavioural practice/rehearsal[A1]
34 Adding objects to the environment[A2]
36 Instruction on how to perform a behaviour[C2]
62 Goal setting (behaviour)[A2]
63 Goal setting (outcome)[C2]
64 Action planning[C2]
68 Commitment[A1]
70 Persuasive source[A1]

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Wood_CP 2008* (cRCT [++], Europe, n=1,938, 36 weeks)
BCTs present:
3 Social support (unspecified)[C2]
28 Generalisation of a target behaviour[A2]
34 Adding objects to the environment[A2]
61 Problem solving[A2]
62 Goal setting (behaviour)[A2]
63 Goal setting (outcome)[C2]
64 Action planning[C2]
65 Review behaviour goal[A2]

White_TB 2012* (RCT [+], Australia, n=116, 6 weeks)
BCTs present:
3 Social support (unspecified)[C2]
29 Graded tasks[A1]
61 Problem solving[A2]
62 Goal setting (behaviour)[A2]
64 Action planning[C2]
71 Pros and cons[A2]

Evidence statement 4.5 –Multi-session dietary interventions delivered face to face in groups and one on one among Type 2 Diabetes patients

Inconsistent evidence was identified from seven trials regarding the effectiveness of extended (Osborn 2010* [+]) and multi-session (Thoolen 2009* [+], Toobert 2010* [+], Keogh 2011* [+], Clark 2004* [+], Glasgow 2006 [+], Eakin 2010* [+]) dietary interventions among individuals with Type 2 Diabetes.

An extended face to face intervention with print feedback (Osborn 2010* [+]) was no more effective than usual care at improving compliance with diet recommendations among patients with Type 2 Diabetes (SMD 0.41, 95% CI -0.005 to 0.83).

Two trials (Thoolen 2009* [+], Toobert 2010* [+]) utilised multi-session interventions delivered primarily to a group, and were no more effective than

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usual care at changing dietary habits (Thoolen 2009* [+] SMD 0.19, 95% CI -0.10 to 0.49; Toobert 2010* [+] SMD 0.15, 95% CI -0.09 to 0.39).

Three trials (Keogh 2011* [+], Clark 2004* [+], Glasgow 2006 [+]) employed multi-session dietary interventions delivered face to face and remotely among diabetes patients. One trial (Keogh 2011* [+]) resulted in a very small, non-significant effect (SMD 0.07, 95% CI -0.29 to 0.42), while the remaining two trials had small to medium significant effects (Clark 2004* [+] SMD 0.55, 95% CI 0.15 to 0.95; Glasgow 2006 [+] SMD 0.37, 95% CI 0.14 to 0.60).

Results from one trial (Eakin 2010* [+]) suggests that an intervention of multiple counselling phone calls can have a small, significant effect on vegetable consumption among socioeconomically disadvantaged diabetes patients (SMD 0.20, 95% CI 0.01 to 0.39).

The three interventions resulting in significant effects (Clark 2004* [+], Glasgow 2006 [+], Eakin 2010* [+]) all reported use of BCT 8 Feedback on behaviour; this BCT was not reported in any of the non-significant interventions.

Osborn 2010* (RCT [+], USA, n=91, 12 weeks)
BCTs present:
9 Feedback on outcome of behaviour[A]
23 Behavioural practice/rehearsal[A1]
25 Behaviour substitution[A2]
34 Adding objects to the environment[A2]
36 Instruction on how to perform a behaviour[C2]
37 Information about antecedents[A]
56 Social reward[A1]
61 Problem solving[A2]
63 Goal setting (outcome)[C2]
64 Action planning[C2]
78 Information about health consequences[A1]
80 Information about social and environmental consequences[A]

Thoolen 2009* (RCT [+], Netherlands, n=180, 40 weeks)
BCTs present:

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11 Self-monitoring of outcome of behaviour[A1]
23 Behavioural practice/rehearsal[A1]
61 Problem solving[A2]
63 Goal setting (outcome)[C2]
64 Action planning[C2]
65 Review behaviour goal[A2]

Toobert 2010* (RCT [+], USA, n=279, 260 weeks)
BCTs present:
3 Social support (unspecified)[C2]
5 Reduce negative emotions[A1]
10 Self-monitoring of behaviour[C2]
25 Behaviour substitution[A2]
29 Graded tasks[A1]
35 Body changes[A2]
36 Instruction on how to perform a behaviour[C2]
54 Material reward for behaviour[A]
62 Goal setting (behaviour)[A2]
64 Action planning[C2]

Keogh 2011* (RCT [+], Ireland, n=121, 21 weeks)
BCTs present:
3 Social support (unspecified)[C2]
61 Problem solving[A2]
62 Goal setting (behaviour)[A2]
64 Action planning[C2]
67 Behavioural contract[A2]
68 Commitment[A1]
78 Information about health consequences[A1]

Clark 2004* (RCT [+], UK, n=100, 24 weeks)
BCTs present:
8 Feedback on behaviour[A2]
43 Self-talk[A1]
61 Problem solving[A2]
62 Goal setting (behaviour)[A2]
63 Goal setting (outcome)[C2]
65 Review behaviour goal[A2]
69 Discrepancy between current behaviour and goal[A2]
71 Pros and cons[A2]

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Glasgow 2006 (RCT [+], USA, n=299, 4 weeks)
BCTs present:
3 Social support (unspecified)[C2]
8 Feedback on behaviour[A2]
25 Behaviour substitution[A2]
32 Avoidance/reducing exposure to cues for the behaviour[A1]
36 Instruction on how to perform a behaviour[C2]
61 Problem solving[A2]
62 Goal setting (behaviour)[A2]
64 Action planning[C2]
65 Review behaviour goal[A2]
67 Behavioural contract[A2]
78 Information about health consequences[A1]

Eakin 2010* (cRCT [+], Australia, n=429, 24 weeks)
BCTs present:
1 Social support (practical)[A2]
3 Social support (unspecified)[C2]
8 Feedback on behaviour[A2] (also reported in control arm)
10 Self-monitoring of behaviour[C2]
34 Adding objects to the environment[A2]
35 Body changes[A2]
61 Problem solving[A2]
62 Goal setting (behaviour)[A2]
64 Action planning[C2]
65 Review behaviour goal[A2]
69 Discrepancy between current behaviour and goal[A2]
85 Social comparison[A2]

Evidence statement 4.6 – Multi-session dietary interventions for individuals at risk for cardiovascular conditions

Inconsistent evidence was identified from eight interventions regarding the effectiveness of multi-session dietary interventions delivered face to face (Hardcastle 2008* [+], Ellingsen 2005* [+], Wood_HR 2008* [++], Wright_NE 2011 [+], Burke 2008* [+]), remotely (Wright_TDF 2011 [+]), or a combination of the two (Groeneveld 2011* [+], Koelewijn-van Loon 2003* [+]).

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Three of these interventions resulted in significant changes to the dietary behaviour of individuals at elevated cardiovascular risk (Ellingsen 2005* [+], Wood_HR 2008* [++], Groeneveld 2011* [+]). No BCTs were reported in all three significant interventions that didn't also appear in some of the interventions with non-significant effects.

No significant differences in were found in five trials, various modes of delivery and outcomes, including fatty food consumption among overweight and obese individuals at risk for CHD or CVD (Hardcastle 2008* [+] SMD 0.07, 95% CI -0.15 to 0.29; Koelewijn-van Loon 2003* [+] SMD 0.19, 95% CI -0.07 to 0.44), fruit and vegetable consumption among individuals with elevated cardiovascular risk (Wright_NE 2011 [+] SMD 0.26, 95% CI -0.18 to 0.70; Burke 2008* [+] SMD 0.21, 95% CI -0.08 to 0.49; Wright_TDF 2011 [+] SMD 0.26, 95% CI -0.18 to 0.70).

Two trials resulted in small effects on fatty food consumption (Ellingsen 2005* [+] SMD 0.34, 95% CI 0.17 to 0.51), oily fish consumption (Wood_HR 2008* [++] SMD 0.37, 95% CI 0.19 to 0.55) among individuals with elevated cardiovascular risk. A third trial specifically recruited male construction workers at risk for CVD, and resulted in a large, significant effect on fruit and vegetable consumption (SMD 1.11, 95% CI 0.91 to 1.32).

Hardcastle 2008* (RCT [+], UK, n=334, 0 weeks)
BCTs reported:
3 Social support (unspecified)[C2]

Ellingsen 2005* (RCT [+], Norway, n=563, 1,040 weeks)
BCTs present:
3 Social support (unspecified)[C2]
36 Instruction on how to perform a behaviour[C2]
62 Goal setting (behaviour)[A2]
64 Action planning[C2]

Wood_HR 2008* (cRCT [++], Europe, n=2,023, 36 weeks)
BCTs present:
3 Social support (unspecified)[C2]

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28 Generalisation of a target behaviour[A2]
34 Adding objects to the environment[A2]
61 Problem solving[A2]
62 Goal setting (behaviour)[A2]
63 Goal setting (outcome)[C2]
64 Action planning[C2]
65 Review behaviour goal[A2]

Wright_NE 2011 (RCT [+], Australia, n=120, 4 weeks)
BCTs present:
36 Instruction on how to perform a behaviour[C2]
62 Goal setting (behaviour)[A2]

Burke 2008* (RCT [+], Australia, n=241, 156 weeks)
BCTs reported:
1 Social support (practical)[A2]
3 Social support (unspecified)[C2]
8 Feedback on behaviour[A2]
10 Self-monitoring of behaviour[C2]
14 Biofeedback[A] (also reported in control arm)
62 Goal setting (behaviour)[A2]
63 Goal setting (outcome)[C2]
64 Action planning[C2]

Wright_TDF 2011 (RCT [+], Australia, n=120, 2 weeks)
BCTs present:
8 Feedback on behaviour[A2]
10 Self-monitoring of behaviour[C2]
57 Non-specific reward[A1]
62 Goal setting (behaviour)[A2]
69 Discrepancy between current behaviour and goal[A2]
71 Pros and cons[A2]
76 Incompatible beliefs[A1]
85 Social comparison[A2]

Groeneveld 2011* (RCT [+], Netherlands, n=429, 24 weeks)
BCTs present:
3 Social support (unspecified)[C2]
63 Goal setting (outcome)[C2]
64 Action planning[C2]
71 Pros and cons[A2]

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Koelewijn-van Loon 2003* (cRCT [+], Netherlands, n=576, 40 weeks)
BCTs present:
3 Social support (unspecified)[C2]
10 Self-monitoring of behaviour[C2]
34 Adding objects to the environment[A2] (also reported in control arm)
62 Goal setting (behaviour)[A2]
63 Goal setting (outcome)[C2]
78 Information about health consequences[A1]

Evidence statement 4.7 – Multi-session dietary interventions delivered face to face and remotely for people at risk for Type 2 Diabetes

Limited evidence from one trial (Lindahl 2009* [+]) suggests that a multi-session residential programme with face to face and remote components is no more effective than usual care at improving vegetable consumption among overweight and obese individuals with impaired glucose tolerance (SMD 0.35, 95% CI -0.05 to 0.75).

Lindahl 2009* (RCT [+], Sweden, n=168, 144 weeks)
BCTs reported:
3 Social support (unspecified)[C2] (also reported in control arm)
5 Reduce negative emotions[A1]
10 Self-monitoring of behaviour[C2]
30 Restructuring the physical environment[A]
31 Restructuring the social environment[A]
61 Problem solving[A2]
62 Goal setting (behaviour)[A2]

Evidence statement 4.8 – Multi-session dietary interventions for overweight or obese individuals

Inconsistent evidence was identified regarding the effectiveness multi-session interventions delivered face to face (Stolley 2009* [+]) or remotely (van Wier_I 2009* [+], van Wier_T 2009* [+], Morey 2009* [++], Patrick 2011* [+]) at altering fruit and vegetable consumption among overweight or obese individuals.

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Delivery methods, comparators and participant characteristics varied across the trials with non-significant results. Non-significant effects on dietary behaviours were detected in three trials: a face to face group intervention (Stolley 2009* [+]) was no more effective that general health information at improving vegetable intake among obese African American women (SMD 0.19, 95% CI -0.12 to 0.48). One trial assessed two remotely delivered interventions; both the internet based (van Wier_I 2009* [+]) and telephone based interventions were no more effective than usual care at changing fruit consumption among overweight and obese employed individuals (van Wier_I 2009* [+] SMD -0.06, 95% CI -0.35 to 0.23; van Wier_T 2009* [+] SMD 0.05, 95% CI -0.23 to 0.34).

Two remotely delivered interventions (Morey 2009* [++], Patrick 2011* [+]) resulted in small, significant effects among older (age >65 years) overweight and obese long term cancer survivors (Morey 2009* [++] SMD 0.49, 95% CI 0.34 to 0.65) and overweight or obese men aged 25 to 55 years (Patrick 2011* [+] SMD 0.31, 95% CI 0.08 to 0.53). Both trials assessed fruit and vegetable intake (combined) compared to a waitlist control, and reported use of BCT 8 Feedback on behaviour; this BCT was not used in any of the trials with non-significant effects.

Stolley 2009* (RCT [+], USA, n=182, 0 weeks)
BCTs present:
3 Social support (unspecified)[C2]
23 Behavioural practice/rehearsal[A1]
25 Behaviour substitution[A2]
35 Body changes[A2]
36 Instruction on how to perform a behaviour[C2]
61 Problem solving[A2]
62 Goal setting (behaviour)[A2]
64 Action planning[C2]
84 Demonstration of the behaviour[A]

van Wier_I 2009* (RCT [+], Netherlands, n=524, 0 weeks)
BCTs present:

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3 Social support (unspecified)[C2]
10 Self-monitoring of behaviour[C2]
36 Instruction on how to perform a behaviour[C2]
63 Goal setting (outcome)[C2]
64 Action planning[C2]

van Wier_T 2009* (RCT [+], Netherlands, n=524, 0 weeks)
BCTs present:
3 Social support (unspecified)[C2]
10 Self-monitoring of behaviour[C2]
36 Instruction on how to perform a behaviour[C2]
63 Goal setting (outcome)[C2]
64 Action planning[C2]

Morey 2009* (RCT [++], USA, n=641, 0 weeks)
BCTs present:
3 Social support (unspecified)[C2]
8 Feedback on behaviour[A2]
10 Self-monitoring of behaviour[C2]
15 Prompts/cues[A1]
34 Adding objects to the environment[A2]
35 Body changes[A2]
36 Instruction on how to perform a behaviour[C2]
56 Social reward[A1]
61 Problem solving[A2]
62 Goal setting (behaviour)[A2]
63 Goal setting (outcome)[C2]
64 Action planning[C2]
85 Social comparison[A2]

Patrick 2011* (RCT [+], USA, n=309, 0 weeks)
BCTs present:
8 Feedback on behaviour[A2]
25 Behaviour substitution[A2]
62 Goal setting (behaviour)[A2]
64 Action planning[C2]
65 Review behaviour goal[A2]
69 Discrepancy between current behaviour and goal[A2]

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Evidence statement 4.9 – Multi-session dietary interventions other individuals or patients

Limited evidence was identified regarding the effectiveness of dietary interventions among highly variable populations.

Multi-session face to face one on one interventions

A single study (Eakin 2007* [+]) suggests that a multi-session dietary intervention delivered face to face and one on one and remotely may be effective at altering fatty food and fibre consumption among individuals with one or more chronic conditions (SMD 0.38, 95% CI 0.10 to 0.66).

One trial (Sallit 2009* [+]) suggests that a multi-session dietary intervention delivered face to face and one on one may be at improving healthy eating effective among weight concerned female smokers (SMD 0.89, 95% CI 0.53 to 1.26).

Multi-session face to face group intervention

One study (Guelinckx_B+LI 2010* [+]) suggests that a multi-session dietary intervention is no more effective than usual care at improving fruit intake among obese white women at risk for Gestational Diabetes (SMD 0.40, 95% CI -0.03 to 0.83).

Eakin 2007* (RCT [+], USA, n=200, 12 weeks)
BCTs present:
3 Social support (unspecified)[C2] (also reported in control arm)
8 Feedback on behaviour[A2]
61 Problem solving[A2]
62 Goal setting (behaviour)[A2]
64 Action planning[C2]
67 Behavioural contract[A2]

Sallit 2009* (RCT [+], USA, n=128, 36 weeks)
BCTs present
3 Social support (unspecified)[C2]

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5 Reduce negative emotions[A1]
11 Self-monitoring of outcome of behaviour[A1]
63 Goal setting (outcome)[C2]
75 Framing/reframing[A1]

Guelinckx_B+LI 2010* (RCT [+], Belgium, n=85, 8 weeks)
BCTs present:
3 Social support (unspecified)[C2]
5 Reduce negative emotions[A1]
25 Behaviour substitution[A2]
36 Instruction on how to perform a behaviour[C2]
61 Problem solving[A2]
62 Goal setting (behaviour)[A2]

4.6 Physical activity

4.6.1 Included studies

Sixty RCTs and cluster RCTs, which included 75 interventions, assessing individual level interventions targeting physical activity met the population, intervention, comparator and outcome inclusion criteria after full text appraisal. Study characteristics and results for these studies are summarised in the evidence tables in Appendix G.

Of these 75 interventions, 63 interventions (53 RCTs) provided outcome data which could be converted into standardised mean differences (SMDs) for comparison across studies and use in the meta-analysis and meta-regression. Of the interventions included in the meta-regression, 21 addressed physical activity on its own, and 42 examined physical activity as part of a wider lifestyle change programme, often paired with diet. These multi-topic interventions are designated with an * throughout the report. The narrative review and analyses include these 63 interventions.

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4.6.2 Quality assessment

Among the 53 trials which provided useable outcome data, 16 studies had internal validity rated as very good [++], and 37 studies as good [+].The results of the quality appraisals for the individual studies are found in Evidence tables in Appendix G.

4.6.3 BCTs

The individual BCTs that occurred across 63 interventions described in the 53 physical activity trials are summarised in Figure 13, along with the effectiveness of the interventions including each BCT.

The following BCTs were reported only in trials with positive intervention effects, more than one of which was significant (annotated A2). The significance of this effect varied across the trials (see Figure 13 for details of frequency and significance):

- 15 Prompts/cues
- 28 Generalisation of target behaviour
- 29 Graded tasks
- 68 Commitment
- 70 Persuasive source
- 71 Pros and cons
- 78 Information about health consequences
- 84 Demonstration of the behaviour

The following BCTs were reported only in trials with positive intervention effects, one of which was significant (annotated A1). The significance of this effect varied across the trials (see Figure 13 for details of frequency and significance):

- 2 Social support - emotional
- 11 Self-monitoring of outcome(s) of behaviour
- 12 Monitoring of behaviour by others without feedback
- 14 Biofeedback
- 24 Habit formation

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- 30 Restructuring the physical environment
- 31 Restructuring the social environment
- 37 Information about antecedents
- 56 Social reward
- 57 Non-specific reward
- 66 Review outcome goal
- 72 Comparative imagining of future outcomes
- 75 Framing/reframing

The following BCTs were reported only in trials with positive intervention effects, none of which were significant (annotated A) (see Figure 13 for details of frequency and significance):

- 4 Pharmacological support
- 25 Behaviour substitution
- 43 Self talk
- 54 Material reward

The following BCTs were reported in trials with positive both and negative directions of effect; at least two of the trials with a positive effect were significant (annotated C2 throughout the physical activity sections). The significance of this effect varied across the trials (see Figure 13 for details of frequency of use in significant interventions):

- 1 Social support – practical
- 3 Social support – unspecified
- 5 Reduce negative emotions
- 8 Feedback on behaviour
- 10 Self-monitoring of behaviour
- 23 Behavioural practice/rehearsal
- 34 Adding objects to the environment
- 35 Body changes
- 36 Instruction on how to perform a behaviour
- 61 Problem solving
- 62 Goal setting - behaviour
- 63 Goal setting - outcome
- 64 Action planning

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- 65 Review behaviour goal(s)
- 67 Behavioural contract
- 69 Discrepancy between current behaviour and goal
- 80 Information about social and environmental consequences

The following BCTs were reported in trials with positive both and negative directions of effect; one of the trials with a positive effect were significant (annotated C1 throughout the physical activity sections). The significance of this effect varied across the trials (see Figure 13 for details of frequency and significance):

- 9 Feedback on outcome(s) of behaviour
- 85 Social comparison

One BCT was reported in a single trial with a negative, non-significant effect (annotated B throughout the physical activity sections):

- 13 Monitoring outcome of behaviour by others without feedback

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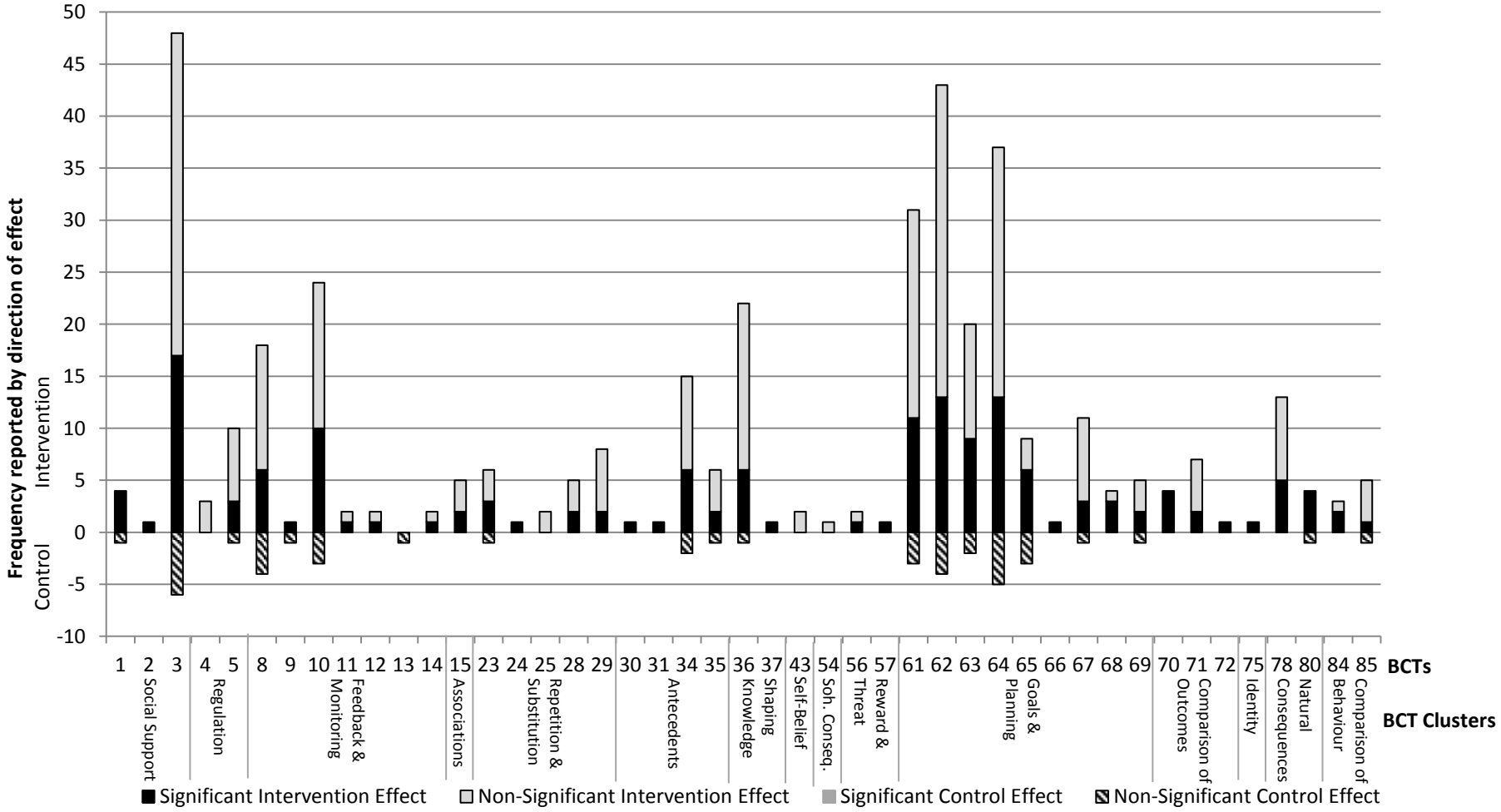
Figure 13: Distribution of behaviour change techniques in physical activity trials; direction and significance of effect



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4.6.4 Variation of effects across population groups

Tables 35 to 41 summarise the intervention type, mode of delivery, and effect size and significance, for physical activity behaviour change interventions among people with varying levels of clinical illness or risk for such illness. The subgroups covered by Tables 35 to 41 include: individuals with cardiovascular conditions, individuals with Type 2 Diabetes Mellitus (T2DM), those at risk for cardiovascular conditions, individuals at risk for T2DM, inactive individuals, and those who are overweight or obese. These tables in combination with Figure 13 were used to assess the effects of the interventions in different population subgroups and develop evidence statements relating to these effects.

Individuals with cardiovascular conditions

Ten interventions (Muniz 2010* [+], Giannuzzi 2008* [+], Wood_CR 2008* [++], VHSG 2003* [++], Smeulders 2009* [+], Tingstrom 2006 [+], White 2012* [+], Moore 2006 [+], Vale 2003* [++], Reid 2012 [++]) assessed the effect of physical activity behaviour change interventions among people with cardiovascular conditions.

All ten interventions were delivered over multiple sessions. Those delivered face to face on an individual or combined individual and group level were effective at changing physical activity compared to usual care. Face to face interventions delivered solely at the group level were no more effective than usual care at improving physical activity. Limited evidence was identified concerning the effectiveness of remotely delivered interventions.

Multi-session face to face, individual and combination individual and group

Four interventions (Muniz 2010* [+], Giannuzzi 2008* [+], Vestfold Heartcare Study Group [VHSG] 2003* [++], Wood_CR 2008* [++]) assessed the effect of multi-session interventions delivered face to face on either an individual or

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combined individual and group level on physical activity among cardiovascular patients.

Muniz 2010* [+] randomised recently discharged acute coronary syndrome patients to either a multi-session lifestyle intervention (with both physical activity and diet components) or usual care. The intervention had a very small, significant effect on the proportion of patients exercising at least five times per week four months after the end of the intervention (SMD 0.14, 95% CI 0.01to 0.27).

Giannuzzi 2008* [+] included patients who had recently had a heart attack and completed a cardiac rehabilitation programme. The intervention, which also included a dietary component, resulted in a very small, significant effect on leisure time physical activity at the end of the treatment period compared to usual care (SMD 0.18, 95% CI 0.11 to 0.25).

VHSG 2003* [++] assessed the effect of a physical activity and dietary intervention among cardiac patients hospitalised for acute MI, unstable angina, a coronary artery bypass graft (CABG) or percutaneous coronary intervention (PCI). Approximately two years after the end of the intervention there was a small, significant effect on the proportion of patients regularly exercising for more than 1 hour per week approximately compared to usual care (SMD 0.48, 95% CI 0.16 to 0.80).

Wood_CR 2008* [++] provided a family based physical activity and dietary intervention for patients hospitalised for coronary heart disease. At nine months post-intervention there was a large, significant effect on the proportion of patients achieving at least 30 minutes of physical activity at least four times per week compared to usual care (SMD 0.86, 95% CI 0.75 to 0.98).

BCTs 3 Social support (unspecified) was the only technique reported in all four interventions.

Multi-session face to face group interventions

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Four interventions (Smeulders 2009* [+], Tingstrom 2006 [+], White 2012* [+], Moore 2006 [+]) assessed the effect of multi-session interventions delivered face to face on a group level on physical activity among cardiovascular patients.

Smeulders 2009* [+] assessed the effect of a lifestyle intervention (with physical activity, dietary and smoking components) on the number of minutes per month that patients with congestive heart failure walked for exercise compared to usual care. Eleven months after the end of the intervention, there was a very small, non-significant effect (SMD 0.10, 95% CI -0.12 to 0.33).

Tingstrom 2006 [+] assessed the effect of a physical activity intervention on the physical activity levels of MI, PCI and CABG patients. At the end of the intervention there was no difference in physical activity between the intervention and usual care arms (SMD 0.00, 95% CI -0.30 to 0.30).

White 2012* [+] included older patients with cardiovascular disease or T2DM. At six weeks post intervention, there was a small, non-significant intervention effect on physical activity compared to a waitlist control arm (SMD 0.22, 95 % CI -0.20 to 0.64).

Moore 2006 [+] assessed the effect of a physical activity intervention on the number of hours per month spent exercising among cardiac rehabilitation patients. At the end of the intervention, there was a very small, non-significant effect compared to usual care (SMD 0.07, 95% CI -0.18 to 0.32).

All four interventions reported use of BCTs 3 Social support (unspecified) and 62 Goal setting (behaviour), both of which were also reported in the usual care arms of Tingstrom 2006 [+] and Moore 2006 [+]

Multi-session remotely delivered interventions

Three interventions (Vale 2003* [++], Reid 2012 [++], Pinto 2011 [++]) assessed the effect of multi-session remotely delivered interventions on the

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physical activity of individuals with cardiovascular conditions. The phone based intervention described in Vale 2003* [++] included physical activity, dietary and smoking components for individuals hospitalised for acute MI, unstable angina, CABG or PCI. The trial resulted in a medium, significant effect on the percentage of patients who had taken up walking at four weeks post intervention, compared to usual care (SMD 0.59, 95% CI 0.34 to 0.85).

At the end of the phone based intervention assessed in Reid 2012 [++] there was a very small, non-significant effect on the number of kilometres walked per week by patients who had been hospitalised for acute coronary syndrome, compared to usual care (SMD 0.15, 95% CI -0.18 to 0.48).

Pinto 2011 [++] included patients over the age of 40 years who had completed a cardiac rehabilitation programme that had included an exercise training component. Participants in the intervention arm received multiple telephone calls to encourage the maintenance of physical activity. At the end of the intervention there was a small, non-significant difference in the proportion of participants meeting physical activity guidelines versus the comparator group (SMD 0.44, 95% CI -0.06 to 0.95).

The two trials (Reid 2012 [++], Pinto 2011 [++]) with non-significant effects reported use of BCTs 3 Social support (unspecified), 8 Feedback on behaviour, and 10 Self-monitoring of behaviour, none of which were reportedly used in the intervention with a significant effect (Vale 2003* [++]).

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Table 35: Physical activity interventions for individuals with cardiovascular conditions

Author year	Intervention Type	Primary delivery mode	Outcome	SMD	95% CI lower	95% CI upper	Intervention BCTs Control BCTs
Muniz 2010* [+]	Multi-session	Face to face, individual	Exercise 5 times per week	0.14	0.01	0.27	3 Social support (unspecified)[C2] 34 Adding objects to the environment[C2] 65 Review behaviour goal[C2] 68 Commitment[A2] 70 Persuasive source[A2] 80 Information about social and environmental consequences[C2] None reported
Giannuzzi 2008* [+]	Multi-session	Face to face, individual	Leisure time physical activity	0.18	0.11	0.25	1 Social support (practical)[C2] 3 Social support (unspecified)[C2] 23 Behavioural practice/ rehearsa[C2] 34 Adding objects to the environment[C2] 36 Instruction on how to perform a behaviour[C2] 62 Goal setting (behaviour)[C2] 63 Goal setting (outcome)[C2] 64 Action planning[C2] 68 Commitment[A2] 70 Persuasive source[A2] None reported
Vestfold Heartcare Study Group 2003* [++]	Multi-session	Face to face individual and group	Regular exercise for more than 1h per week	0.48	0.16	0.80	1 Social support (practical)[C2] 3 Social support (unspecified)[C2] 5 Reduce negative emotions[C2] 10 Self-monitoring of behaviour[C2] 23 Behavioural practice/ rehearsal[C2] 35 Body changes[C2] 36 Instruction on how to perform a behaviour[C2] 61 Problem solving[C2] 84 Demonstration of the behaviour[A2] None reported

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Author year	Intervention Type	Primary delivery mode	Outcome	SMD	95% CI lower	95% CI upper	Intervention BCTs Control BCTs
Wood_CR 2008* [++]	Multi-session	Face to face individual and group	At least 30 minutes of physical activity, at least 4 times per week	0.86	0.75	0.98	3 Social support (unspecified)[C2] 28 Generalisation of a target behaviour[A2] 34 Adding objects to the environment[C2] 61 Problem solving[C2] 62 Goal setting (behaviour)[C2] 63 Goal setting (outcome)[C2] 64 Action planning[C2] 65 Review behaviour goal[C2] None reported
Smeulders 2009* [+]	Multi-session	Face to face, group	Walking for exercise	0.10	-0.12	0.33	3 Social support (unspecified)[C2] 62 Goal setting (behaviour)[C2] 64 Action planning[C2] None reported
Tingstrom 2006 [+]	Multi-session	Face to face, group	Physical activity	0.00	-0.30	0.30	3 Social support (unspecified)[C2] 61 Problem solving[C2] 62 Goal setting (behaviour)[C2] 85 Social comparison[C1] 3 Social support (unspecified)[C2]
White 2012* [+]	Multi-session	Face to face, group	Physical activity	0.22	-0.20	0.64	3 Social support (unspecified)[C2] 29 Graded tasks[A2] 61 Problem solving[C2] 62 Goal setting (behaviour)[C2] 64 Action planning[C2] 71 Pros and cons[A2] None reported
Moore 2006 [+]	Multi-session	Face to face, group	Amount of exercise	0.07	-0.18	0.32	3 Social support (unspecified)[C2] 5 Reduce negative emotions[C2] 10 Self-monitoring of behaviour[C2] 14 Biofeedback[A1]

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Author year	Intervention Type	Primary delivery mode	Outcome	SMD	95% CI lower	95% CI upper	Intervention BCTs Control BCTs
							61 Problem solving[C2] 62 Goal setting (behaviour)[C2] 63 Goal setting (outcome)[C2] 64 Action planning[C2] 67 Behavioural contract[C2] 85 Social comparison[C1] 3 Social support (unspecified)[C2] 5 Reduce negative emotions[C2] 10 Self-monitoring of behaviour[C2] 14 Biofeedback[A1] 62 Goal setting (behaviour)[C2] 64 Action planning[C2] 67 Behavioural contract[C2]
Vale 2003* [++]	Multi-session	Remote (phone)	Taking up walking for exercise	0.59	0.34	0.85	36 Instruction on how to perform a behaviour[C2] 61 Problem solving[C2] 63 Goal setting (outcome)[C2] 72 Comparative imagining of future outcomes[A1] 78 Information about health consequences[A2] None reported
Reid 2012 [++]	Multi-session	Remote (phone) and face to face	Kilometres travelled per week	0.15	-0.18	0.48	3 Social support (unspecified)[C2] 8 Feedback on behaviour[C2] 10 Self-monitoring of behaviour[C2] 28 Generalisation of a target behaviour[A2] 36 Instruction on how to perform a behaviour[C2] 61 Problem solving[C2] 62 Goal setting (behaviour)[C2] 64 Action planning[C2] 68 Commitment[A2] None reported
Pinto 2011 [++]	Multi-session	Remote (internet	At least 150	0.44	-0.06	0.95	3 Social support (unspecified)[C2]

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Author year	Intervention Type	Primary delivery mode	Outcome	SMD	95% CI lower	95% CI upper	Intervention BCTs Control BCTs
		based)	minutes of physical activity per week				8 Feedback on behaviour[C2] 10 Self-monitoring of behaviour[C2] 34 Adding objects to the environment[C2] 67 Behavioural contract[C2] None reported
A positive SMD represents a benefit with the intervention (i.e. favours the intervention), and a negative SMD represents a benefit with the comparator (favours comparator). A SMD of <0.2 represents a very small effect size, of ≥0.2 to <0.5 represents a small effect size, of ≥0.5 to <0.8 a medium effect size, and of ≥0.8 a large effect size. * Intervention targeted multiple behaviour topcs							

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Individuals with Type 2 Diabetes Mellitus

Twelve interventions (Kirk 2009_PA-P [+], Debussche 2012* [+], Clark 2004* [+], Keogh 2011* [+], Di Loreto 2003 [+],Toobert 2010* [+], Thoolen 2009* [+], Toobert 2011* [+], Horden 2009* [+], Kirk_PA-W 2009 [+], Lorig_SM 2010* [++], Lorig_SM+MR 2010* [++]) assessed the impact of physical activity interventions among individuals with Type 2 Diabetes.

Moderate evidence suggests that multi-session, remotely delivered interventions may be effective at improving physical activity among T2DM patients compared to usual care. There was limited evidence that multi-session face to face group interventions are no more effective than usual care at changing physical activity in this population.

Evidence concerning the effectiveness of multi-session face to face interventions with remote components, multi-session face to face interventions with combined individual and group components was inconsistent in this population subgroup.

Multi-session face to face interventions with remote components

Five interventions (Kirk_PA-P 2009 [+], Debussche 2012* [+], Clark 2004* [+], Keogh 2011* [+], Di Loreto 2003 [+]) assessed the effectiveness of multiple individual, face to face and remotely delivered session on physical activity behaviour among T2DM patients. While all five interventions resulted in a positive direction of effect, this was only significant in two trials (Keogh 2011* [+], Di Loreto 2003 [+]).

No BCTs were consistently reported in the effective interventions that weren’t also reported in at least one of the non-effective interventions. Similarly, no BCTs were consistently reported in the non-effective interventions that weren’t also reported in at least one of the effective interventions.

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Kirk_PA-P 2009 [+] assessed a multi-session physical activity intervention delivered face to face with telephone follow-up to T2DM patients. The trial resulted in a small, non-significant difference in the average number of minutes per week of at least moderate physical activity, compare to usual care (SMD 0.26, 95% CI -0.29 to 0.82).

Debussche 2012* [+] assessed a multi-session physical activity intervention delivered face to face with telephone follow-up to T2DM patients. The intervention resulted in a very-small, non-significant effect on leisure time physical activity compared to usual care (SMD 0.09, 95% CI -0.13 to 0.31).

Clark 2004* [+] enrolled overweight and obese individuals with T2DM for a multi-session intervention delivered face to face with telephone follow-up. The trial resulted in a small, non-significant effect on weekly physical activity six months follow-up (SMD 0.33, 95% CI -0.06 to 0.73).

Keogh 2011* [+] employed a multi-session diet and physical activity intervention involving both the patient and a family member. The intervention resulted in a medium, significant effect on exercise behaviour to usual care (SMD 0.62, 95% CI 0.26 to 0.99).

Di Loreto 2003 [+] assessed a multi-session physical activity intervention delivered face to face with telephone follow-up among T2DM patients. The trial resulted in a large, significant effect on the amount of energy expended each week through voluntary physical activity (SMD 1.10, 95% CI 0.87 to 1.33).

Multi-session face to face interventions with combined individual and group components

Two interventions (Toobert 2010* [+], Thoolen 2009* [+]) included T2DM patients in physical activity and dietary interventions. These trials resulted in inconsistent effects in terms of significance, although the direction of effect favoured the intervention in both cases.

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Toobert * 2010 [+] enrolled postmenopausal women with T2DM in a multi-session diet and physical activity intervention delivered both one on one and at a group level. The trial included a three day retreat and regular group meetings thereafter, and resulted in a very small, non-significant effect on physical activity (SMD 0.01, 95% CI -0.23 to 0.25).

Thoolen 2009* [+] included individuals with recently screen detected T2DM in a diabetes self-management intervention with diet and physical activity components. The trial resulted in a small, significant effect on weekly physical activity at follow-up (SMD 0.35, 95% CI 0.06 to 0.65).

Multi-session face to face group interventions

Two trials (Toobert 2011* [+], Horden 2009* [+]) assessed the effect of face to face group interventions delivered over multiple sessions among patients with T2DM. Both interventions resulted in non-significant effects compared to usual care.

Toobert 2011* [+] examined a multi-session group based intervention on physical activity behaviour among Latina T2DM patients. The trial enrolled Latina women, and involved a 3 day residential retreat, followed by regular group meetings. At the end of the intervention, there was a very small, non-significant difference in days of the week the women were physically active compared to women receiving usual care (SMD 0.11, 95% CI -0.12 to 0.35).

Horden 2009* [+] described an exercise training programme that aimed to prevent myocardial infarction among T2DM patients considered to be at risk for such an event. The trial resulted in a very small, non-significant difference in average weekly vigorous physical activity compared to usual care (SMD 0.16, 95% CI -0.14 to 0.45).

Both interventions included BCTs 23 Behavioural practice/rehearsal, 36 Instruction on how to perform a behaviour, 61 Problem solving, and 62 Goal setting (behaviour), and 64 Action planning.

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Multi-session remotely delivered interventions

Three interventions (Kirk_PA-W 2009 [+], Lorig_SM 2010* [++], Lorig_SM+MR 2010* [++]) described in two trials included a multi-session physical activity intervention that was remotely delivered to T2DM patients.

In Kirk_PA-W 2009 [+], inactive T2DM patients received written materials concerning physical activity behaviour change, as well as follow-up telephone calls. At three months' follow-up, the intervention resulted in a medium, non-significant effect on the average number of minutes per week of at least moderate physical activity, compare to usual care (SMD 0.42, 95% CI -0.13 to 0.97).

Two interventions (Lorig_SM 2010* [++], Lorig_SM+MR 2010* [++]) were included in one trial that assessed the effect of multi-session, internet based diabetes self-care interventions on physical activity. Both interventions resulted in non-significant differences in weekly aerobic exercise compared to usual care. This effect favoured the intervention in one arm (Lorig_SM 2010* [++]SMD 0.04, 95% CI -0.20 to 0.29), and the comparator in another arm (Lorig_SM+MR 2010* [++]SMD -0.001, 95% CI -0.25 to 0.25).

All three trials reported use of BCT 64 Action planning; this BCT was also reported in the usual care arm of Kirk_PA-W 2009 [+].

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Table 36: Physical activity interventions for individuals with Type 2 Diabetes Mellitus

Author year	Intervention Type	Primary delivery mode	Outcome	SMD	95% CI lower	95% CI upper	Intervention BCTs Control BCTs
Kirk_PA-P 2009 [+]	Multi-session	Face to face with remote (phone) follow up	Minutes of moderate and above activity per week	0.26	-0.29	0.82	3 Social support (unspecified)[C2] 34 Adding objects to the environment[C2] 61 Problem solving[C2] 62 Goal setting (behaviour)[C2] 63 Goal setting (outcome)[C2] 64 Action planning[C2] 78 Information about health consequences[A2] --- 3 Social support (unspecified)[C2] 29 Graded tasks[A2] 36 Instruction on how to perform a behaviour[C2] 62 Goal setting (behaviour)[C2] 64 Action planning[C2] 78 Information about health consequences[A2] 79 Information about emotional consequences
Debussche 2012* [+]	Multi-session	Face to face with remote (phone and post) follow up	Change in leisure time physical activity	0.09	-0.13	0.31	3 Social support (unspecified)[C2] 61 Problem solving[C2] 62 Goal setting (behaviour)[C2] --- 3 Social support (unspecified)[C2] 10 Self-monitoring of behaviour[C2] 80 Information about social and environmental consequences[C2]
Clark 2004* [+]	Multi-session	Face to face with remote (phone)	Weekly physical activity	0.33	-0.06	0.73	8 Feedback on behaviour[C2] 43 Self-talk[A] 61 Problem solving[C2] 62 Goal setting (behaviour[C2] 63 Goal setting (outcome)[C2] 65 Review behaviour goal[C2] 69 Discrepancy between current behaviour and goal[C2] 71 Pros and cons[A2] --- None reported

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Author year	Intervention Type	Primary delivery mode	Outcome	SMD	95% CI lower	95% CI upper	Intervention BCTs Control BCTs
Keogh 2011* [+]	Multi-session	Face to face (with family member) with remote (phone) follow-up	Exercise	0.62	0.26	0.99	3 Social support (unspecified)[C2] 61 Problem solving[C2] 62 Goal setting (behaviour)[C2] 64 Action planning[C2] 67 Behavioural contract[C2] 68 Commitment[A2] 78 Information about health consequences[A2] None reported
Di Loreto 2003 [+]	Multi-session	Face to face with remote (phone)	Energy expenditure through voluntary physical activity	1.10	0.87	1.33	1 Social support (practical)[C2] 3 Social support (unspecified)[C2] 8 Feedback on behaviour[C2] 10 Self-monitoring of behaviour[C2] 29 Graded tasks[A2] 61 Problem solving[C2] 62 Goal setting (behaviour)[C2] 64 Action planning[C2] 65 Review behaviour goal[C2] 70 Persuasive source[A2] 78 Information about health consequences[A2] 80 Information about social and environmental consequences[C2] None reported
Toobert 2010* [+]	Multi-session	Face to face individual and group	Frequency of activity	0.01	-0.23	0.25	3 Social support (unspecified)[C2] 5 Reduce negative emotions[C2] 10 Self-monitoring of behaviour[C2] 25 Behaviour substitution[A] 29 Graded tasks[A2] 35 Body changes[C2] 36 Instruction on how to perform a behaviour[C2] 54 Material reward for behaviour[A] 62 Goal setting (behaviour)[C2] 64 Action planning[C2]

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Author year	Intervention Type	Primary delivery mode	Outcome	SMD	95% CI lower	95% CI upper	Intervention BCTs Control BCTs
							None reported
Thoolen 2009* [+]	Multi-session	Face to face individual and group	Weekly physical activity	0.35	0.06	0.65	11 Self-monitoring of outcome of behaviour[A1] 23 Behavioural practice/ rehearsal[C2] 61 Problem solving[C2] 63 Goal setting (outcome)[C2] 64 Action planning[C2] 65 Review behaviour goal[C2] None reported
Toobert 2011* [+]	Multi-session	face to face, group	Physical activity days per week	0.11	-0.12	0.35	5 Reduce negative emotions[C2] 23 Behavioural practice/ rehearsal[C2] 36 Instruction on how to perform a behaviour[C2] 61 Problem solving[C2] 62 Goal setting (behaviour)[C2] None reported
Horden 2009* [+]	Multi-session	Face to face, group primarily, individual optional	Weekly vigorous physical activity	0.16	-0.14	0.45	3 Social support (unspecified)[C2] 12 Monitoring of behaviour by others without feedback[A1] 23 Behavioural practice/ rehearsal[C2] 28 Generalisation of a target behaviour[A2] 36 Instruction on how to perform a behaviour[C2] 61 Problem solving[C2] 62 Goal setting (behaviour)[C2] 64 Action planning[C2] 3 Social support (unspecified)[C2]
Kirk_PA-W 2009 [+]	Multi-session	Remote (written and phone)	Minutes of moderate and above activity per week	0.42	-0.13	0.97	3 Social support (unspecified)[C2] 34 Adding objects to the environment[C2] 61 Problem solving[C2] 62 Goal setting (behaviour)[C2] 63 Goal setting (outcome)[C2] 64 Action planning[C2] 78 Information about health consequences[A2]

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Author year	Intervention Type	Primary delivery mode	Outcome	SMD	95% CI lower	95% CI upper	Intervention BCTs Control BCTs
							3 Social support (unspecified)[C2] 29 Graded tasks[A2] 36 Instruction on how to perform a behaviour[C2] 62 Goal setting (behaviour)[C2] 64 Action planning[C2] 78 Information about health consequences[A2] 79 Information about emotional consequences
Lorig_SM+MR 2010* [++]	Multi-session	Remote (internet based)	Weekly aerobic exercise	-0.001	-0.25	0.25	3 Social support (unspecified)[C2] 5 Reduce negative emotions[C2] 8 Feedback on behaviour[C2] 61 Problem solving[C2] 64 Action planning[C2] None reported
Lorig_SM 2010* [++]	Multi-session	Remote (internet based)	Weekly aerobic exercise	0.041	-0.20	0.29	5 Reduce negative emotions[C2] 8 Feedback on behaviour[C2] 61 Problem solving[C2] 64 Action planning[C2] None reported

A positive SMD represents a benefit with the intervention (i.e. favours the intervention), and a negative SMD represents a benefit with the comparator (favours comparator). A SMD of <0.2 represents a very small effect size, of ≥0.2 to <0.5 represents a small effect size, of ≥0.5 to <0.8 a medium effect size, and of ≥0.8 a large effect size.
* Intervention targeted multiple behaviour topcs

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Individuals at risk for cardiovascular conditions

Twelve interventions (Hardcastle 2008* [+], ter Bogt 2011* [+], Harting 2006* [+], Koelewijn-van Loon 2003* [+], Groeneveld 2011* [+], Hyman_Sic 2007* [++], Hyman_Sec 2007* [++], van Sluijs 2005 [++], Wood_HR 2008* [++], Burke 2008* [+], Eriksson 2009* [++], Eakin 2010* [+]) assessed the effect of physical activity interventions among individuals considered to be at elevated cardiovascular risk.

Overall, these interventions resulted in a wide range of effects, in terms of direction, size and significance. Limited evidence suggests that multi-session interventions addressing multiple behaviour targets that are delivered on a combined group and individual level are effective at improving physical activity compared to usual care. Face to face interventions delivered remotely or primarily at the group level appear to be no more effective than usual care at changing physical activity behaviour. Evidence from other intervention type/delivery combinations was inconsistent.

Multi-session face to face interventions

Three interventions (Hardcastle 2008* [+], ter Bogt 2011* [+], Harting 2006* [+]) assessed the effectiveness of a face to face physical activity interventions among individuals with elevated cardiovascular risk. Inconsistent results were seen across the trials, in terms of both direction and significance of effect.

One trial (Hardcastle 2008* [+]) provided lifestyle counselling (which involved both diet and physical activity) face to face and one on one over multiple sessions to overweight and obese patients at risk for coronary artery disease. The trial found a small, significant difference in weekly physical activity compared to usual care (SMD 0.23, 95% CI 0.01 to 0.45).

Ter Bogt 2011* [+] enrolled overweight or obese individuals with hypertension and/or dyslipidaemia to a multi-session, face to face intervention or usual care. Four months after the end of the intervention, there was a very small,

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negative, non-significant difference in weekly physical activity, with the comparator arm reporting a higher average of minutes of weekly activity (SMD -0.06, 95% CI -0.31 to 0.19).

Harting 2006* [+] assessed the effect of a multi-session physical activity and smoking intervention among individuals considered to be at high risk of a cardiovascular event. The trial resulted in a very small, non-significant difference in the proportion of participants reporting to be physically active approximately one year after the end of the intervention, compared to usual care (SMD 0.01, 95% CI -0.11 to 0.13).

No BCTs were reported in the intervention with a significant effect (Hardcastle 2008* [+]) that weren't also reported in the two interventions with non-significant effects (Ter Bogt 2011* [+], Harting 2006* [+]).

Multi-session face to face interventions with remote component

Five interventions (Koelewijn-van Loon 2003* [+], Groeneveld 2011* [+], Hyman_Sic 2007* [++], Hyman_Sec 2007* [++], van Sluijs 2005 [++]) assessed the impact of multi-session face to face interventions with a remote component on physical activity behaviour change among individuals at risk for various cardiovascular conditions.

Koelewijn-van Loon 2003* [+] assessed the impact of a multi-session face to face individual and telephone lifestyle intervention (addressing diet, physical activity and smoking) on the physical activity of patients deemed eligible for cardiovascular risk management. The intervention resulted in a very small, non-significant difference in weekly moderate to vigorous physical activity at 10 months follow-up compared to usual care (SMD 0.03, 95% CI -0.22 to 0.28).

Groeneveld 2011* [+] assessed the effect of a multi-component lifestyle intervention (including diet, physical activity and smoking) delivered face to face and over the phone on an individual level to male construction workers

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screened as at risk for CVD. At six months' follow-up, the intervention had a very small, non-significant effect on weekly leisure time activity compared to usual care (SMD 0.03, 95% CI -0.16 to 0.22).

One trial described two interventions (Hyman_SiC 2007* [++], Hyman_SeC 2007* [++]). These interventions included physical activity, diet and smoking components, and were provided to black men with hypertension. The interventions were identical save for the order in which the components were delivered (Hyman_SiC 2007* [++] addressed all three behaviour change topics simultaneously, while Hyman_SeC 2007* [++] addressed the topics sequentially). Both resulted in very small non-significant differences in the average number of daily steps (Hyman_SiC 2007* [++]SMD 0.02, 95% CI -0.33 to 0.37; Hyman_SeC 2007* [++]SMD 0.03, 95% CI -0.32 to 0.39).

The van Sluijs 2005 [++] trial included inactive individuals deemed to be at elevated cardiovascular risk due to the presence of hypertension, high cholesterol, T2DM or a combination of these factors. The intervention resulted in a very small, non-significant effect favouring the usual care arm (SMD -0.01, 95% CI -0.26 to 0.25).

All five interventions reported use of BCTs 3 Social support (unspecified); this BCT was also reported in the usual care arm of van Sluijs 2005 [++].

Multi-session face to face interventions, one on one and group

Two interventions (Wood_HR 2008* [++], Burke 2008* [+]) assessed the effect of combined individual and group interventions delivered face to face over multiple sessions on the physical activity of individuals at risk for cardiovascular conditions.

Wood_HR 2008* [++] assessed the effect of a multi-session physical activity intervention (which also addressed diet) delivered face to face to primary care patients with elevated CV risk; patients' partners could join the patients for the intervention. The trial resulted in a large, significant effect on the proportion of

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patients participating in at least 30 minutes of physical activity at least four times a week nine months after the intervention conclusion (SMD 0.70, 95% CI 0.59 to 0.81) and reported use of BCTs 3 Social support (unspecified), 28 Generalisation of a target behaviour, 34 Adding objects to the environment, 61 Problem solving, 62 Goal setting (behaviour), 63 Goal setting (outcome), 64 Action planning, and 65 Review behaviour goal. No BCTs were reported in the usual care arm.

Burke 2008* [+] provided a multi-session CV risk and lifestyle intervention (that addressed diet, physical activity and alcohol) delivered face to face primarily on a group basis to overweight and obese individuals being treated with antihypertensive medication. The trial resulted in a small, significant effect on weekly physical activity of at least moderate intensity compared usual care three years follow-up (SMD 0.26, 95% CI 0.01 to 0.52).

Both interventions reported use of BCTs 3 Social support (unspecified), 62 Goal setting (behaviour), and 63 Goal setting (outcome).

Multi-session group interventions

One trial (Eriksson 2009* [++]) included patients considered to be at moderate to high risk of cardiovascular disease based on clinical diagnosis of hypertension, dyslipidaemia, T2DM, obesity or combinations of those risk factors. At the end of the multi-session group intervention, there was a small, non-significant difference in the proportion of patients reporting being moderately or very physically active, compared to usual care (SMD 0.34, 95% CI -0.01 to 0.72).

Multi-session remotely delivered interventions

One trial (Eakin 2010* [+]) assessed the effect of multi-session physical activity and diet intervention delivered over the phone on the physical activity of individuals deemed to be at risk for CVD based on a diagnosis of T2DM or hypertension. The trial resulted in a very small, negative (favouring usual

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care), non-significant effect on average weekly physical activity of at least moderate intensity (SMD -0.06, 95% CI -0.25 to 0.13).

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Table 37: Physical activity interventions for individuals at risk for cardiovascular conditions

Author year	Type	Primary delivery mode	Outcome	SMD	95% CI lower	95% CI upper	Intervention BCTs Control BCTs
Hardcastle 2008* [+]	Multi-session	Face to face one on one	Physical activity MET-min per week	0.23	0.01	0.45	3 Social support (unspecified)[C2] None reported
ter Bogt 2011* [+]	Multi-session	Face to face one on one	Weekly minutes of physical activity	-0.06	-0.31	0.19	3 Social support (unspecified)[C2] 9 Feedback on outcome of behaviour[C1] 63 Goal setting (outcome)[C2] None reported
Harting 2006* [+]	Multi-session	Face to face (with single family member/company)	Physically active	0.01	-0.11	0.13	3 Social support (unspecified)[C2] 4 Pharmacological support[A] 62 Goal setting (behaviour)[C2] 64 Action planning[C2] None reported
Koelewijn-van Loon [+]	Multi-session	Face to face with remote follow up	Weekly moderate-to vigorous physical activity	0.03	-0.22	0.28	3 Social support (unspecified)[C2] 10 Self-monitoring of behaviour[C2] 34 Adding objects to the environment[C2] 62 Goal setting (behaviour)[C2] 63 Goal setting (outcome)[C2] 78 Information about health consequences[A2] 34 Adding objects to the environment[C2]
Groeneveld 2011* [+]	Multi-session	Face to face with remote (phone)	Leisure time physical activity	0.03	-0.16	0.22	3 Social support (unspecified)[C2] 63 Goal setting (outcome)[C2] 64 Action planning[C2] 71 Pros and cons[A2] None reported
Hyman_SiC 2007* [++]	Multi-session	Face to face with remote follow up	Steps per day	0.02	-0.33	0.37	3 Social support (unspecified)[C2] 4 Pharmacological support[A] 8 Feedback on behaviour[C2] 34 Adding objects to the environment[C2]

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Author year	Type	Primary delivery mode	Outcome	SMD	95% CI lower	95% CI upper	Intervention BCTs Control BCTs
							36 Instruction on how to perform a behaviour[C2] 62 Goal setting (behaviour)[C2] 69 Discrepancy between current behaviour and goal[C2] None reported
Hyman_SeC 2007* [++]	Multi-session	Face to face with remote follow up	Steps per day	0.03	-0.32	0.39	3 Social support (unspecified)[C2] 4 Pharmacological support[A] 8 Feedback on behaviour[C2] 34 Adding objects to the environment[C2] 36 Instruction on how to perform a behaviour[C2] 62 Goal setting (behaviour)[C2] 69 Discrepancy between current behaviour and goal[C2] None reported
van Sluijs 2005 [++]	Multi-session	Face to face with remote (phone)	Meeting American College Sports Medicine/CDC physical activity guidelines	-0.01	-0.26	0.25	3 Social support (unspecified)[C2] 8 Feedback on behaviour[C2] 10 Self-monitoring of behaviour[C2] 61 Problem solving[C2] 62 Goal setting (behaviour)[C2] 64 Action planning[C2] 65 Review behaviour goal[C2] 67 Behavioural contract[C2] 80 Information about social and environmental consequences[C2] 3 Social support (unspecified)[C2]
Wood_HR 2008* [++]	Multi-session	Face to face individual and group	At least 30 minutes of physical activity, at least 4 times per week	0.70	0.59	0.81	3 Social support (unspecified)[C2] 28 Generalisation of a target behaviour[A2] 34 Adding objects to the environment[C2] 61 Problem solving[C2] 62 Goal setting (behaviour)[C2] 63 Goal setting (outcome)[C2] 64 Action planning[C2] 65 Review behaviour goal[C2]

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Author year	Type	Primary delivery mode	Outcome	SMD	95% CI lower	95% CI upper	Intervention BCTs Control BCTs
							None reported
Burke 2008* [+]	Multi-session	Face to face, group	Weekly moderate-to vigorous physical activity	0.26	0.01	0.52	1 Social support (practical)[C2] 3 Social support (unspecified) 8 Feedback on behaviour[C2] 10 Self-monitoring of behaviour[C2] 14 Biofeedback[A1] 62 Goal setting (behaviour)[C2] 63 Goal setting (outcome)[C2] 64 Action planning[C2] 14 Biofeedback[A1]
Eriksson 2009* [++]	Multi-session	Face to face, group	At least moderate physical activity	0.34	-0.01	0.72	3 Social support (unspecified)[C2] 5 Reduce negative emotions[C2] 8 Feedback on behaviour[C2] 29 Graded tasks[A2] 35 Body changes[C2] 36 Instruction on how to perform a behaviour[C2] 61 Problem solving[C2] 62 Goal setting (behaviour)[C2] 63 Goal setting (outcome)[C2] 64 Action planning[C2] 78 Information about health consequences[A2] 62 Goal setting (behaviour)[C2] 64 Action planning[C2]
Eakin 2010* [+]	Multi-session	Remote (phone)	Weekly moderate-to vigorous physical activity	-0.06	-0.25	0.13	1 Social support (practical)[C2] 3 Social support (unspecified)[C2] 8 Feedback on behaviour[C2] 10 Self-monitoring of behaviour[C2] 34 Adding objects to the environment[C2] 35 Body changes[C2] 61 Problem solving[C2]

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Author year	Type	Primary delivery mode	Outcome	SMD	95% CI lower	95% CI upper	Intervention BCTs Control BCTs
							62 Goal setting (behaviour)[C2] 64 Action planning[C2] 65 Review behaviour goal[C2] 69 Discrepancy between current behaviour and goal[C1] 85 Social comparison[C2] 8 Feedback on behaviour[C2]
A positive SMD represents a benefit with the intervention (i.e. favours the intervention), and a negative SMD represents a benefit with the comparator (favours comparator). A SMD of <0.2 represents a very small effect size, of ≥0.2 to <0.5 represents a small effect size, of ≥0.5 to <0.8 a medium effect size, and of ≥0.8 a large effect size. * Intervention targeted multiple behaviour topcs							

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Individuals at risk for Type 2 Diabetes Mellitus

Three interventions (Lindahl 2009* [+], Vermunt 2011* [+], Penn 2009* [+]) assessed the effect of physical activity interventions for individuals at risk for T2DM.

Overall, limited evidence suggests multi-session face to face interventions delivered face to face and one on one have a significant effect. Inconsistent evidence was identified for multi-session interventions delivered on a face to face combined individual and group level.

Multi-session face to face individual interventions

One trial (Lindahl 2009* [+]) assessed the effect of a residential lifestyle intervention (delivered over multiple face to face sessions, with telephone follow-up) on physical activity among overweight and obese individuals with impaired glucose tolerance. The trial resulted in a medium, significant effect on the proportion of participants exercising at least once per week 3 years after the end of the intervention (SMD 0.50, 95% CI 0.14 to 0.87).

Multi-session face to face individual and group interventions

Two trials (Vermunt 2011* [+], Penn 2009* [+]) assessed the effect of multi-session physical activity interventions delivered face to face on both an individual and group level.

Vermunt 2011* [+] included individuals over the age of 40 years who were considered to be at risk for T2DM. At the end of the diabetes prevention intervention (that included physical activity and dietary components) there was a small, significant difference in the average amount of weekly physical activity, compared to usual care (SMD 0.20, 95% CI 0.06 to 0.35).

Penn 2009* [+] assessed the effect of a physical activity and diet intervention on sustained beneficial change among individuals at risk for T2DM. The trial resulted in a very small, negative, non-significant effect on sustained change

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in physical activity from the beginning to end of the intervention (SMD -0.05, 95% CI -0.49 to 0.40).

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Table 38: Physical activity interventions for individuals at risk for Type 2 Diabetes Mellitus

Author year	Type	Primary delivery mode	Outcome	SMD	95% CI lower	95% CI upper	Intervention BCTs Control BCTs
Lindahl 2009* [+]	Multi-session	Face to face one on one	Exercise at least once per week	0.50	0.13	0.87	3 Social support (unspecified)[C2] 5 Reduce negative emotions[C2] 10 Self-monitoring of behaviour[C2] 30 Restructuring the physical environment[A] 31 Restructuring the social environment[A] 61 Problem solving[A2] 62 Goal setting (behaviour)[A2] 3 Social support (unspecified)[C2]
Vermunt 2011* [+]	Multi-session	Face to face combined one on one and group	Minutes of weekly activity	0.20	0.06	0.35	3 Social support (unspecified)[C2] 62 Goal setting (behaviour)[C2] 63 Goal setting (outcome)[C2] 64 Action planning[C2] 78 Information about health consequences[A2] 80 Information about social and environmental consequences[C2] 78 Information about health consequences[A2] 80 Information about social and environmental consequences[C2]
Penn 2009* [+]	Multi-session	Face to face combined one on one and group	Sustained beneficial change (>0.01 units) in physical activity score for two years or more	-0.05	-0.49	0.40	3 Social support (unspecified)[C2] 8 Feedback on behaviour[C2] 10 Self-monitoring of behaviour[C2] 13 Monitoring outcome of behaviour by others without feedback[B] 23 Behavioural practice/ rehearsal[C2] 34 Adding objects to the environment[C2] 36 Instruction on how to perform a behaviour[C2] 62 Goal setting (behaviour)[C2] 63 Goal setting (outcome)[C2] 64 Action planning[C2] 65 Review behaviour goal[C2] None reported

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Overweight or obese individuals

Six interventions (Kuller 2012* [+], Nijamkin 2012* [++], van Wier_I 2009* [+], van Wier_T 2009* [+], Morey 2009* [++], Patrick 2011* [+]) assessed the effect of behaviour change interventions on the physical activity levels of overweight or obese individuals.

Overall, there is limited evidence concerning the effectiveness of the different types of physical activity behaviour change interventions; single trials were identified for multi-session face to face group interventions as well as multi-session face to face group interventions that included a remote follow-up component. The evidence surrounding the effectiveness of multi-session remotely delivered interventions in this population is inconsistent.

Multi-session face to face group interventions

One trial (Kuller 2012* [+]) enrolled overweight and obese women between the ages of 52 and 62 years to receive a multidisciplinary lifestyle intervention (addressing physical activity and diet) delivered over multiple group sessions. One year after the end of the intervention, there was a very small, non-significant difference in weekly leisure time physical activity between the intervention and comparator arms (SMD 0.13, 95% CI -0.06 to 0.32).

Multi-session face to face group interventions with remote follow-up

One trial (Nijamkin 2012* [++]) assessed the effect of a multi-session group based nutrition and lifestyle intervention, which included phone and email components, on the weekly physical activity on obese Hispanic Americans who had recently undergone gastric bypass surgery. The trial resulted in a medium, significant effect on the average minutes per week spent physically active compared to the information only control arm (SMD 0.49, 95% CI 0.14 to 0.83).

Multi-session remotely delivered interventions

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Four interventions (van Wier_I 2009* [+], van Wier_T 2009* [+], Morey 2009* [++], Patrick 2011* [+]) provided multi-session, remotely delivered physical activity interventions to overweight or obese individuals. Overall, the effect size ranged from very small to small across the four trials (SMD range 0.137 to 0.324). This effect was significant in two interventions (van Wier_T 2009* [+], Patrick 2011* [+]) and non-significant in the remaining two (van Wier_I 2009* [+], Morey 2009* [++]).

One trial describing two interventions (van Wier_I 2009* [+], van Wier_T 2009* [+]) compared usual care to a multi-session counselling intervention (targeting diet and physical activity) delivered either via the internet (van Wier_I 2009* [+] or over the telephone (van Wier_T 2009* [+]) among overweight and obese employees. The internet arm (van Wier_I 2009* [+]) resulted in a very small, non-significant difference in the proportion of participants meeting physical activity guidelines (at least 30 minutes per day, five days per week) at the end of the intervention (SMD 0.19, 95% CI -0.08 to 0.45). The telephone counselling arm (van Wier_T 2009* [+]) resulted in a small, significant difference in the proportion of participants meeting physical activity guidelines (SMD 0.32, 95% CI 0.09 to 0.56).

Morey 2009* [++] compared a multi-session counselling intervention delivered over the phone and via post among overweight or obese long term colorectal, breast and prostate cancer survivors (over the age of 65 years). The intervention resulted in a very small, non-significant difference in weekly endurance exercising at the end of the trial (SMD 0.14, 95% CI -0.02 to 0.29).

Patrick 2011* [+] compared an internet based multi-session intervention to a wait list control, among overweight or obese men aged 25 to 55 years. The intervention resulted in a small, significant difference in average daily walking (SMD 0.23, 95% CI 0.01 to 0.46).

No BCTs were consistently reported in the effective interventions that weren’t also reported in at least one of the non-effective interventions. Similarly, no

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BCTs were consistently reported in the non-effective interventions that weren't also reported in at least one of the effective interventions

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Table 39: Physical activity interventions for overweight or obese individuals

Author year	Type	Primary delivery mode	Outcome	SMD	95% CI lower	95% CI upper	Intervention BCTs Control BCTs
Kuller 2012* [+]	Multi-session	Face to face, group	Weekly leisure time physical activity	0.13	-0.06	0.32	3 Social support (unspecified)[C2] 36 Instruction on how to perform a behaviour[C2] 62 Goal setting (behaviour)[C2] 63 Goal setting (outcome)[C2] None reported
Nijamkin 2012* [++]	Multi-session	Face to face, group and remote (phone, email)	Weekly physical activity	0.49	0.14	0.83	2 Social support (emotional)[A1] 3 Social support (unspecified)[C2] 5 Reduce negative emotions[C2] 10 Self-monitoring of behaviour[C2] 24 Habit formation[A1] 36 Instruction on how to perform a behaviour[C2] 37 Information about antecedents[A1] 61 Problem solving[C2] 63 Goal setting (outcome)[C2] 3 Social support (unspecified)[C2] 24 Habit formation[A1] 36 Instruction on how to perform a behaviour
van Wier_I 2009* [+]	Multi-session	Remote (internet based)	At least 30 minutes of physical activity, at least 5 days a week	0.19	-0.08	0.45	3 Social support (unspecified)[C2] 10 Self-monitoring of behaviour[C2] 36 Instruction on how to perform a behaviour[C2] 63 Goal setting (outcome)[C2] 64 Action planning[C2] None reported
van Wier_T 2009* [+]	Multi-session	Remote (Phone)	At least 30 minutes of physical activity, at least 5 days a week	0.32	0.09	0.56	3 Social support (unspecified)[C2] 10 Self-monitoring of behaviour[C2] 36 Instruction on how to perform a behaviour[C2] 63 Goal setting (outcome)[C2] 64 Action planning[C2]

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Author year	Type	Primary delivery mode	Outcome	SMD	95% CI lower	95% CI upper	Intervention BCTs Control BCTs
							None reported
Morey 2009* [++]	Multi-session	remote (phone and post)	Weekly endurance exercise	0.14	-0.02	0.29	3 Social support (unspecified)[C2] 8 Feedback on behaviour[C2] 10 Self-monitoring of behaviour[C2] 15 Prompts/cues[A2] 34 Adding objects to the environment[C2] 35 Body changes[C2] 36 Instruction on how to perform a behaviour[C2] 56 Social reward[A1] 61 Problem solving[C2] 62 Goal setting (behaviour)[C2] 63 Goal setting (outcome)[C2] 64 Action planning[C2] 85 Social comparison[C1] None reported
Patrick 2011* [+]	Multi-session	Remote (internet based)	Weekly walking	0.23	0.01	0.46	8 Feedback on behaviour[C2] 10 Self-monitoring of behaviour[C2] 34 Adding objects to the environment[C2] 35 Body changes[C2] 62 Goal setting (behaviour)[C2] 64 Action planning[C2] 65 Review behaviour goal[C2] 69 Discrepancy between current behaviour and goal[C2] None reported
A positive SMD represents a benefit with the intervention (i.e. favours the intervention), and a negative SMD represents a benefit with the comparator (favours comparator). An SMD of <0.2 represents a very small effect size, of ≥0.2 to <0.5 represents a small effect size, of ≥0.5 to <0.8 a medium effect size, and of ≥0.8 a large effect size.							

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Inactive or underactive individuals

Fifteen interventions (Grandes 2009 [++], Armit_ES 2009 [++], McMurdo_BCI+P 2010* [+], Armit_ES+P 2009 [++], McMurdo_BCI 2010* [+], Lawton 2008 [++], Elley 2003 [++], Hertogh 2010 [+], Nies 2003 [+], Marcus_TB 2007 [+], Kolt 2007 [+], Marcus_PB 2007 [+], Prestwich_II 2009 [+], Prestwich_SMS 2009 [+], Prestwich_II+SMS 2009 [+]) assessed the effectiveness of physical activity behaviour change interventions among inactive or underactive individuals.

All identified interventions resulted in a positive direction of effect. Much of the evidence is inconsistent in terms of significance of that effect, however. Limited evidence suggests that face to face interventions delivered one on one, and group interventions with a remote follow-up component are no more effective than usual care at encouraging physical activity behaviour change in this population. The evidence regarding face to face, one on one interventions with a remote follow-up is inconsistent, as is the evidence concerning remotely delivered interventions.

Figure 14 presents the frequency of use for each reported behaviour change technique across physical activity interventions among under- or in-active individuals. The x-axis is identical to that of Figure 13 to allow for comparison of reported BCTs in this population vs. physical activity interventions more generally; if a BCT was reported in any physical activity trial but not in the trials relevant to this population there is a gap for that BCT in Figure 14.

Multi-session face to face interventions, one on one or group

Two trials (Grandes 2009 [++], Hertogh 2010 [+]) examined the effectiveness of multi-session face to face interventions on physical activity among individuals not meeting guidelines of at least 30 minutes of moderate physical activity per day, 5 days week per week.

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Grandes 2009 [++] enrolled underactive primary care patients into a multi-session face to face intervention delivered one on one. Six months after the end of the intervention, there was a very small, non-significant difference in average weekly minutes of moderate or vigorous physical activity versus usual care (SMD 0.03, 95% CI -0.08 to 0.15).

Hertogh 2010 [+] recruited healthy, underactive post-menopausal women (aged 50 to 69 years) to physical activity intervention. The trial resulted in a very small, non-significant difference in physical activity at one year follow-up compared to no intervention (SMD 0.01, 95% CI -0.32 to 0.340).

Both interventions reported use of BCTs 3 Social support (unspecified), 10 Self-monitoring of behaviour, 36 Instruction on how to perform a behaviour, 62 Goal setting (behaviour), and 64 Action planning; no BCTs were reported in the comparator arms.

Multi-session face to face interventions with remote follow-up

Six interventions (Armit_ES 2009 [++], Armit_ES+P 2009 [++], McMurdo_BCI 2010* [+], McMurdo_BCI+P 2010* [+], Lawton 2008 [++], Elley 2003 [++]) included multi-session face to face interventions with a remote follow-up component.

Overall, there was evidence of non-significant effects on changes in physical activity, and limited evidence of significant effects on long term (>6 months) changes in activity.

One trial included two interventions (Armit_ES 2009 [++], Armit_ES+P 2009 [++]) among primary care patients (aged 50 to 70 years) who did not meet the recommended 150 minutes of moderate physical activity the previous week. The first intervention (Armit_ES 2009 [++]) involved counselling and telephone follow-up, and the second intervention (Armit_ES+P 2009 [++]) involved counselling, provision of a pedometer, and follow-up phone calls. Three months after the end of the interventions, both arms resulted in non-significant

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differences in the proportion of patients meeting physical activity guidelines compared to usual care (Armit_ES 2009 [++]SMD 0.07, 95% CI -0.54 to 0.68; Armit_ES+P 2009 [++]SMD 0.48, 95% CI -0.11 to 1.07).

Two interventions (McMurdo_BCI 2010* [+], McMurdo_BCI+P 2010* [+]) were reported by McMurdo 2010. This trial recruited community dwelling females over the age of 70 years who were inactive or underactive (not meeting guidelines of moderate intensity physical activity of at least 30 minutes 5 days per week or at least 20 minutes of continuous vigorous intensity physical activity 3 or more times per week). McMurdo_BCI 2010* [+] involved a face to face physical activity and nutrition intervention with follow-up telephone calls, and resulted in a small, non-significant difference in activity at the end of the trial compared to usual care (SMD 0.40, 95% CI -0.01 to 0.82). In addition, the second arm (McMurdo_BCI+P 2010* [+]) included the provision of a pedometer, and resulted in a medium, non-significant difference in physical activity (SMD 0.22, 95% CI -0.19 to 0.64).

Lawton 2008 [++] enrolled females between the age of 40 and 74 years who did not meet physical activity guidelines (30 minutes of physical activity on at least 5 days per week). One year and four months after the end of the intervention there was a very small, significant difference in the proportion of women meeting physical activity guidelines compared to usual care (SMD 0.16, 95% CI 0.02 to 0.29).

Elley 2003 [++] enrolled primary care patients aged 40 to 79 years and provided a brief face to face intervention with multiple follow-up telephone calls in order to improve physical activity in this group. The intervention resulted in a small, significant effect on average weekly leisure time physical activity (SMD 0.26, 95% CI 0.08 to 0.45).

No BCTs were consistently reported in the effective intervention that weren’t also reported in at least one of the non-effective interventions. Similarly, no

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BCTs were consistently reported in the non-effective interventions that weren't also reported in at least one of the effective interventions.

Remotely delivered interventions

Seven interventions (Prestwich_II 2009 [+], Prestwich_SMS 2009 [+], Prestwich_II+SMS 2009 [+], Nies 2003 [+], Marcus_TB 2007 [+], Marcus_PB 2007 [+],Kolt 2007 [+]) described in five trials assessed the effect of remotely delivered interventions targeting physical activity.

One trial describing three brief interventions (Prestwich_II 2009 [+], Prestwich_II+SMS 2009 [+], Prestwich_SMS 2009 [+]) assessed the effect of remotely delivered behaviour change programmes on the amount of exercise undertaken by university students who exercised less than three times per week. Participants in one arm of the trial (Prestwich_II 2009 [+]) were asked to form implementation intentions regarding exercise and resulted in a very small, non-significant effect (SMD 0.07, 95% CI -0.65 to 0.79). Another arm (Prestwich_SMS 2009 [+]) received text messages regarding exercise and resulted in a small, non-significant effect (SMD 0.16, 95% CI -0.55 to 0.87). Finally, the third (Prestwich_II+SMS 2009 [+]) received both interventions combined, and resulted in a medium, non-significant effect (SMD 0.44, 95% CI -0.29 to 1.17).

Two interventions (Nies 2003 [+], Marcus_TB 2007 [+]) resulted in very small, non-significant effects on physical activity compared to an attention control arm (assessment of physical activity only). Nies 2003 [+] provided multiple telephone counselling sessions to women aged 30 to 60 years who were either sedentary or frequently inactive (SMD 0.05, 95% CI -0.28 to 0.38). A telephone based feedback intervention (Marcus_TB 2007 [+]) among underactive but otherwise healthy adults was no more effective than the comparator in terms of weekly physical activity (SMD 0.15, 95% -0.23 to 0.54).

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A print based feedback intervention (Marcus_PB 2007 [+]) resulted in a medium, significant effect on weekly physical activity among underactive adults (SMD 0.52, 95% CI 0.13 to 0.91)

Kolt 2007 [+] enrolled patients over the age of 65 years who had not met physical activity guidelines (30 minutes of activity on 5 or more days per week) for six months or more. The telephone counselling intervention resulted in a small, significant difference in weekly leisure activity nine months after the end of the intervention, compared to usual care (SMD 0.46, 95% CI 0.15 to 0.77).

One BCT (71 Pros and cons) was reported in both interventions with significant effects (Marcus_PB 2007 [+], Kolt 2007 [+]) and was not used in any of the non-significant interventions (Prestwich_II 2009 [+], Prestwich_SMS 2009 [+], Prestwich_II+SMS 2009 [+], Nies 2003 [+], Marcus_TB 2007 [+]). There were no BCTs common across all non-significant interventions.

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Table 40: Physical activity interventions for inactive or underactive individuals

Author year	Type	Primary delivery mode	Outcome	SMD	95% CI lower	95% CI upper	Intervention BCTs Control BCTs
Grandes 2009 [++]	Multi-session	Face to face	Weekly moderate and vigorous activity	0.03	-0.08	0.15	3 Social support (unspecified)[C2] 10 Self-monitoring of behaviour[C2] 36 Instruction on how to perform a behaviour[C2] 61 Problem solving[C2] 62 Goal setting (behaviour)[C2] 64 Action planning[C2] 67 Behavioural contract[C2] 71 Pros and cons[A2] 78 Information about health consequences[A2] None reported
Hertogh 2010 [+]	Multi-session	Face to face, group primary, individual optional	Physical activity	0.01	-0.32	0.34	3 Social support (unspecified)[C2] 10 Self-monitoring of behaviour[C2] 23 Behavioural practice/ rehearsal[C2] 28 Generalisation of a target behaviour[A2] 35 Body changes[C2] 36 Instruction on how to perform a behaviour[C2] 62 Goal setting (behaviour)[C2] 64 Action planning[C2] None reported
Armit_ES 2009 [++]	Multi-session	Face to face with remote (phone) follow up	At least 30 minutes of physical activity per day, 5 days per week	0.07	-0.54	0.68	3 Social support (unspecified)[C2] 11 Self-monitoring of outcome of behaviour[A1] 63 Goal setting (outcome)[C2] 71 Pros and cons[A2] None reported
Armit_ES+P 2009 [++]	Multi-session	Face to face with remote (phone) follow up	At least 30 minutes of physical activity per day, 5 days per week	0.48	-0.11	1.07	3 Social support (unspecified)[C2] 10 Self-monitoring of behaviour[C2] 34 Adding objects to the environment[C2] 62 Goal setting (behaviour)[C2]

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Author year	Type	Primary delivery mode	Outcome	SMD	95% CI lower	95% CI upper	Intervention BCTs Control BCTs
							None reported
McMurdo_BCI 2010* [+]	Multi-session	Face to face with remote (phone) follow up	Accelerometry	0.40	-0.01	0.82	3 Social support (unspecified)[C2] 8 Feedback on behaviour[C2] 10 Self-monitoring of behaviour[C2] 29 Graded tasks[A2] 36 Instruction on how to perform a behaviour[C2] 61 Problem solving[C2] 62 Goal setting (behaviour)[C2] 64 Action planning[C2] 65 Review behaviour goal[C2] 67 Behavioural contract[C2] 78 Information about health consequences[A2] None reported
McMurdo_BCI+P 2010* [+]	Multi-session	Face to face with remote (phone) follow up	Accelerometry	0.22	-0.19	0.64	3 Social support (unspecified)[C2] 8 Feedback on behaviour[C2] 10 Self-monitoring of behaviour[C2] 29 Graded tasks[A2] 34 Adding objects to the environment[C2] 36 Instruction on how to perform a behaviour[C2] 61 Problem solving[C2] 62 Goal setting (behaviour)[C2] 64 Action planning[C2] 65 Review behaviour goal[C2] 67 Behavioural contract[C2] 78 Information about health consequences[A2] None reported
Lawton 2008 [++]	Multi-session	Face to face with remote (phone) follow up	At least 150 minutes physical activity per week	0.16	0.02	0.29	3 Social support (unspecified)[C2] 9 Feedback on outcome of behaviour[C1] 10 Self-monitoring of behaviour[C2] 12 Monitoring of behaviour by others without feedback[A1] 15 Prompts/cues[A2]

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Author year	Type	Primary delivery mode	Outcome	SMD	95% CI lower	95% CI upper	Intervention BCTs Control BCTs
							34 Adding objects to the environment[C2] 56 Social reward[A1] 61 Problem solving[C2] 62 Goal setting (behaviour)[C2] 64 Action planning[C2] 67 Behavioural contract[C2] 78 Information about health consequences[A2] None reported
Elley 2003 [++]	Multi-session	Face to face with remote (print) follow up	Weekly leisure exercise	0.26	0.08	0.45	3 Social support (unspecified)[C2] 8 Feedback on behaviour[C2] 62 Goal setting (behaviour)[C2] 67 Behavioural contract[C2] 70 Persuasive source[A2] None reported
Prestwich_II 2009 [+]	Brief	Remote (computer and text message)	Exercise	0.07	-0.65	0.79	62 Goal setting (behaviour)[C2] 64 Action planning[C2] 67 Behavioural contract[C2] None reported
Prestwich_SMS 2009 [+]	Brief	Remote (text message)	Exercise	0.16	-0.55	0.87	15 Prompts/cues[A2] None reported
Prestwich_II+SMS 2009 [+]	Brief	Remote (computer)	Exercise	0.44	-0.29	1.17	15 Prompts/cues[A2] 62 Goal setting (behaviour)[C2] 64 Action planning[C2] 67 Behavioural contract[C2] None reported
Nies 2003 [+]	Multi-session	Remote (phone)	Daily walking	0.05	-0.28	0.38	3 Social support (unspecified)[C2] 10 Self-monitoring of behaviour[C2] 29 Graded tasks[A2]

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Author year	Type	Primary delivery mode	Outcome	SMD	95% CI lower	95% CI upper	Intervention BCTs Control BCTs
							61 Problem solving[C2] 62 Goal setting (behaviour)[C2] 64 Action planning[C2] 78 Information about health consequences[A2] None reported
Marcus_TB 2007 [+]	Multi-session	Remote (phone)	Weekly physical activity (at least moderate)	0.15	-0.23	0.54	3 Social support (unspecified)[C2] 8 Feedback on behaviour[C2] 10 Self-monitoring of behaviour[C2] 36 Instruction on how to perform a behaviour[C2] 62 Goal setting (behaviour)[C2] 64 Action planning[C2] 85 Social comparison[C1] 10 Self-monitoring of behaviour[C2]
Marcus_PB 2007 [+]	Multi-session	Remote (print)	Weekly physical activity (at least moderate)	0.52	0.13	0.91	3 Social support (unspecified)[C2] 8 Feedback on behaviour[C2] 10 Self-monitoring of behaviour[C2] 62 Goal setting (behaviour)[C2] 64 Action planning[C2] 71 Pros and cons[A2] 85 Social comparison[C1] 10 Self-monitoring of behaviour[C2]
Kolt 2007 [+]	Multi-session	Remote (phone)	Weekly leisure activity	0.46	0.15	0.77	3 Social support (unspecified)[C2] 8 Feedback on behaviour[C2] 10 Self-monitoring of behaviour[C2] 15 Prompts/cues[A2] 29 Graded tasks[A2] 36 Instruction on how to perform a behaviour[C2] 57 Non-specific reward[A1] 61 Problem solving[C2] 62 Goal setting (behaviour)[C2]

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Author year	Type	Primary delivery mode	Outcome	SMD	95% CI lower	95% CI upper	Intervention BCTs Control BCTs
							64 Action planning[C2] 69 Discrepancy between current behaviour and goal[C2] 71 Pros and cons[A2] 75 Framing/ reframing[A1] 80 Information about social and environmental consequences[C2] 84 Demonstration of the behaviour[A2] None reported
A positive SMD represents a benefit with the intervention (i.e. favours the intervention), and a negative SMD represents a benefit with the comparator (favours comparator). An SMD of <0.2 represents a very small effect size, of ≥0.2 to <0.5 represents a small effect size, of ≥0.5 to <0.8 a medium effect size, and of ≥0.8 a large effect size.							

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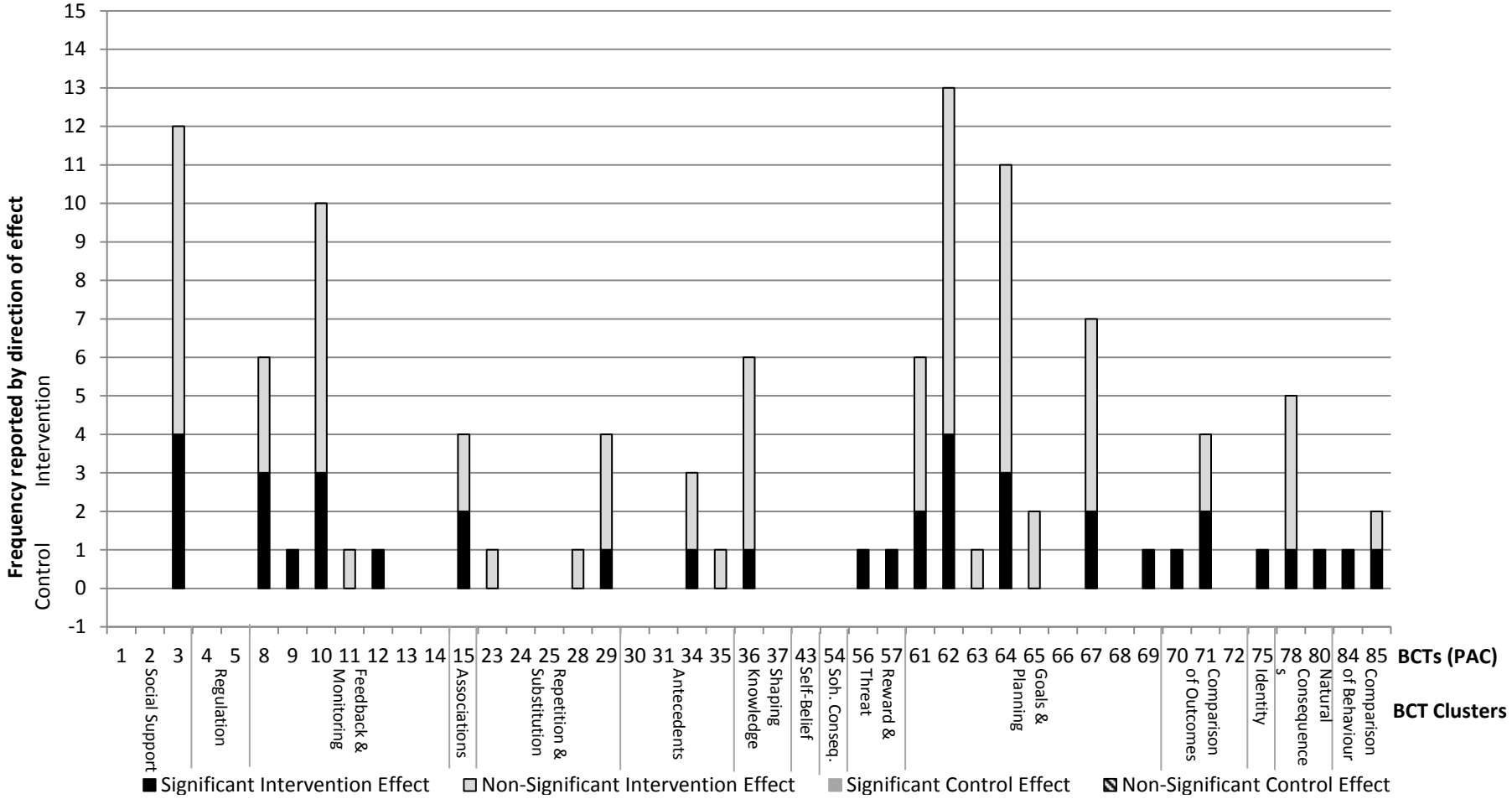
Figure 14: Distribution of behaviour change techniques in physical activity trials among under- or in-active individuals; direction and significance of effect



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Others in need of physical activity interventions

Four interventions (Lorig 2006* [++], Eakin 2007* [+], Luoto 2011* [+], Guelinckx 2010* [+]) assessed the impact of physical activity behaviour change interventions among other individuals who were judged to have a health status that could benefit from improved activity. This included individuals with chronic conditions (Lorig 2006* [++], Eakin 2007* [+]) and women at risk for gestational diabetes (Luoto 2011* [+], Guelinckx_BLI 2010* [+]).

Limited evidence was identified suggesting the multi-session physical activity interventions are no more effective than usual care an encouraging increased physical activity in people with chronic conditions or pregnant women at risk for gestational diabetes

Multi-session interventions for people with chronic conditions

Two trials (Lorig 2006* [++], Eakin 2007* [+])assessed the effect of a multi-session physical activity interventions among individuals with chronic conditions (other than only cardiovascular disease or T2DM).

Lorig 2006* [++] enrolled individuals with a physician's diagnosis of heart disease, chronic lung disease or T2DM. In addition to one of these diagnoses, individuals could have other chronic conditions. Participants received multiple, remotely delivered physical activity and nutrition workshops, which resulted in a very small, non-significant effect on weekly aerobic exercise compared to usual care (SMD 0.06, 95% CI -0.08 to 0.20).

Eakin 2007* [+] assessed the effect of a physical activity and dietary among individuals with one or more of the following chronic conditions: hypertension, chronic pain, hypercholesterolemia, depression, type 2 diabetes, osteoarthritis, obesity, chronic lung disease, heart disease, osteoporosis, hepatitis, history of cancer, previous stroke, or multiple sclerosis. The intervention took place over multiple sessions and employed both face to face

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(individual level) and remote components (telephone and print materials). The trial resulted in a very small, non-significant difference in the number of minutes spent walking each week at 3 months follow up compared to usual care (SMD 0.13, 95% CI -0.15 to 0.40).

Both interventions reported use of BCTs 3 Social support (unspecified), 8 Feedback on behaviour, 61 Problem solving, and 64 Action planning; BCT 3 Social support (unspecified) was also reported in the usual care arm of Eakin 2007* [+].

Multi-session interventions for pregnant women at risk for gestational diabetes

Two trials (Luoto 2011* [+], Guelinckx_B+LI 2010* [+]) examined the effectiveness of multi-session interventions on the physical activity habits of pregnant women at risk for gestational diabetes.

Luoto 2011* [+] enrolled euglycaemic women who were in their first trimester of pregnancy and had at least one risk factor for gestational diabetes. The intervention involved multiple one on one counselling sessions delivered face to face, and resulted in a very small, negative, non-significant effect on weekly physical activity (SMD -0.19, 95% CI -0.40 to 0.02).

Guelinckx_B+LI 2010* [+]) examined the effectiveness of a multi-session group intervention with remote components on the physical activity habits of pregnant women at risk for gestational diabetes. The study enrolled obese, white, pregnant women into a trial that aimed to reduce gestational weight gain and lower the risk of associated conditions including gestational diabetes. The multi-session group counselling intervention resulted in a small, non-significant difference in physical activity compared to usual care (SMD 0.27, 95% CI -0.15 to 0.70).

Both interventions reported use of BCTs 3 Social support (unspecified), and 62 Goal setting (behaviour). No BCTs were reported in the control arms

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Table 41: Physical activity interventions for other individuals in need of intervention

Author year	Type	Primary delivery mode	Outcome	SMD	95% CI lower	95% CI upper	Intervention BCTs Control BCTs
Lorig 2006* [++]	Multi-session	Remote (computer, post)	Weekly aerobic exercise	0.06	-0.08	0.20	3 Social support (unspecified)[C2] 5 Reduce negative emotions[C2] 8 Feedback on behaviour[C2] 43 Self-talk[A] 61 Problem solving[C2] 64 Action planning[C2] 84 Demonstration of the behaviour[A2] None reported
Eakin 2007* [+]	Multi-session	Face to face individual with remote (phone and post)	Weekly walking	0.13	-0.15	0.40	3 Social support (unspecified)[C2] 8 Feedback on behaviour[C2] 61 Problem solving[C2] 62 Goal setting (behaviour)[C2] 64 Action planning[C2] 67 Behavioural contract[C2] 3 Social support (unspecified)[C2]
Luoto 2011* [+]	Multi-session	Face to face	Weekly physical activity (MET min/week)	-0.19	-0.40	0.02	3 Social support (unspecified)[C2] 62 Goal setting (behaviour)[C2] 64 Action planning[C2] None reported
Guelinckx 2010* [+]	Multi-session	Face to face, group plus remote (print)	Physical activity	0.27	-0.15	0.70	3 Social support (unspecified)[C2] 5 Reduce negative emotions[C2] 25 Behaviour substitution[A] 36 Instruction on how to perform a behaviour[C2] 61 Problem solving[C2] 62 Goal setting (behaviour)[C2] None reported
A positive SMD represents a benefit with the intervention (i.e. favours the intervention), and a negative SMD represents a benefit with the comparator (favours comparator). A SMD of <0.2 represents a very small effect size, of ≥0.2 to <0.5 represents a small effect size, of ≥0.5 to <0.8 a medium effect size, and of ≥0.8 a large effect size.							

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A overview of physical activity interventions according to the reviewed parameters of type, mode of delivery and population is provided in Table 42.

Table 42: Summary of physical activity interventions according to type, mode of delivery, population and significant of effect

Category	Number of interventions	Number significant	% of 63 total PAC interventions (category interventions /topic total)	% of 20 total significant PAC interventions (category significant/ topic significant)	% of category resulting in significant effect (category significant/ category total)
Intervention Type					
Brief	3	0	4.76%	0.00%	0.00%
Extended	0	0	0.00%	0.00%	NA
Multi-session	60	20	95.24%	100.00%	33.33%
Mode of Delivery					
Face to face, one on one	8	4	12.70%	20.00%	50.00%
Face to face, group	10	1	15.87%	5.00%	10.00%
Face to face combined	7	5	11.11%	25.00%	71.43%
Face to face with remote	20	5	31.75%	25.00%	25.00%
Remote	18	5	28.57%	25.00%	27.78%
Population					
CV conditions	11	5	17.46%	25.00%	45.45%
CV risk	12	3	19.05%	15.00%	25.00%
T2DM	12	3	19.05%	15.00%	25.00%
T2DM risk	3	2	4.76%	10.00%	66.67%
Overweight or obese	6	3	9.52%	15.00%	50.00%
Under- or inactive	15	4	23.81%	20.00%	26.67%

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4.6.5 BCT clusters

BCT clusters used in the physical activity interventions are summarised in Table 7.

The most commonly used BCT clusters in the physical activity interventions were BCT cluster (BCT-C) 11 ‘Goals and planning’ (86.7%) followed by BCT-C 1 ‘Social support (85.7%). BCT-C 9 ‘Scheduled consequences’, and BCT-C 16 ‘Covert learning’ were not used in any of the interventions.

The association between BCT clusters and intervention effectiveness was assessed in the meta-regression, and results are described in Section 4.6.8.

4.6.6 Intervention functions

Interventions functions used in the physical activity interventions are summarised in Table 8.

The most commonly used intervention functions (IFs) were IF9 ‘Enablement’ (98.4%) and IF1 ‘Education’ (79.4%). IF3 ‘Coercion’ and IF6 ‘Restriction’ were not used in any of the interventions.

The association between intervention function and intervention effectiveness was assessed in the meta-regression, and results are described in Section 4.6.8.

4.6.7 Theory use

Twenty nine comparisons included an intervention explicitly linked to a theory or model. These were:

- Transtheoretical Model (Clark 2004* [+]; Kirk 2009 [+] PA-P and PA-W interventions; Kolt 2007 [+]; Vermunt 2011* [+]; Armit 2008 [++] ES and ES+P interventions; Eriksson 2009* [++]; Hyman 2007* [++] SeC and SiC interventions)

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- Transtheoretical Model and Social Cognitive Theory (Marcus 2007 [+] PB and TB interventions; Pinto 2011 [++]; van Sluijs 2005 [++])
- Self-Regulation Theory/Model (McMurdo 2010* [+] BCI and BCI+P interventions, Keogh 2011* [+])
- Protection Motivation Theory (Prestwich 2009 [+] II, II+SMS, and SMS interventions)
- Social Cognitive Theory (Patrick 2011* [+], Morey 2009* [++])
- Social Cognitive Theory and Social Ecological Theory (Eakin 2010* [+])
- Social Cognitive Theory, Goal Systems Theory, Social Ecological Theory (Toobert 2010* [+])
- Social Ecological theory (Eakin 2007* [+])
- Self-Efficacy Theory (Smeulders 2009* [+])
- Social Problem-Solving Model, Expectancy-Value Theory and Relapse Prevention Theory (Moore 2006 [+])
- Implicit Logic Model (Toobert 2011* [+])
- Theory of Planned Behaviour (White 2012* [+])

The most commonly used theory or model was the Transtheoretical Model (also known as the Stages of Change Model), which was used in 14 interventions. In 4 of these interventions it was combined with Social Cognitive Theory, which was also used in another 4 interventions.

The presence of a theory use was controlled for in the meta-regression, and results are described in Section 4.6.8.

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Table 43: Proportion of between study variance accounted for by individual BCT clusters/intervention functions/theory use in physical activity behaviour in adjusted univariate analysis

BCT clusters	1 Social support	2 Regulation	3 Feedback and monitoring	4 Associations	5 Repetition and substitution	6 Antecedents	7 Shaping knowledge	8 Self-belief	9 Scheduled consequences	10 Reward and threat	11 Goals and planning	12 Comparison of outcomes	13 Identity	14 Natural consequences	15 Comparison of behaviour	16 Covert learning
Adjusted R^2	1.6%	0.4%	3.0%	0%	19.2%	1.5%	0%	-	-	0%	0%	2.2%	-	0%	0%	-

Intervention functions	1 Education	2 Persuasion	3 Incentivisation	4 Coercion	5 Training	6 Restriction	7 Environmental restructuring	8 Modelling	9 Enablement		Theory use
Adjusted R^2	0%	0%	0%	-	0%	-	7.8%	0%	0.2%	**Adjusted R^2**	0%

'-' Indicates that a BCT cluster has not been analysed, because of an insufficient spread of use/non-use in the included comparisons.

Adjusted R^2 indicates the proportion of between study variance explained by a variable(s). Analysis controlled for BCT cluster and intervention function use in the control group.

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4.6.8 Effects of behaviour change interventions, BCT clusters and intervention functions using meta-regression

Results from 63 comparisons (53 studies) were included in the meta-regression models. As shown in Figure 15, overall the studies found a small significant effect of the individual level behaviour change interventions (SMD 0.22, 95% CI 0.15 to 0.29). The analysis had substantial levels of heterogeneity (I^2=83.9%, 95% CI 80.2% to 86.6%; p<0.001). No studies were found to be outliers.

There was no statistical evidence of publication bias using Egger's test for small-study effects (p=0.659), or a filled funnel plot approach.

In adjusted univariate analysis the following variables accounted for some of the between study variance (See Table 43):

- BCT cluster 5 'Repetition and substitution' (19.2%)
- Intervention function 7 'Environmental restructuring' (7.8%)
- BCT cluster 3 ' Feedback and monitoring' (3%)
- BCT cluster 12 'Comparison of Outcomes' (2.2%)
- BCT cluster 1 'Social support' (1.6%)
- BCT cluster 6 'Antecedents' (1.5%)
- BCT cluster 2 'Regulation' (0.4%)

In the primary adjusted multivariate analysis BCT clusters 2 and 6 were dropped from the model as the amount of between study variance explained (indicated by the adjusted R^2 value) did not increase when they were added. The final model explained 29.7% of the between study variance. Two of the individual variables in the model showed significant association with a positive effect of the intervention - BCT cluster 5 'Repetition and substitution' (regression coefficient 0.18, 95% CI 0.05 to 0.31; p=0.006) and Intervention function 7 'Environmental restructuring' (regression coefficient 0.16, 95% CI

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0.02 to 0.30; p=0.030). The association between BCT cluster 1 ‘Social support’ and a negative effect of the intervention showed a trend towards significance (regression coefficient -0.13, 95% CI -0.27 to 0.09; p=0.060). BCT cluster 12 showed a positive direction of effect (regression coefficient 0.12, 95% CI -0.03 to 0.27; p=0.103), and BCT cluster 3 showed a negative direction of effect (regression coefficient -0.09, 95% CI -0.21 to 0.03; p=0.131).

In a sensitivity analysis including only studies with long term follow up (19 comparisons), the multivariate model explained 86.6% of between study variance (see Table 44). BCT cluster 5 ‘Repetition and substitution’ and Intervention function 7 ‘Environmental restructuring’ remained significantly associated with a positive effect of the intervention and the magnitude of the effect increased,. The magnitude of the association between BCT cluster 12 ‘Comparison of outcomes’ and a positive effect of the intervention and between BCT cluster 3 ‘Feedback and monitoring’ and a negative effect of the intervention both increased and became significant in the sensitivity analysis. The magnitude, direction and significance of the association with BCT-C 1 ‘Social support’ remained similar in the sensitivity analysis to the primary analysis. Overall, this suggests that the effects of these variables are maintained in the longer term, and increases in most cases.

Full meta-regression results are provided in Appendix H.

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Figure 15: Overall effect of individual-level behaviour change interventions on physical activity behaviour

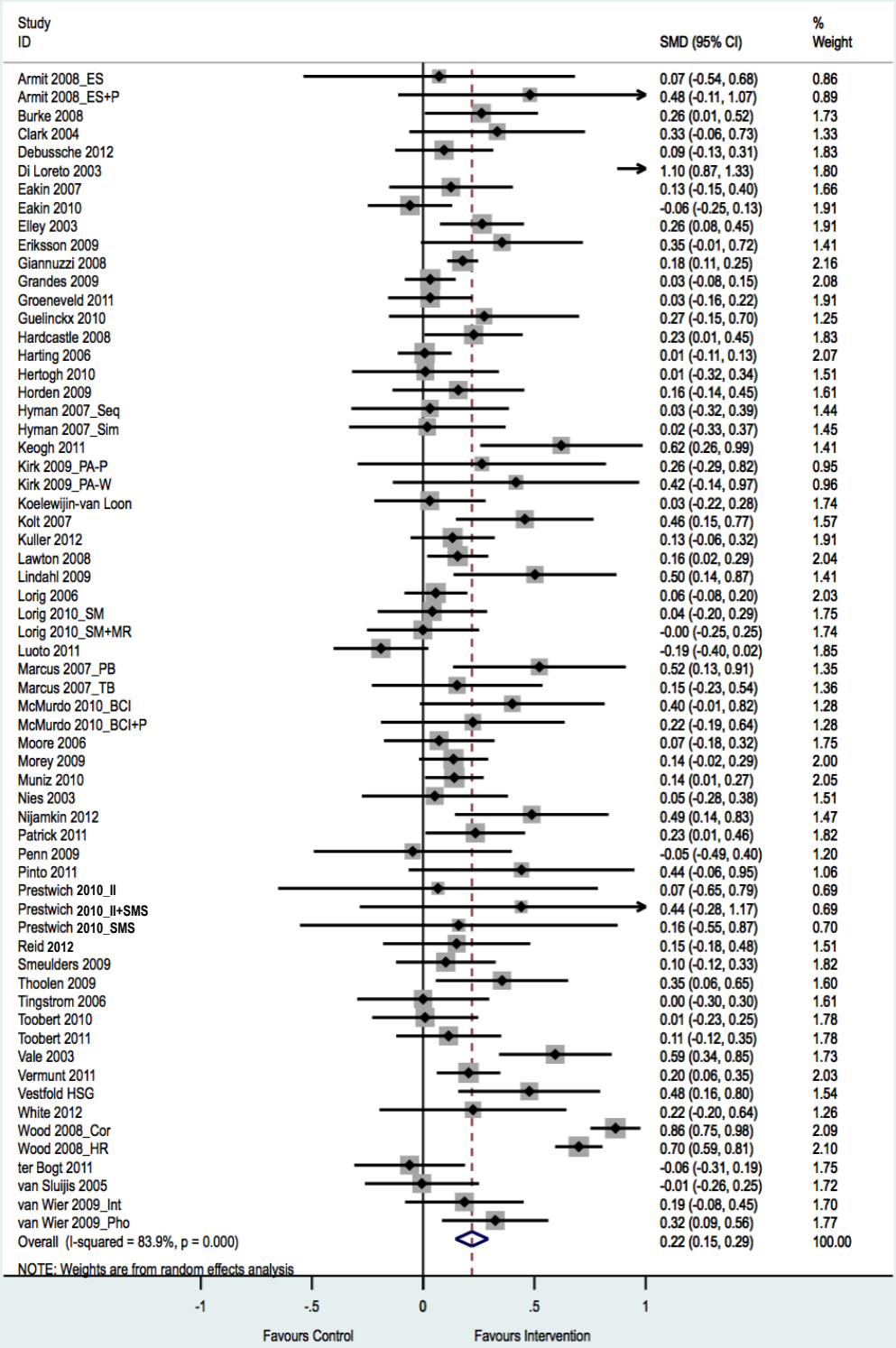

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Table 44: Meta-regression results for the effect of BCT clusters and intervention functions in individual-level interventions for physical activity

Covariate	β	95% CI	P value	Adjusted R^2
Adjusted univariate analysis				
BCT cluster 1 'Social support'	-0.10	-0.25 to 0.05	0.19	1.6%
BCT cluster 2 'Regulation'	-0.07	-0.23 to 0.09	0.39	0.4%
BCT cluster 3 'Feedback and monitoring'	-0.10	-0.23 to 0.04	0.16	3.0%
BCT cluster 5 'Repetition and substitution'	0.19	0.06 to 0.33	0.01	19.2%
BCT cluster 6 'Antecedents'	0.08	-0.06 to 0.22	0.27	1.5%
BCT cluster 12 'Comparison of Outcomes'	0.13	-0.03 to 0.30	0.11	2.2%
Intervention function 7 'Environmental restructuring'	0.17	0.01 to 0.33	0.01	7.8%
Theory use	-0.02	-0.16 to 0.12	0.76	0%
Primary adjusted multivariate analysis				
BCT cluster 2 'Regulation'	Variables dropped from the model as adjusted R^2 did not improve			
BCT cluster 6 'Antecedents'				
BCT cluster 5 'Repetition and substitution'	0.18	0.05 to 0.31	0.006	29.7%
Intervention function 7 'Environmental restructuring'	0.16	0.02 to 0.30	0.030	
BCT cluster 3 'Feedback and monitoring'	-0.09	-0.21 to 0.03	0.131	
BCT cluster 12 'Comparison of Outcomes'	0.12	-0.03 to 0.27	0.103	
BCT cluster 1 'Social support'	-0.13	-0.27 to 0.01	0.060	
Theory use	-0.03	-0.16 to 0.09	0.594	
Sensitivity analysis: adjusted multivariate analysis - long term follow up only				
BCT cluster 5 'Repetition and substitution'	0.32	0.15 to 0.48	0.001	86.6%
Intervention function 7 'Environmental restructuring'	0.27	0.10 to 0.44	0.005	
BCT cluster 3 'Feedback and monitoring'	-0.24	-0.40 to -0.07	0.009	
BCT cluster 12 'Comparison of Outcomes'	0.34	0.07 to 0.61	0.017	
BCT cluster 1 'Social support'	-0.17	-0.40 to 0.05	0.117	
Theory use	-0.12	-0.33 to 0.08	0.201	

β = Regression coefficient; CI = Confidence interval; IF = intervention function

Adjusted R^2 = the proportion of between study variance explained by a variable(s). A positive regression coefficient indicates that the presence of the cluster or intervention function is associated with increased effectiveness of the intervention; a negative regression coefficient indicates that the presence of the cluster or intervention function is associated with decreased effectiveness of the intervention. Intervention function in the comparator group and theory use were controlled for in the analysis.

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4.6.9 Evidence statements

Direction of effect across all interventions in the specified behaviour area	
A	BCT found in interventions with a positive direction of effect only (i.e. effect favours intervention)
B	BCT found in interventions with a negative direction of effect only (i.e. effect favours control)
C	BCT found in interventions with positive and negative directions of effect (i.e. inconsistent direction of effect – some favouring intervention, some favouring control)
Significance and consistency of effect across all interventions in the specified behaviour area	
1	BCT found in one intervention with a significant positive effect
2	BCT found in more than one intervention with a significant positive effect

Applicability and transferability of evidence to the UK

This applicability statement applies to all of the physical activity evidence statements for Review 2. These 63 interventions have partial to direct applicability to the UK. Six trials, describing ten interventions (Kirk_PA-P 2009 [+], Clark 2004 [+], Kirk_PA-W 2009 [+], Hardcastle 2008 [+], Penn 2009 [+], McMurdo_BCI 2010 [+], McMurdo_BCI+P 2010 [+], Prestwich_II 2009 [+], Prestwich_SMS 2009 [+], Prestwich_II+SMS 2009 [+]) were carried out in the UK. Of the remaining 57 interventions, 25 were conducted in in other European countries, one in Canada, 12 in Australia, and 15 in the USA. Therefore caution is required when interpreting findings regarding the interventions carried out in populations that may have different access to services, as well as the interventions having different delivery methods and are provided in different settings from those found in the UK. The individual evidence statements provide further information on the country each study was conducted in.

In terms of transferability to clinical or public health practice, it should be remembered that the behaviour change interventions in the randomised controlled trials in this review varied in the number of sessions provided (ranging from one to over 30) and the types of interventions (brief, extended

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and multi-session). Twenty-five studies included individuals selectively recruited based on characteristics in addition physical activity behaviours. This may reduce their direct applicability to general UK public health practice. These characteristics include: gender (male: Groenveld 2011 [+], Patrick 2011 [+]; female: Guelinckx 2010 [+], Hertogh 2010 [+], Kuller 2012 [+], Lawton 20008 [++], Luoto 2011 [+], McMurdo 2010 [+], Nies 2003 [+], Toobert 2010 [+], Toobert 2011 [+]); age (Armit 2009 [++], Burke 2008 [+], Elley 2003 [++], Kolt 2007 [+], Lawton 20008 [++], McMurdo 2010 [+], Pinto 2011 [++], Vermunt 2011 [+], White 2012 [+]); ethnicity (black: Hyman_Sic 2007* [++], Hyman_Sec 2007* [++]; Hispanic/Latino: Nijamkin 2012 [++], Toobert 2011 [+]); Health status other than cardiovascular or T2DM (cancer survivors: Morey 2009 [++]); and setting (university students: Prestwich 2009 [+]).

Evidence Statement 5.1 – Overall Effectiveness of physical activity behaviour change interventions, BCT clusters and intervention functions

There is strong evidence from 63 interventions (Grandes 2009 [++], Armit_ES 2009 [++], McMurdo_BCI+P 2010* [+], Armit_ES+P 2009 [++], McMurdo_BCI 2010* [+], Lawton 2008 [++], Elley 2003 [++], Hertogh 2010 [+], Nies 2003 [+], Marcus_TB 2007 [+], Kolt 2007 [+], Marcus_PB 2007 [+], Muniz 2010* [+], Giannuzzi 2008* [+], Wood_HR 2008* [++], Wood_CR 2008* [++], VHSG 2003* [++], Smeulders 2009* [+], Tingstrom 2006 [+], White 2012* [+], Moore 2006 [+], Vale 2003* [++], Reid 2012 [++], ter Bogt 2011* [+], Hardcastle 2008* [+], Hyman_SiC 2007* [++], Hyman_SeC 2007* [++], van Sluijs 2005 [++], Koelewijn-van Loon 2003* [+], Groeneveld 2011* [+], Horden 2009* [+], Harting 2006* [+], Eriksson 2009* [++], Burke 2008* [+], Eakin 2010* [+], Lorig 2006* [++], Eakin 2007* [+], Luoto 2011* [+], Toobert 2010* [+], Thoolen 2009* [+], Kirk_PA-P 2009 [+], Debussche 2012* [+], Clark 2004* [+], Di Loreto 2003 [+], Toobert 2011* [+], Keogh 2011* [+], Lorig_SM+MR 2010* [++], Lorig_SM 2010* [++], Kirk_PA-W 2009 [+], Lindahl 2009* [+], Vermunt 2011* [+], Penn 2009* [+], Prestwich_II 2009 [+], Prestwich_II+SMS 2009 [+],

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Prestwich_SMS 2009 [+], Guelinckx 2010* [+], Kuller 2012* [+], Nijamkin 2012* [++], van Wier_I 2009* [+], Pinto 2011 [++], Morey 2009* [++], Patrick 2011* [+], van Wier_T 2009* [+]) to suggest that individual level behaviour change interventions can have a small effect on physical activity behaviour, with an effect size of 0.22 (95% CI 0.15 to 0.29).

Meta-regression of the results of these RCTs found that the following variables explained 29.7% of between study variance:

- BCT cluster 5 ‘Repetition and substitution’ (regression coefficient 0.18, 95% CI 0.05 to 0.31; p=0.006)
- Intervention function 7 ‘Environmental restructuring’ (regression coefficient 0.16, 95% CI 0.02 to 0.30; p=0.030)
- BCT cluster 3 ‘Feedback and monitoring’ (regression coefficient -0.09, 95% CI -0.21 to 0.03; p=0.131)
- BCT cluster 12 ‘Comparison of Outcomes’ (regression coefficient 0.12, 95% CI -0.03 to 0.27; p=0.103)
- BCT cluster 1 ‘Social support’ (regression coefficient -0.13, 95% CI -0.27 to 0.09; p=0.060)

BCT cluster 5 ‘Repetition and substitution’ and Intervention function 7 ‘Environmental restructuring’ were associated with significantly increased effectiveness of the intervention, while BCT cluster 12 ‘Comparison of Outcomes’ was associated with a non-significant increase. BCT cluster 3 ‘Feedback and monitoring’ and BCT cluster 1 ‘Social support’ were associated with non-significant decreases in intervention effectiveness.

These effects remain in the long term, with the effects of BCT clusters 5, 3 and 12 and Intervention function 7 increasing in magnitude, and all being statistically significant.

Evidence Statement 5.2 –BCTs reported in interventions with a positive effect across physical activity trials

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Strong evidence from a body of 63 interventions (see Evidence Statement 5.1 for details) suggests that the following BCTs are consistently associated with a significant intervention effect in physical activity trials (reported only in trials with a positive direction of effect, and in more than one intervention in which this effect was significant versus the comparator arm): 15 Prompts/cues[A2], 28 Generalisation of target behaviour[A2], 29 Graded tasks[A2], 68 Commitment[A2], 70 Persuasive source[A2], 71 Pros and cons[A2], 78 Information about health consequences[A2], 84 Demonstration of the behaviour[A2].

The following BCTs were consistently associated with an intervention effect, one of which was significant: 2 Social support - emotional[A1], 11 Self-monitoring of outcome(s) of behaviour[A1], 12 Monitoring of behaviour by others without feedback[A1], 14 Biofeedback[A1], 24 Habit formation[A1], 30 Restructuring the physical environment[A1], 31 Restructuring the social environment[A1], 37 Information about antecedents[A1], 56 Social reward[A1], 57 Non-specific reward[A1], 66 Review outcome goal[A1], 72 Comparative imagining of future outcomes[A1], 75 Framing/reframing[A1].

Four BCTs were reported only in trials that resulted in a positive, non-significant: 4 Pharmacological support[A] , 25 Behaviour substitution[A], 43 Self talk[A], 54 Material reward[A].

Evidence Statement 5.3 – BCTs reported in interventions with inconsistent effects across physical activity trials

Strong evidence from a body of 63 interventions (see Evidence Statement 5.1 for details) suggests that the following BCTs are associated with inconsistent effects in physical activity trials (reported in trials with a both a positive and negative direction of effect, although the significance of this effect varies): 1 Social support – practical[C2], 3 Social support – unspecified [C2], 5 Reduce negative emotions[C2], 8 Feedback on behaviour[C2], 9 Feedback on outcome(s) of behaviour[C1], 10 Self-monitoring of behaviour[C2], 23 Behavioural practice/rehersal[C2], 34 Adding objects to the environment[C2], 35 Body

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changes[C2], 36 Instruction on how to perform a behaviour[C2], 61 Problem solving[C2], 62 Goal setting - behaviour[C2], 63 Goal setting - outcome[C2], 64 Action planning[C2], 65 Review behaviour goal(s)[C2], 67 Behavioural contract[C2], 69 Discrepancy between current behaviour and goal[C2], 80 Information about social and environmental consequences[C2], 85 Social comparison[C1].

Evidence Statement 5.4 – BCTs reported in interventions with negative effects across physical activity trials

Strong evidence from a body of 63 interventions (see Evidence Statement 5.1 for details) suggests that one BCT, 13 Monitoring outcome of behaviour by others without feedback, is associated solely with negative but non-significant effects.

Evidence statement 5.5 – Multi-session physical activity interventions delivered face to face and one on one or combined one on one and group level to patients with cardiovascular conditions

Strong evidence from four interventions (Muniz 2010* [+], Giannuzzi 2008* [+], Vestfold Heartcare Study Group [VHSG] 2003* [++], Wood_CR 2008* [++]) suggests that physical activity interventions (with an additional dietary component) delivered over multiple sessions at either one on one or combined one on one and group level are effective at physical activity among cardiovascular patients compared to usual care (Muniz 2010* [+] SMD 0.14, 95% CI 0.01to 0.27; Giannuzzi 2008* [+] SMD 0.18, 95% CI 0.11 to 0.25; VHSG 2003* [++] SMD 0.48, 95% CI 0.16 to 0.80; Wood_CR 2008* [++] SMD 0.86, 95% CI 0.75 to 0.98).

All four interventions included use of BCT 3 Social support (unspecified) [C2]. Three of the four (Muniz 2010* [+], Giannuzzi 2008* [+], Wood_CR 2008* [++]) reported use of BCT 34 Adding objects to the environment[C2]. The two interventions delivered one on one to cardiac patients reported use of BCTs 68 Commitment[A2] and 70 Persuasive source[A2]. The two combined delivery

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interventions (VHSG 2003* [++], Wood_CR 2008* [++]) reported use of BCT 61 Problem solving[C2].

Muniz 2010* (RCT [+], Spain, n=1,510, 16 weeks).
BCTs present:
3 Social support (unspecified)[C2]
34 Adding objects to the environment[C2]
65 Review behaviour goal[C2]
68 Commitment[A2]
70 Persuasive source[A2]
80 Information about social and environmental consequences[C2]

Giannuzzi 2008* (RCT [+], Italy, n=3,241, 0 weeks)
BCTs present:
1 Social support (practical)[C2]
3 Social support (unspecified)[C2]
23 Behavioural practice/ rehearsa[C2]
34 Adding objects to the environment[C2]
36 Instruction on how to perform a behaviour[C2]
62 Goal setting (behaviour)[C2]
63 Goal setting (outcome)[C2]
64 Action planning[C2]
68 Commitment[A2]
70 Persuasive source[A2]

VSHG 2003* (RCT, [++], Norway, n=197, 89 weeks)
BCTs present:
1 Social support (practical)[C2]
3 Social support (unspecified)[C2]
5 Reduce negative emotions[C2]
10 Self-monitoring of behaviour[C2]
23 Behavioural practice/ rehearsal[C2]
35 Body changes[C2]
36 Instruction on how to perform a behaviour[C2]
61 Problem solving[C2]
84 Demonstration of the behaviour[A2]

Wood_CR 2008* (cRCT [++], Europe, n=1,934, 36 weeks)
BCTs present:
3 Social support (unspecified)[C2]

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28 Generalisation of a target behaviour[A2]
34 Adding objects to the environment[C2]
61 Problem solving[C2]
62 Goal setting (behaviour)[C2]
63 Goal setting (outcome)[C2]
64 Action planning[C2]
65 Review behaviour goal[C2]

Evidence statement 5.6– Multi-session physical activity interventions delivered face to face on a group level to patients with cardiovascular conditions

Strong evidence from four interventions (Smeulders 2009* [+], Tingstrom 2006 [+], White 2012* [+], Moore 2006 [+]) suggests that multi-session group interventions are no more effective than comparators at improving physical activity among patients with cardiovascular conditions. All four interventions resulted in very small to small, non-significant effects (Smeulders 2009* [+] SMD 0.10, 95% CI -0.12 to 0.33; Tingstrom 2006 [+] SMD 0.00, 95% CI -0.30 to 0.30; White 2012* [+] SMD 0.22, 95 % CI -0.20 to 0.64; Moore 2006 [+] SMD 0.07, 95% CI -0.18 to 0.32). All four interventions reported use of BCTs 3 Social support (unspecified)[C2], and 62 Goal setting (behaviour)[C2].

Smeulders 2009* (RCT [+], Netherlands, n=317, 44 weeks)
BCTs present:
3 Social support (unspecified)[C2]
62 Goal setting (behaviour)[C2]
64 Action planning[C2]

Tingstrom 2006 (RCT [+], Sweden, n=175, 0 weeks)
BCTs present:
3 Social support (unspecified)[C2] (also reported in comparator arm)
61 Problem solving[C2]
62 Goal setting (behaviour)[C2]
85 Social comparison[C1]

White 2012* (RCT [+], Australia, n=111, 6 weeks)
BCTs present:

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3 Social support (unspecified)[C2]
29 Graded tasks[A2]
61 Problem solving[C2]
62 Goal setting (behaviour)[C2]
64 Action planning[C2]
71 Pros and cons[A2]

Moore 2006 (RCT [+], USA, n=250, 0 weeks)
BCTs present:
3 Social support (unspecified)[C2] (also reported in comparator arm)
5 Reduce negative emotions[C2] (also reported in comparator arm)
10 Self-monitoring of behaviour[C2](also reported in comparator arm)
14 Biofeedback[A1] (also reported in comparator arm)
61 Problem solving[C2]
62 Goal setting (behaviour)[C2] (also reported in comparator arm)
63 Goal setting (outcome)[C2] (also reported in comparator arm)
64 Action planning[C2] (also reported in comparator arm)
67 Behavioural contract[C2] (also reported in comparator arm)
85 Social comparison[C1]

Evidence statement 5.7– Multi-session remotely delivered physical activity interventions for patients with cardiovascular conditions

Inconsistent evidence from three interventions (Vale 2003* [++], Reid 2012 [++], Pinto 2011 [++]) was identified concerning the effectiveness of multi-session physical activity interventions delivered over the phone to patients hospitalised with cardiac conditions. Vale 2003* [++] addressed diet and smoking in addition to physical activity, and resulted in a significant intervention effect (SMD 0.59, 95% CI 0.34 to 0.85). Reid 2012 [++] addressed physical activity only, and was no more effective than usual care at changing the walking behaviour (SMD 0.15, 95% CI -0.18 to 0.48). Pinto 2011 [++] resulted in no significant difference in terms of meeting physical activity guidelines between an internet based exercise maintenance counselling programme and the comparator (SMD 0.44, 95% CI -0.06 to 0.95).

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The two trials (Reid 2012 [++], Pinto 2011 [++]) with non-significant effects each addressed physical activity only (as opposed to a combined diet and physical activity approach), and reported use of BCTs 3 Social support (unspecified), 8 Feedback on behaviour, and 10 Self-monitoring of behaviour.

Vale 2003* (RCT [++], Australia, n=320, 4 weeks)
BCTs present:
36 Instruction on how to perform a behaviour[C2]
61 Problem solving[C2]
63 Goal setting (outcome)[C2]
72 Comparative imagining of future outcomes[A1]
78 Information about health consequences[A2]

Reid 2012 (RCT [+], Canada, n=141, 0 weeks)
BCTs present:
3 Social support (unspecified)[C2]
8 Feedback on behaviour[C2]
10 Self-monitoring of behaviour[C2]
28 Generalisation of a target behaviour[A2]
36 Instruction on how to perform a behaviour[C2]
61 Problem solving[C2]
62 Goal setting (behaviour)[C2]
64 Action planning[C2]
68 Commitment[A2]

Pinto 2011 (RCT [++], USA, n=130, 0 weeks)
BCTs present:
3 Social support (unspecified)[C2]
8 Feedback on behaviour[C2]
10 Self-monitoring of behaviour[C2]
34 Adding objects to the environment[C2]
67 Behavioural contract[C2]

Evidence statement 5.8 – Multi-session face to face physical activity interventions for patients with T2DM

Inconsistent evidence was identified from four trials (Toobert 2010* [+], Thoolen 2009* [+], Toobert 2011* [+], Horden 2009* [+]) regarding the

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effectiveness of multi-session physical activity interventions delivered face to face for T2DM patients. All four trials addressed diet as well as physical activity. Two trials were conducted over multiple one on one as well as group sessions. A trial among postmenopausal women with T2DM showed no significant difference in physical activity (Toobert 2010* [+] SMD 0.01, 95% CI -0.23 to 0.25) while a trial among patients whose diabetes had recently been detected through screening resulted in a significant difference in activity (Thoolen 2009* [+] SMD 0.35, 95% CI 0.06 to 0.65).

Evidence from two trials (Toobert 2011* [+], Horden 2009* [+]) suggest that a multi-session group interventions are no more effective than usual care at improving physical activity among female Latina T2DM patients (Toobert 2011* [+] SMD 0.11, 95% CI -0.12 to 0.35) or T2DM patients considered to be at risk for myocardial infarction (Horden 2009* [+] SMD 0.16, 95% CI -0.14 to 0.45).

The intervention reporting significant effects (Thoolen 2009* [+]) reported use of several BCTs which did not appear in any of the three trials with insignificant effects: 11 Self-monitoring of outcome of behaviour, 63 Goal setting (outcome), and 65 Review behaviour goal.

Toobert 2010* (RCT [+], USA, n=279, 260 weeks)
BCTs present:
3 Social support (unspecified)[C2]
5 Reduce negative emotions[C2]
10 Self-monitoring of behaviour[C2]
25 Behaviour substitution[A]
29 Graded tasks[A2]
35 Body changes[C2]
36 Instruction on how to perform a behaviour[C2]
54 Material reward for behaviour[A]
62 Goal setting (behaviour)[C2]
64 Action planning[C2]

Thoolen 2009* (RCT [+], Netherlands, n=180, 40 weeks)

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BCTs present:
11 Self-monitoring of outcome of behaviour[A1]
23 Behavioural practice/ rehearsal[C2]
61 Problem solving[C2]
63 Goal setting (outcome)[C2]
64 Action planning[C2]
65 Review behaviour goal[C2]

Toobert 2011* (RCT [+], USA, n=277, 0 weeks)
BCTs present:
5 Reduce negative emotions
23 Behavioural practice/ rehearsal
36 Instruction on how to perform a behaviour
61 Problem solving
62 Goal setting (behaviour)

Horden 2009* (RCT [+], Australia, n=176, 0 weeks)
BCTs present:
3 Social support (unspecified)[C2] (also reported in control arm)
12 Monitoring of behaviour by others without feedback[A1]
23 Behavioural practice/ rehearsal[C2]
28 Generalisation of a target behaviour[A2]
36 Instruction on how to perform a behaviour[C2]
61 Problem solving[C2]
62 Goal setting (behaviour)[C2]
64 Action planning[C2]

Evidence statement 5.9– Multi-session physical activity interventions delivered remotely or with remote components among T2DM patients

Inconsistent evidence was identified from eight interventions regarding the effectiveness of multi-session face to face interventions with remotely delivered components (Kirk_PA-P 2009 [+], Debussche 2012* [+], Clark 2004* [+], Keogh 2011* [+], Di Loreto 2003 [+]) and multi-session remotely delivered interventions (Kirk_PA-W 2009 [+], Lorig_SM 2010* [++], Lorig_SM+MR 2010* [++]) among T2DM patients.

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Three of these interventions (Kirk_PA-P 2009 [+], Debussche 2012* [+], Clark 2004* [+]) resulted in very small to small, non-significant effects (Kirk_PA-P 2009 [+] SMD 0.26, 95% CI -0.29 to 0.82; Debussche 2012* [+] SMD 0.09, 95% CI -0.13 to 0.31; Clark 2004* [+] SMD 0.33, 95% CI -0.06 to 0.73). Medium to large, significant intervention effects were seen among a diet and physical activity intervention delivered to T2DM patients and a family member (Keogh 2011* [+] SMD 0.62, 95% CI 0.26 to 0.99), and among T2DM patients alone (Di Loreto 2003 [+] SMD 1.10, 95% CI 0.87 to 1.33).

Evidence from three interventions (Kirk_PA-W 2009 [+], Lorig_SM 2010* [++], Lorig_SM+MR 2010* [++]) described in two trials suggests that multi-session, remotely delivered physical activity interventions are no more effective than usual care at improving weekly physical activity among T2DM patients (Kirk_PA-W 2009 [+] SMD 0.42, 95% CI -0.13 to 0.97; Lorig_SM 2010* [++] SMD 0.04, 95% CI -0.20 to 0.29; Lorig_SM+MR 2010* [++] SMD -0.001, 95% CI -0.25 to 0.25).

No BCTs were reported in the two significant interventions that we're also reported in an intervention with non-significant effects. Similarly, no BCTs were reported across non-significant interventions that didn't also appear in at least one of the significant trials.

Kirk_PA-P 2009 (RCT [+], UK, n=81, 12 weeks)
BCTs present:
3 Social support (unspecified)[C2] (also reported in control arm)
34 Adding objects to the environment[C2]
61 Problem solving[C2]
62 Goal setting (behaviour)[C2] (also reported in control arm)
63 Goal setting (outcome)[C2]
64 Action planning[C2] (also reported in control arm)
78 Information about health consequences[A2] (also reported in control arm)

Debussche 2012* (RCT [+], Reunion Island, n=318, 12 weeks)
BCTs present:
3 Social support (unspecified)[C2] (also reported in control arm)
61 Problem solving[C2]

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62 Goal setting (behaviour)[C2]

Clark 2004* (RCT [+], UK, n=100, 26 weeks)
BCTs present:
8 Feedback on behaviour[C2]
43 Self-talk[A]
61 Problem solving[C2]
62 Goal setting (behaviour[C2]
63 Goal setting (outcome)[C2]
65 Review behaviour goal[C2]
69 Discrepancy between current behaviour and goal[C2]
71 Pros and cons[A2]

Keogh 2011* (RCT [+], Ireland, n=121, 21 weeks)
BCTs present:
3 Social support (unspecified)[C2]
61 Problem solving[C2]
62 Goal setting (behaviour)[C2]
64 Action planning[C2]
67 Behavioural contract[C2]
68 Commitment[A2]
78 Information about health consequences[A2]

Di Loreto 2003 (RCT [+], Italy, n=340, 0 weeks)
BCTs present:
1 Social support (practical)[C2]
3 Social support (unspecified)[C2]
8 Feedback on behaviour[C2]
10 Self-monitoring of behaviour[C2]
29 Graded tasks[A2]
61 Problem solving[C2]
62 Goal setting (behaviour)[C2]
64 Action planning[C2]
65 Review behaviour goal[C2]
70 Persuasive source[A2]
78 Information about health consequences[A2]
80 Information about social and environmental consequences[C2]

Kirk_PA-W 2009 (RCT [+], UK, n=86, 12 weeks)
BCTs present:

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3 Social support (unspecified)[C2] (also reported in control arm)
34 Adding objects to the environment[C2]
61 Problem solving[C2]
62 Goal setting (behaviour)[C2] (also reported in control arm)
63 Goal setting (outcome)[C2]
64 Action planning[C2] (also reported in control arm)
78 Information about health consequences[A2] (also reported in control arm)

Lorig_SM+MR 2010* (RCT [++], USA, n=360, 70 weeks)
BCTs present:
3 Social support (unspecified)[C2]
5 Reduce negative emotions[C2]
8 Feedback on behaviour[C2]
61 Problem solving[C2]
64 Action planning[C2]

Lorig_SM 2010* (RCT [++], USA, n=388, 70 weeks)
BCTs present:
5 Reduce negative emotions[C2]
8 Feedback on behaviour[C2]
61 Problem solving[C2]
64 Action planning[C2]

Evidence statement 5.10 – Face to face physical activity interventions for individuals at elevated cardiovascular risk

Inconsistent evidence from six interventions was identified regarding the effectiveness of multi-session face to face interventions delivered one on one (Hardcastle 2008* [+], ter Bogt 2011* [+], Harting 2006* [+]), in groups (Eriksson 2009* [++]), or a combination of the two (Wood_HR 2008* [++], Burke 2008* [+]). All six trials addressed multiple behaviours, and the significance of effect varied across trials.

Among the three interventions with non-significant effects, two were delivered one on one, and enrolled overweight or obese patients with hypertension and/or dyslipidaemia (ter Bogt 2011* [+] SMD -0.06, 95% CI -0.31 to 0.19) and smokers considered to be at high risk for a cardiovascular event (Harting

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2006* [+] SMD 0.01, 95% CI -0.11 to 0.13). One trial included a group intervention among individuals at risk for developing cardiovascular conditions ((Eriksson 2009* [++] SMD 0.34, 95% CI -0.01 to 0.72).

Three interventions resulted in significant differences in activity. One was delivered one on one among overweight and obese individuals at risk for CAD (Hardcastle 2008* [+] SMD 0.23, 95% CI 0.01 to 0.45). Two trials (Wood_HR 2008* [++], Burke 2008* [+]) provided multi-session interventions addressing multiple behaviour targets that are delivered on a combined group and individual level compared to usual care. The effect was strongest in the trial with shorter follow-up (Wood_HR 2008* [++]), with large effects among high risk primary care patients at nine months post intervention (SMD 0.70, 95% CI 0.59 to 0.81). A small but still significant was seen at 3 years post intervention follow-up in one trial (Burke 2008* [+] SMD 0.26, 95% CI 0.01 to 0.52).

No BCTs were reported in all of the trials with significant effects (Hardcastle 2008* [+]), Wood_HR 2008* [++], Burke 2008* [+]) that didn't also appear in trials with non-significant effects (ter Bogt 2011* [+], Harting 2006* [+], Eriksson 2009* [++]).

Hardcastle 2008* (RCT [+], UK, n=334, 0 weeks)
BCTs present:
3 Social support (unspecified)[C2]

ter Bogt 2011* (RCT [+], Netherlands, n=249, 16 weeks)
BCTs present:
3 Social support (unspecified)[C2]
9 Feedback on outcome of behaviour[C1]
63 Goal setting (outcome)[C2]

Harting 2006* (RCT [+], Netherlands, n=1,270, 56 weeks)
BCTs present:
3 Social support (unspecified)[C2]
4 Pharmacological support[A]
62 Goal setting (behaviour)[C2]
64 Action planning[C2]

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Eriksson 2009* (RCT [++], Sweden, n=145, 0 weeks)
BCTs present:
3 Social support (unspecified)[C2]
5 Reduce negative emotions[C2]
8 Feedback on behaviour[C2]
29 Graded tasks[A2]
35 Body changes[C2]
36 Instruction on how to perform a behaviour[C2]
61 Problem solving[C2]
62 Goal setting (behaviour)[C2] (also reported in control arm)
63 Goal setting (outcome)[C2]
64 Action planning[C2] (also reported in control arm)
78 Information about health consequences[A2]

Wood_HR 2008* (cRCT [++], Europe, n=2,021, 36 weeks)
BCTs present:
3 Social support (unspecified)[C2]
28 Generalisation of a target behaviour[A2]
34 Adding objects to the environment[C2]
61 Problem solving[C2]
62 Goal setting (behaviour)[C2]
63 Goal setting (outcome)[C2]
64 Action planning[C2]
65 Review behaviour goal[C2]

Burke 2008* (RCT [+], Australia, n=241, 156 weeks)
BCTs present:
1 Social support (practical)[C2]
3 Social support (unspecified)
8 Feedback on behaviour[C2]
10 Self-monitoring of behaviour[C2]
14 Biofeedback[A1] (also reported in control arm)
62 Goal setting (behaviour)[C2]
63 Goal setting (outcome)[C2]
64 Action planning[C2]

Evidence statement 5.11 – Remotely delivered (or with remote components) physical activity interventions for individuals at elevated cardiovascular risk

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Strong evidence from six interventions suggests that multi-session interventions targeting more than one behaviour and delivered either face to face with a remote component (Koelewijn-van Loon 2003* [+], Groeneveld 2011* [+], Hyman_SiC 2007* [++], Hyman_SeC 2007* [++], van Sluijs 2005 [++]) or remotely (Eakin 2010* [+]) are no more effective than usual care at altering the physical activity behaviour of individuals with elevated CV risk.

Among the face to face interventions with either remote follow-up or a remotely delivered component, several different population groups were involved, including individuals deemed eligible for cardiovascular risk management (Koelewijn-van Loon 2003* [+] SMD 0.03, 95% CI -0.22 to 0.28), male construction workers (Groeneveld 2011* [+] SMD 0.03, 95% CI -0.16 to 0.22), black men with hypertension (Hyman_SiC 2007* [++] SMD 0.02, 95% CI -0.33 to 0.37; Hyman_SeC 2007* [++] SMD 0.03, 95% CI -0.32 to 0.39), inactive individuals with hypertension, high cholesterol, T2DM or a combination of the three (van Sluijs 2005 [++] SMD -0.01, 95% CI -0.26 to 0.25).

A remotely delivered intervention addressing both physical activity and diet was no more effective than usual care at improving the amount of moderate intensity physical activity undertaken by individuals with hypertension or T2DM (Eakin 2010* [+] SMD -0.06, 95% CI -0.25 to 0.13).

The only technique reported in all five interventions was BCT 3 Social support (unspecified).

Koelewijn-van Loon 2003* (cRCT [+], Netherlands, n=247, 40 weeks)
BCTs present:
3 Social support (unspecified)[C2]
10 Self-monitoring of behaviour[C2]
34 Adding objects to the environment[C2] (also reported in control arm)
62 Goal setting (behaviour)[C2]
63 Goal setting (outcome)[C2]
78 Information about health consequences[A2]

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Groeneveld 2011* (RCT [+], Netherlands, n=429, 24 weeks)
BCTs present:
3 Social support (unspecified)[C2]
63 Goal setting (outcome)[C2]
64 Action planning[C2]
71 Pros and cons[A2]

Hyman_SiC 2007* (RCT [++], USA, n=189, 0 weeks)
BCTs present:
3 Social support (unspecified)[C2]
4 Pharmacological support[A]
8 Feedback on behaviour[C2]
34 Adding objects to the environment[C2]
36 Instruction on how to perform a behaviour[C2]
62 Goal setting (behaviour)[C2]
69 Discrepancy between current behaviour and goal[C2]

Hyman_SeC 2007* (RCT [++], USA, n=185, 0 weeks)
BCTs present:
3 Social support (unspecified)[C2]
4 Pharmacological support[A]
8 Feedback on behaviour[C2]
34 Adding objects to the environment[C2]
36 Instruction on how to perform a behaviour[C2]
62 Goal setting (behaviour)[C2]
69 Discrepancy between current behaviour and goal[C2]

van Sluijs 2005 (cRCT [++], Netherlands, n=396, 44 weeks)
BCTs present:
3 Social support (unspecified)[C2] (also reported in control arm)
8 Feedback on behaviour[C2]
10 Self-monitoring of behaviour[C2]
61 Problem solving[C2]
62 Goal setting (behaviour)[C2]
64 Action planning[C2]
65 Review behaviour goal[C2]
67 Behavioural contract[C2]
80 Information about social and environmental consequences[C2]

Eakin 2010* (cRCT [+], Australia, n=429, 24 weeks)
BCTs present:

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1 Social support (practical)[C2]
3 Social support (unspecified)[C2]
8 Feedback on behaviour[C2] (also reported in control arm)
10 Self-monitoring of behaviour[C2]
34 Adding objects to the environment[C2]
35 Body changes[C2]
61 Problem solving[C2]
62 Goal setting (behaviour)[C2]
64 Action planning[C2]
65 Review behaviour goal[C2]
69 Discrepancy between current behaviour and goal[C1]
85 Social comparison[C2]

Evidence statement 5.12 – Physical activity interventions for individuals at risk for T2DM

Inconsistent evidence was identified from three trials regarding the effectiveness of multi-session face to face interventions among individuals at risk for T2DM that were delivered one on one (Lindahl 2009* [+]) or combining one on one and group approaches (Vermunt 2011* [+], Penn 2009* [+]).

A one on one intervention (Lindahl 2009* [+]) delivered as part of a residential lifestyle programme has an effect on physical activity levels among overweight or obese individuals with impaired glucose tolerance (SMD 0.50, 95% CI 0.14 to 0.87).

Of the multi-session physical activity interventions delivered face to face at one on one and group level among people at risk for T2DM, one trial (Vermunt 2011* [+]) resulted in a small, significant effect on weekly physical activity at the end of the intervention (SMD 0.20, 95% CI 0.06 to 0.35). The other trial resulted in a very small, non-significant effect on sustained change favouring the usual care arm (Penn 2009* [+] SMD -0.05, 95% CI -0.49 to 0.40).

The two interventions with significant effects reported no common BCTs that didn’t also appear in the non-significant trail. The intervention with a non-

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significant effect (Penn 2009* [+]) reported use of several BCTs that were not found in either Lindahl 2009* [+] or Vermunt 2011* [+]: 8 Feedback on behaviour, 13 Monitoring outcome of behaviour by others without feedback, 23 Behavioural practice/ rehearsal, 34 Adding objects to the environment, 36 Instruction on how to perform a behaviour, and 65 Review behaviour goal.

Lindahl 2009* (RCT [+], Sweden, n=168, 156 weeks)
BCTs present:
3 Social support (unspecified)[C2] (also reported in control arm)
5 Reduce negative emotions [C2]
10 Self-monitoring of behaviour[C2]
30 Restructuring the physical environment[A]
31 Restructuring the social environment[A]
61 Problem solving[A2]
62 Goal setting (behaviour)[A2]

Vermunt 2011* (RCT [+], Netherlands, n=764, 0 weeks)
BCTs present:
3 Social support (unspecified)[C2]
62 Goal setting (behaviour)[C2]
63 Goal setting (outcome)[C2]
64 Action planning[C2]
78 Information about health consequences[A2] (also reported in control arm)
80 Information about social and environmental consequences[C2] (also reported in control arm)

Penn 2009 * (RCT [+], UK, n=51, 0 weeks)
BCTs present:
3 Social support (unspecified)[C2]
8 Feedback on behaviour[C2]
10 Self-monitoring of behaviour[C2]
13 Monitoring outcome of behaviour by others without feedback[B]
23 Behavioural practice/ rehearsal[C2]
34 Adding objects to the environment[C2]
36 Instruction on how to perform a behaviour[C2]
62 Goal setting (behaviour)[C2]
63 Goal setting (outcome)[C2]
64 Action planning[C2]
65 Review behaviour goal[C2]

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Evidence statement 5.13 – Multi-session physical activity interventions for overweight or obese individuals

Inconsistent evidence was identified regarding the effectiveness of multi-session physical activity interventions among overweight or obese individuals, delivered either face to face on a group level (Kuller 2012* [+]), face to face with remote components (Nijamkin 2012* [++]), or remotely (van Wier_I 2009* [+], van Wier_T 2009* [+], Morey 2009* [++], Patrick 2011* [+]).

Evidence from one intervention (Kuller 2012* [+]) suggests that a multi-session group intervention is no more effective than a general health education comparator at improving physical activity among overweight or obese women (SMD 0.13, 95% CI -0.06 to 0.32). Two remotely delivered interventions resulted in very small, non-significant effects on activity (van Wier_I 2009* [+] SMD 0.19, 95% CI -0.08 to 0.45; Morey 2009* [++] SMD 0.14, 95% CI -0.02 to 0.29).

One group intervention with remote follow-up saw improvements in in physical activity among obese Hispanic Americans who have recently had gastric bypass surgery (Nijamkin 2012* [++] SMD 0.49, 95% CI 0.14 to 0.83). Two remotely delivered interventions addressing multiple health behaviours (van Wier_T 2009* [+], Patrick 2011* [+]) resulted in small, significant effects on activity (van Wier_T 2009* [+] SMD 0.32, 95% CI 0.09 to 0.56; Patrick 2011* [+] SMD 0.23, 95% CI 0.01 to 0.46).

Kuller 2012* (RCT [+], USA, n=433, 52 weeks)
BCTs present:
3 Social support (unspecified)[C2]
36 Instruction on how to perform a behaviour[C2]
62 Goal setting (behaviour)[C2]
63 Goal setting (outcome)[C2]

Nijamkin 2012* (RCT [++], USA, n=133, 18 weeks)
BCTs present:

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2 Social support (emotional)[A1]
3 Social support (unspecified)[C2] (also reported in control arm)
5 Reduce negative emotions[C2]
10 Self-monitoring of behaviour[C2]
24 Habit formation[A1] (also reported in control arm)
36 Instruction on how to perform a behaviour[C2] (also reported in control arm)
37 Information about antecedents[A1]
61 Problem solving[C2]
63 Goal setting (outcome)[C2]

van Wier_I 2009* (RCT [+], Netherlands, n=523, 0 weeks)
BCTs present:
3 Social support (unspecified)[C2]
10 Self-monitoring of behaviour[C2]
36 Instruction on how to perform a behaviour[C2]
63 Goal setting (outcome)[C2]
64 Action planning[C2]

van Wier_T 2009* (RCT [+], Netherlands, n=523, 0 weeks)
BCTs present:
3 Social support (unspecified)[C2]
10 Self-monitoring of behaviour[C2]
36 Instruction on how to perform a behaviour[C2]
63 Goal setting (outcome)[C2]
64 Action planning[C2]

Morey 2009* (RCT [++], USA, n=641, 0 weeks)
BCTs present:
3 Social support (unspecified)[C2]
8 Feedback on behaviour[C2]
10 Self-monitoring of behaviour[C2]
15 Prompts/cues[A2]
34 Adding objects to the environment[C2]
35 Body changes[C2]
36 Instruction on how to perform a behaviour[C2]
56 Social reward[A1]
61 Problem solving[C2]
62 Goal setting (behaviour)[C2]
63 Goal setting (outcome)[C2]
64 Action planning[C2]
85 Social comparison[C1]

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Patrick 2011* (RCT [+], USA, n=309, 0 weeks)
BCTs present:
8 Feedback on behaviour[C2]
10 Self-monitoring of behaviour[C2]
34 Adding objects to the environment[C2]
35 Body changes[C2]
62 Goal setting (behaviour)[C2]
64 Action planning[C2]
65 Review behaviour goal[C2]
69 Discrepancy between current behaviour and goal[C2]

Evidence statement 5.14 – Face to face physical activity interventions among inactive or underactive individuals

Inconsistent evidence from six trials was identified regarding the effectiveness of multi-session face to face interventions (Grandes 2009 [++], Hertogh 2010 [+]), and face to face interventions with a remotely delivered component (Armit_ES 2009 [++], Armit_ES+P 2009 [++], McMurdo_BCI 2010* [+], McMurdo_BCI+P 2010* [+], Lawton 2008 [++], Elley 2003 [++])

Evidence from two trials suggests that face to face interventions (Grandes 2009 [++], Hertogh 2010 [+]) are no more effective than comparators at changing physical activity among individuals not meeting PA guidelines of at least 30 minutes of moderate physical activity per day, 5 days week per week. One trial (Grandes 2009 [++]) was delivered one on one (SMD 0.03, 95% CI -0.08 to 0.15). The face to face group intervention (Hertogh 2010 [+]) included underactive but otherwise healthy post-menopausal women (SMD 0.01, 95% CI -0.32 to 0.34). Four of the interventions with a remotely delivered component (Armit_ES 2009 [++], Armit_ES+P 2009 [++], McMurdo_BCI 2010* [+], McMurdo_BCI+P 2010* [+]) resulted in very small to medium, non-significant differences in physical activity over the short term, compared to usual care (Armit_ES 2009 [++] SMD 0.07, 95% CI -0.54 to 0.68; Armit_ES+P 2009 [++] SMD 0.48, 95% CI -0.11 to 1.07; McMurdo_BCI 2010* [+] SMD

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0.40, 95% CI -0.01 to 0.82; McMurdo_BCI+P 2010* [+] SMD 0.22, 95% CI -0.19 to 0.64).

Two interventions delivered primarily face to face, but with a remote component resulted in significant differences to physical activity approximately one year after the end of the interventions (Lawton 2008 [++] SMD 0.16, 95% CI 0.02 to 0.29; Elley 2003 [++] SMD 0.26, 95% CI 0.08 to 0.45).

No BCTs were reported in the trials with significant effects (Lawton 2008 [++], Elley 2003 [++]) that weren't also reported in at least one of the trials with non-significant effects.

Grandes 2009 (cRCT [++], Spain, n=1,178, 24 weeks)
BCTs present:
3 Social support (unspecified)[C2]
10 Self-monitoring of behaviour[C2]
36 Instruction on how to perform a behaviour[C2]
61 Problem solving[C2]
62 Goal setting (behaviour)[C2]
64 Action planning[C2]
67 Behavioural contract[C2]
71 Pros and cons[A2]
78 Information about health consequences[A2]

Hertogh 2010 (RCT [+], Netherlands, n=142, 52 weeks)
BCTs present:
3 Social support (unspecified)[C2]
10 Self-monitoring of behaviour[C2]
23 Behavioural practice/ rehearsal[C2]
28 Generalisation of a target behaviour[A2]
35 Body changes[C2]
36 Instruction on how to perform a behaviour[C2]
62 Goal setting (behaviour)[C2]
64 Action planning[C2]

Armit_ES 2009 (RCT [++], Australia, n=91, 12 weeks)
BCTs present:

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3 Social support (unspecified)[C2]
11 Self-monitoring of outcome of behaviour[A1]
63 Goal setting (outcome)[C2]
71 Pros and cons[A2]

Armit_ES+P 2009 (RCT [++], Australia, n=91, 12 weeks)
BCTs present:
3 Social support (unspecified)[C2]
10 Self-monitoring of behaviour[C2]
34 Adding objects to the environment[C2]
62 Goal setting (behaviour)[C2]

McMurdo_BCI 2010* (RCT [+], UK, n=136, 0 weeks)
BCTs present:
3 Social support (unspecified)[C2]
8 Feedback on behaviour[C2]
10 Self-monitoring of behaviour[C2]
29 Graded tasks[A2]
34 Adding objects to the environment[C2]
36 Instruction on how to perform a behaviour[C2]
61 Problem solving[C2]
62 Goal setting (behaviour)[C2]
64 Action planning[C2]
65 Review behaviour goal[C2]
67 Behavioural contract[C2]
78 Information about health consequences[A2]

McMurdo_BCI+P 2010* (RCT [+], UK, n=136, 0 weeks)
BCTs present:
3 Social support (unspecified)[C2]
8 Feedback on behaviour[C2]
10 Self-monitoring of behaviour[C2]
29 Graded tasks[A2]
36 Instruction on how to perform a behaviour[C2]
61 Problem solving[C2]
62 Goal setting (behaviour)[C2]
64 Action planning[C2]
65 Review behaviour goal[C2]
67 Behavioural contract[C2]
78 Information about health consequences[A2]

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Lawton 2008 (RCT [++], New Zealand, n=1,089, 68 weeks)
BCTs present:
3 Social support (unspecified)[C2]
9 Feedback on outcome of behaviour[C1]
10 Self-monitoring of behaviour[C2]
12 Monitoring of behaviour by others without feedback[A1]
15 Prompts/cues[A2]
34 Adding objects to the environment[C2]
56 Social reward[A1]
61 Problem solving[C2]
62 Goal setting (behaviour)[C2]
64 Action planning[C2]
67 Behavioural contract[C2]
78 Information about health consequences[A2]

Elley 2003 (cRCT [++], New Zealand, n=439, 52 weeks)
BCTs present:
3 Social support (unspecified)[C2]
8 Feedback on behaviour[C2]
62 Goal setting (behaviour)[C2]
67 Behavioural contract[C2]
70 Persuasive source[A2]

Evidence statement 5.15 – Remotely delivered physical activity interventions for inactive or underactive individuals

Inconsistent evidence from seven interventions (Prestwich_II 2009 [+], Prestwich_SMS 2009 [+], Prestwich_II+SMS 2009 [+], Nies 2003 [+], Marcus_TB 2007 [+], Marcus_PB 2007 [+],Kolt 2007 [+]) was identified regarding the effectiveness of remotely delivered interventions targeting physical activity among inactive or underactive individuals.

Five interventions (Prestwich_II 2009 [+], Prestwich_SMS 2009 [+], Prestwich_II+SMS 2009 [+], Nies 2003 [+], Marcus_TB 2007 [+]) resulted in non-significant effects ranging in size from very small (Prestwich_II 2009 [+] SMD 0.07, 95% CI -0.65 to 0.79; Nies 2003 [+] SMD 0.05, 95% CI -0.28 to 0.38; Marcus_TB 2007 [+] SMD 0.15, 95% -0.23 to 0.54) to small

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(Prestwich_SMS 2009 [+] SMD 0.16, 95% CI -0.55 to 0.87) to medium (Prestwich_II+SMS 2009 [+] SMD 0.44, 95% CI -0.29 to 1.17).

Two interventions (Marcus_PB 2007 [+], Kolt 2007 [+]) resulted in significant effects of similar sizes (Marcus_PB 2007 [+] SMD 0.52, 95% CI 0.13 to 0.91; Kolt 2007 [+] SMD 0.46, 95% CI 0.15 to 0.77).

The two interventions with significant effects (Marcus_PB 2007 [+], Kolt 2007 [+]) reported use of BCT 71 Pros and cons; this BCT was not reported in any of the non-significant interventions.

Prestwich_II 2009 (RCT [+], UK, n=60, 4 weeks)
BCTs present:
62 Goal setting (behaviour)[C2]
64 Action planning[C2]
67 Behavioural contract[C2]

Prestwich_II+SMS 2009 (RCT [+], UK, n=60, 0 weeks)
BCTs present:
15 Prompts/cues[A2]
62 Goal setting (behaviour)[C2]
64 Action planning[C2]
67 Behavioural contract[C2]

Prestwich_SMS 2009 (RCT [+], UK, n=62, 0 weeks)
BCTs present:
15 Prompts/cues[A2]

Nies 2003 (RCT [+], USA, n=159, 0 weeks)
BCTs present:
3 Social support (unspecified)[C2]
10 Self-monitoring of behaviour[C2]
29 Graded tasks[A2]
61 Problem solving[C2]
62 Goal setting (behaviour)[C2]
64 Action planning[C2]
78 Information about health consequences[A2]

Marcus_TB 2007 (RCT [+], USA, n=158, 0 weeks)

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BCTs present:
3 Social support (unspecified)[C2]
8 Feedback on behaviour[C2]
10 Self-monitoring of behaviour[C2] (also reported in control arm)
36 Instruction on how to perform a behaviour[C2]
62 Goal setting (behaviour)[C2]
64 Action planning[C2]
85 Social comparison[C1]

Marcus_PB 2007 (RCT [+], USA, n=159, 0 weeks)
BCTs present:
3 Social support (unspecified)[C2]
8 Feedback on behaviour[C2]
10 Self-monitoring of behaviour[C2] (also reported in control arm)
62 Goal setting (behaviour)[C2]
64 Action planning[C2]
71 Pros and cons[A2]
85 Social comparison[C1]

Kolt 2007 (RCT [+], New Zealand, n=165, 36 weeks)
BCTs present:
3 Social support (unspecified)[C2]
8 Feedback on behaviour[C2]
10 Self-monitoring of behaviour[C2]
15 Prompts/cues[A2]
29 Graded tasks[A2]
36 Instruction on how to perform a behaviour[C2]
57 Non-specific reward[A1]
61 Problem solving[C2]
62 Goal setting (behaviour)[C2]
64 Action planning[C2]
69 Discrepancy between current behaviour and goal[C2]
71 Pros and cons[A2]
75 Framing/ reframing[A1]
80 Information about social and environmental consequences[C2]
84 Demonstration of the behaviour[A2]

Evidence statement 5.16 – Multi-session physical activity interventions for individuals with chronic conditions

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Limited evidence from two interventions (Lorig 2006* [++], Eakin 2007* [+]) suggests that multi-session physical activity interventions are no more effective than usual care at changing activity among individuals with chronic conditions. Both trials resulted in a very small, positive, non-significant effects (Lorig 2006* [++] SMD 0.06, 95% CI -0.08 to 0.20); Eakin 2007* [+] SMD 0.13, 95% CI -0.15 to 0.40). Both trials included BCTs 3 Social support (unspecified), 8 Feedback on behaviour, 61 Problem solving, and 64 Action planning.

Lorig 2006* **(**RCT [++], USA, n=780, 46 weeks)
BCTs present:
3 Social support (unspecified)[C2]
5 Reduce negative emotions[C2]
8 Feedback on behaviour[C2]
43 Self-talk[A]
61 Problem solving[C2]
64 Action planning[C2]
84 Demonstration of the behaviour[A2]

Eakin 2007* (RCT [+], USA, n=200, 12 weeks)
BCTs present:
3 Social support (unspecified)[C2] (also reported in control arm)
8 Feedback on behaviour[C2]
61 Problem solving[C2]
62 Goal setting (behaviour)[C2]
64 Action planning[C2]
67 Behavioural contract[C2]

Evidence statement 5.17 – Multi-session physical activity interventions for pregnant women at risk for gestational diabetes

Limited evidence from two trials (Luoto 2011* [+], Guelinckx_B+LI 2010* [+]) suggests that multi-session behaviour change interventions are no more effective than usual care at improving physical activity among pregnant women at risk for gestational diabetes. One trial (Luoto 2011* [+] resulted in a very small, negative, non-significant effect (SMD -0.19, 95% CI -0.40 to 0.02)

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while the other (Guelinckx_B+LI 2010* [+]) resulted in a small, positive, non-significant effect (SMD 0.27, 95% CI -0.15 to 0.70). Both trials reported use of BCTs 3 Social support (unspecified), and 62 Goal setting (behaviour).

Luoto 2011* (cRCT [+], Finland, n=341, 0 weeks)
BCTs present:
3 Social support (unspecified)[C2]
62 Goal setting (behaviour)[C2]
64 Action planning[C2]

Guelinckx 2010* (RCT [+], Belgium, n=85, 8 weeks)
BCTs present:
3 Social support (unspecified)[C2]
5 Reduce negative emotions[C2]
25 Behaviour substitution[A]
36 Instruction on how to perform a behaviour[C2]
61 Problem solving[C2]
62 Goal setting (behaviour)[C2]

4.7 Overall analysis across all behaviour areas

When pooling the results from the trials addressing sexual health, alcohol, smoking, diet and physical activity together, overall the interventions were found to be significantly more effective at changing behaviour than the comparators. There was a substantial amount of variation (heterogeneity) between the results of different studies that had been pooled. An analysis was carried out to see which if any of the BCT techniques, intervention functions of the interventions might be responsible for some of this variation, and if so, whether they seemed to be present in interventions that were more or less effective at changing behaviour.

Some of these factors had stronger statistical evidence of effect. Interventions reporting use of Pharmacological support (BCT 4) had a very small but significant increase in effectiveness compared to those interventions that did not report providing, or encouraging the use of/adherence to drugs to facilitate

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behaviour change . Similarly, interventions reporting use of Graded tasks (BCT 29) see a small but significant increase in effectiveness over interventions that did not report use of this BCT. Graded tasks involve initially setting easy to perform tasks that gradually increase in difficulty until the desired behaviour is performed in full. For example, if the eventual goal is for a person to do 30 minutes of moderate-to-vigorous exercise 5 days a week, a graded task might involve asking the person to do 10 minutes 3 days a week to start with, and gradually build up to the goal.

The other factors did not have as strong statistical evidence that they had an effect, as the analysis suggested that there was still a possibility that their presence could either increase or decrease the effects of an intervention. This uncertainty could be due to there not being enough data on some factors.

Among these factors, Restructuring the social environment (BCT 31) could potentially have a similar sized positive effect to Pharmacological support (BCT 4) or Graded tasks (BCT 29), but the evidence for this is not as robust. Providing feedback on biological effects, or Biofeedback (BCT 14), could potentially have a negative effect, but the evidence for this is not as robust. The other factors potentially have smaller effects.

Behaviour changes would ideally be maintained in the long term, and a second analysis looked only at studies that reported long term results (more than six months after the end of the intervention), to see which factors might have an effect in the long term. The analysis suggested that interventions that reported using Pharmacological support (BCT 4) had a small but significant increase in effectiveness compared to the interventions not reporting use of this technique. Interventions that reported setting or agreeing to a goal surrounding the outcome of performing a behaviour (BCT 63 Goal setting - outcome) had a very small, significant increase in effect compared with those interventions that did not use this technique; as with all effects covered in this review, the difference in effect related to the performance behaviour, despite the goal being outcome focused. Finally, the analysis suggested that

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interventions that serve to change the physical or social context in which the behaviour is performed (Intervention Function 7 – Environmental restructuring) are more effective at changing long term behaviour than those interventions which do not report this doing so.

Details of these analyses and the results are provided in Sections 4.7.1 and 4.7.2.

4.7.1 Overall effect of individual level behaviour change interventions

Data from 197 comparisons was included in the overall meta-analysis. Overall, individual level behaviour change interventions had a small positive effect on behaviour (SMD 0.23, 95% CI 0.19 to 0.26). There was a substantial level of heterogeneity in the analysis (I^2 = 66.0%, 95% CI 60.6% to 70.7%). None of the studies were identified as outliers.

Egger's test for small study effects did not identify significant publication bias (p=0.137). However, using a filled funnel plot approach, addition of hypothetical results from potential missing studies led to a reduction in the pooled effect size, but the effect remained statistically significant (SMD 0.14, 95% CI 0.10 to 0.18; p<0.001). This suggests that publication bias could be present, increasing the size but not significance of the pooled effect in the overall analysis. This bias could relate in part to the exclusion of studies with small sample sizes from the review.

4.7.2 Effects of individual BCTs, BCT clusters and intervention functions using meta-regression

Univariate analysis

Table 45 summarises the variables identified as contributing to between study variance in the overall adjusted univariate meta-regression.

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Twelve BCTs in eight clusters explained between 1.04% and 6.74% of the between study variation. Nine BCTs were associated with increased effectiveness of interventions (positive direction of effect: BCTs 1 Social support (practical), 4 Pharmacological support, 28 Generalisation of target behaviour, 29 Graded tasks, 31 Restructuring the social environment, 34 Adding objects to the environment, 63 Goal setting (outcome), 65 Review behaviour goal(s), and 70 Persuasive source), while three were associated with reduced effectiveness of interventions (negative direction of effect; BCTs 14 Biofeedback, 80 Information about social and environmental consequences, and 85 Social comparison). One intervention function (IF 7 Environmental restructuring) accounted for 8.13% of between study variance.

Based on the individual BCT analysis, BCT clusters which contained more than one BCT that contributed to between study variance and were associated with a positive effect were:

- Cluster 5 (Repetition and Substitution): includes BCT 29 Graded tasks, and BCT 28 Generalisation of target behaviour
- Cluster 6 (Antecedents): includes BCT 34 Adding objects to the environment, and BCT 31 Restructuring the social environment
- Cluster 11 (Goals and planning): includes BCT 65 Review behaviour goal(s), and BCT 63 Goal setting (outcome)

In adjusted univariate analysis of the BCT clusters themselves, two of these BCT clusters contributed to between study variance (BCT clusters 5 Repetition and substitution and 6). BCT cluster 2 Regulation also contributed to between study variance; this cluster contains BCT 4 Pharmacological support, the BCT which explained the greatest proportion of between study variance.

All three of these clusters were associated with significantly increased intervention effectiveness and contained at least one BCT which contributed

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to between study variance. Between them they included the three BCTs with the greatest contribution to between study variance (BCTs 4 Pharmacological support, 29 Graded tasks, and 34 Adding objects to the environment).

Among the intervention functions, only intervention function 7 (Environmental restructuring) explained some of the between study variance (8.13%), and it was associated with significantly increased intervention effectiveness. This intervention function is linked to a number of BCTs, including two individual BCTs which contribute to between study variance: BCT 31 Restructuring the social environment, and BCT 34 Adding objects to the environment.

Theory use did not explain any between study variance in the adjusted univariate analysis.

Multivariate analysis of BCTs and intervention functions

Two separate multivariate analyses were carried out for (i) the individual BCTs and intervention functions, and (ii) the BCT clusters and intervention functions. The latter analysis was the equivalent of that carried out in the individual behaviour areas. The analyses were controlled for BCT/BCT cluster and intervention function use in the control group and theory use of the intervention. For each analysis a sensitivity analysis including only studies with long term follow up (over 6 months) was carried out.

The variables listed in Table 45 were tested for inclusion in the multivariate models. Table 46 summarises the results of the multivariate analyses.

In the primary multivariate analysis of BCTs (197 comparisons) and intervention function, the final model included seven BCTs (BCTs 4 Pharmacological support, 14 Biofeedback, 29 Graded tasks, 31 Restructuring the social environment, 63 Goal setting (outcome), 65 Review behaviour goal(s), and 80 Information about social and environmental consequences) and IF 7 Environmental restructuring, and accounted for 29.5% of between study variance. BCTs 1 Social support (practical), 28 Generalisation of target

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behaviour, 34 Adding objects to the environment, 70 Persuasive source, and 85 Social comparison were dropped from the final model. IF 7 Environmental restructuring is linked to BCTs 31 and 34, and there was correlation between IF7 and BCT 34. IF7 was the first variable added to the multivariate model as it explained the largest proportion of variance, and subsequent addition of BCT 34 did not increase the amount of variance explained by the model and was therefore removed. However, the correlation between IF7 and BCT 34 means that the link between IF 7 and intervention effectiveness may relate at least in part to the presence of this BCT.

Five of the BCTs were associated with increased intervention effect (BCTs 4 Pharmacological support, 29 Graded tasks, 31 Restructuring the social environment, 63 Goal setting (outcome), and 65 Review behaviour goal), and two were associated with reduced intervention effect (BCTs 14 Biofeedback and 80 Information about social and environmental consequences). The associations were statistically significant for BCTs 4 and 29.

In sensitivity analysis of studies with long term follow up (71 comparisons), results were broadly similar. The final model explained a greater proportion of between study variance (46.7%).

The positive effects associated with IF 7 Environmental restructuring and BCT 63 Goal setting (outcome) increased and became statistically significant in the sensitivity analysis. The positive effect associated with BCT 29 Graded tasks remained similar in terms of magnitude, but became statistically non-significant. The negative effect associated with BCT 80 Information about social and environmental consequences became smaller in magnitude and remained statistically non-significant.

In primary multivariate analysis of BCT clusters and intervention functions the final model explained 14.1% of between study variance. It included one intervention function (IF 7 Environmental restructuring) and two BCT clusters (2 Regulation, and 5 Repetition and Substitution), all of which were associated

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with a positive direction of effect. Only intervention function 7 was associated with a statistically significant effect, but the BCT clusters also tended towards statistical significance.

In sensitivity analysis of studies with long term follow up, the model explained more of the between study variance (35.4%), otherwise the results were broadly similar. The positive effect associated with IF 7 Environmental restructuring increased and remained statistically significant, and the effect associated with BCT-C 2 Regulation increased and continued to show a trend towards significance. The effect of BCT-C 5 Repetition and substitution remained of the same magnitude but did not show a trend towards statistical significance.

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Table 45: BCTs, BCT clusters and intervention functions accounting for some of the between study variance (adjusted $R^2 \geq 1\%$) in overall adjusted univariate analysis (in order of magnitude)

BCT Number	BCT name	Cluster containing this BCT	Direction of effect	Adjusted R^2
BCT 4†	Pharmacological support	Cluster 2 – Regulation‡	Positive*	6.74%
BCT 29†	Graded tasks	Cluster 5 – Repetition and Substitution‡	Positive*	5.87%
BCT 34	Adding objects to the environment	Cluster 6 – Antecedents‡	Positive	4.97%
BCT 65†	Review behaviour goal(s)	Cluster 11 – Goals and planning	Positive	3.77%
BCT 80†	Information about social and environmental consequences	Cluster 14 – Natural consequences	Negative*	2.66%
BCT 1	Social support (practical)	Cluster 1 – Social support	Positive	2.39%
BCT 31†	Restructuring the social environment	Cluster 6 – Antecedents	Positive	1.97%
BCT 85	Social comparison	Cluster 15 - Comparison of behaviour	Negative	1.46%
BCT 28	Generalisation of a target behaviour	Cluster 5 – Repetition and Substitution	Positive	1.39%
BCT 63†	Goal setting (outcome)	Cluster 11 – Goals and planning	Positive	1.29%
BCT 70	Persuasive source	Cluster 12 – Comparison of outcomes	Positive	1.11%

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BCT 14†	Biofeedback	Cluster 3 – Feedback and monitoring	Negative	1.04%
BCT cluster number	**BCT cluster name**	**BCTs in this cluster which explain some between study variance**	**Direction of effect**	**Adjusted R^2**
BCT-C 6	Antecedents	BCT 34 - Adding objects to the environment BCT 31 - Restructuring the social environment	Positive*	5.71%
BCT-C 5	Repetition and Substitution†	BCT 29 - Graded tasks BCT 28 - Generalisation of target behaviour	Positive*	5.58%
BCT-C 2	Regulation†	BCT 4 – Pharmacological support	Positive*	4.01%
IF Number	**IF name**	**BCTs linked to this IF which explain some between study variance**	**Direction of effect**	**Adjusted R^2**
IF 7†	Environmental restructuring	BCT 31 Restructuring the social environment BCT 34 Adding objects to the environment	Positive*	8.13%

*Statistically significant; † variable included in the final multivariate model; ‡ BCT clusters which explained some between study variation in the cluster analysis (adjusted R^2 ≥1%); NA not applicable

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Table 46: Effects of variables included in multivariate analyses

Behaviour (Adjusted R^2)	Variables included	Primary analysis		Sensitivity analysis (long term follow up)	
		Regression Coefficient (β) (95% CI)	P value	Regression Coefficient (β) (95% CI)	P value
Model 1a – individual BCTs and intervention functions					
All behaviours **Primary analysis –** adjusted R^2 29.5% **Sensitivity analysis -** adjusted R^2 46.7%	IF 7 Environmental restructuring	0.08 (-0.02 to 0.18)	0.134	**0.16 (0.008 to 0.31)**	**0.039**
	BCT 4 Pharmacological support	**0.13 (0.03 to 0.22)**	**0.013**	**0.20 (0.05 to 0.36)**	**0.010**
	BCT 29 Graded tasks	**0.24 (0.08 to 0.40)**	**0.004**	0.22 (-0.08 to 0.52)	0.153
	BCT 65 Review behaviour goal(s)	0.09 (-0.02 to 0.20)	0.115	0.06 (-0.14 to 0.27)	0.530
	BCT 80 Information about social and environmental consequences	-0.07 (-0.16 to 0.02)	0.130	-0.009 (-0.13 to 0.11)	0.875
	BCT 31 Restructuring the social environment	0.15 (-0.11 to 0.41)	0.254	0.18 (-0.32 to 0.68)	0.472
	BCT 63 Goal setting (outcome)	0.07 (-0.02 to 0.16)	0.133	**0.17 (0.01 to 0.32)**	**0.037**
	BCT 14 Biofeedback	-0.15 (-0.42 to 0.11)	0.257	-0.20 (-0.56 to 0.15)	0.259
	Theory use	-0.04 (-0.12 to 0.03)	0.273	-0.06 (-0.21 to 0.09)	0.421
Model 1b – BCT clusters and intervention functions					
All behaviours **Primary analysis –** adjusted R^2 14.1%	**IF 7 Environmental restructuring**	**0.11 (0.01 to 0.21)**	**0.031**	**0.22 (0.09 to 0.36)**	**0.002**
	BCT-C 5 Repetition and substitution	0.07 (-0.01 to 0.15)	0.090	0.07 (-0.06 to 0.20)	0.274

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Sensitivity analysis - adjusted R^2 35.4%	BCT-C 2 Regulation	0.07 (-0.01 to 0.16)	0.071	0.11 (-0.0003 to 0.22)	0.051
	Theory- use	-0.02 (-0.10 to 0.06)	0.575	-0.04 (-0.18 to 0.09)	0.520
Sexual Health	None	NA	NA	NA	NA
Alcohol **Primary analysis –** adjusted R^2 100% **Sensitivity analysis -** adjusted R^2 100%	**BCT-C 3 Feedback and monitoring**	**0.12 (0.04 to 0.21)**	**0.006**	**0.11 (0.01 to 0.20)**	**0.028**
	IF 2 Persuasion	**-0.09 (-0.17 to -0.004)**	**0.040**	-0.09 (-0.19 to 0.003)	0.056
	Theory use	0.03 (-0.12 to 0.18)	0.684	0.09 (-0.10 to 0.28)	0.342
Smoking **Primary analysis –** adjusted R^2 34.3% **Sensitivity analysis -** adjusted R^2 41.1%	BCT-C 1 Social support	0.11 (-0.03 to 0.26)	0.108	-0.13 (-0.51 to 0.25)	0.494
	BCT-C 2 Regulation	0.09 (-0.04 to 0.22)	0.163	0.10 (-0.14 to 0.35)	0.387
	IF 7 Environmental restructuring	0.06 (-0.10 to 0.21)	0.471	0.13 (-0.11 to 0.38)	0.267
	BCT-C 11 Goals and planning	**-0.14 (-0.27 to -0.004)**	**0.044**	-0.23 (-0.47 to 0.01)	0.059
	Theory use	-0.07 (-0.22 to 0.08)	0.364	-0.22 (-0.59 to 0.16)	0.242
Diet **Primary analysis –** adjusted R^2 18.0% **Sensitivity analysis -** adjusted R^2 98.1%	BCT-C 12 Comparison of outcomes	0.24 (-0.01 to 0.49)	0.061	No long term studies used BCT-C 12	
	IF 5 Training	-0.14 (-0.33 to 0.05)	0.142	-0.19 (-0.41 to 0.04)	0.094
	Theory use	-0.03 (-0.22 to 0.16)	0.739	-0.11 (-0.50 to 0.28)	0.513

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Physical Activity **Primary analysis –** adjusted R^2 29.7% **Sensitivity analysis -** adjusted R^2 86.6%	**BCT-C 5 Repetition and substitution**	**0.18 (0.05 to 0.31)**	**0.006**	**0.32 (0.15 to 0.48)**	**0.001**
	IF 7 Environmental restructuring	**0.16 (0.02 to 0.30)**	**0.030**	**0.27 (0.10 to 0.44)**	**0.005**
	BCT-C 3 Feedback and monitoring	-0.09 (-0.21 to 0.03)	0.131	**-0.24 (-0.40 to -0.07)**	**0.009**
	BCT-C12 Comparison of outcomes	0.12 (-0.03 to 0.27)	0.103	**0.34 (0.07 to 0.61)**	**0.017**
	BCT-C 1 Social support	-0.13 (-0.27 to 0.09)	0.060	-0.17 (-0.40 to 0.05)	0.117
	Theory use	-0.03 (-0.16 to 0.09)	0.594	-0.12 (-0.33 to 0.08)	0.201

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4.7.3 Comparison between individual behaviour areas and overall analysis

Table 47 gives an overview of the findings of the primary multivariate analyses for each behaviour area individually, and in the overall analysis over all five behaviour areas. Table 48 provides a similar comparison for the long term sensitivity analysis.

For intervention functions, intervention function 7 Environmental restructuring is associated with an overall significant positive effect, and also shows a positive effect in physical activity (significant) and smoking (not significant).

Intervention functions 2 Persuasion and 5 Training are associated with a negative effect in alcohol and diet respectively (not significant). These effects do not appear in any of the other behaviour areas.

Among the BCT clusters which showed an effect in the overall analysis, BCT-Cluster 2 Regulation had a positive non-significant effect overall and in smoking specifically. This effect may relate largely to BCT 4 Pharmacological support – an individual BCT in this cluster which was associated with a statistically significant positive effect in the overall primary multivariate analysis of individual BCTs. In the context of smoking, this BCT usually indicates the recommendation or provision of nicotine replacement therapy.

BCT-Cluster 5 Repetition and substitution is associated with a non-significant positive effect in the overall analysis and in the alcohol analysis. It was also associated with a significant positive effect of physical activity interventions. This effect may relate to BCT 29 Graded tasks, which showed statistical significance in the overall primary multivariate analyses of individual BCTs. This cluster was not associated with effects in other behaviours, this may relate to graded tasks not being commonly used in some behaviour areas such as smoking or sexual health, where interventions tended to focus on either cessation of risky behaviours.

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Other BCT clusters were associated with effects in individual behaviour areas but not in the overall analysis. BCT-Cluster 1 Social support was associated with a positive direction of effect in smoking but a negative direction of effect in physical activity. Both associations were non-significant. One BCT in this cluster, BCT 1 Social support (practical), contributed to between study variance in the overall univariate analysis and was associated with a positive effect, but was not retained in the final multivariate model.

BCT-Cluster 3 Feedback and monitoring was associated with a significant positive direction of effect in smoking, but a non-significant negative effect in physical activity. One BCT in this cluster, BCT 14 Biofeedback, contributed to between study variance and was associated with a negative effect in the overall multivariate analysis.

BCT-Cluster 6 Antecedents did not contribute to any of the primary multivariate models in any behaviour area, but included two BCTs which contributed to between study variance and showed a positive direction of effect in the overall univariate analysis (BCT 31 Restructuring the social environment and BCT 34 Adding objects to the environment). These BCTs are linked to intervention function 7 Environmental restructuring, and they may contribute to the effect of this variable.

BCT-Cluster 11 Goals and planning was associated with a significant negative effect in smoking, but two BCTs in this cluster showed a positive direction of effect in the overall multivariate analysis (BCT 63 – Goal setting (outcome) and 65 – Review behaviour goals).

BCT-Cluster 12 Comparison of outcomes was associated with a non-significant positive effect in diet and physical activity. One BCT in this cluster – BCT 70 Persuasive source - contributed to between study variance and showed a positive direction of effect in the overall univariate analysis, but was not retained in the final multivariate model.

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BCT-Cluster 14 Natural consequences did not contribute to any of the primary multivariate models in any behaviour area, but included one BCT which showed a non-significant negative effect in the overall multivariate analysis (BCT 80 Information about social and environmental consequences).

The lack of effect of BCT clusters in some areas may relate to the limited amount of data in an area e.g. sexual health, or the limited use of these BCTs within the area (BCT 29 Graded tasks is not commonly used in smoking).

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Table 47: Comparison of effects (regression coefficients and 95% CI) associated with intervention functions and BCT-Clusters across behaviour areas in primary multivariate analysis

	Overall	Sexual health	Alcohol	Smoking	Diet	Physical activity
Intervention functions						
IF 2 Persuasion			***-0.09 (-0.17 to -0.004)***			
IF 7 Environmental restructuring	**0.11 (0.01 to 0.21)** ((Linked with BCT 34 and 31 among others))			0.06 (-0.10 to 0.21)		**0.16 (0.02 to 0.30)**
IF 5 Training					*-0.14 (-0.33 to 0.05)*	
BCT clusters						
BCT-C 1 Social support				0.11 (-0.03 to 0.26)		*-0.13 (-0.27 to 0.09)*
BCT-C 2 Regulation	0.07 (-0.01 to 0.16) ((**BCT4**))			0.09 (-0.04 to 0.22)		

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	Overall	Sexual health	Alcohol	Smoking	Diet	Physical activity
BCT-C 3 Feedback and monitoring	((*BCT 14*))		**0.12 (0.04 to 0.21)**			*-0.09 (-0.21 to 0.03)*
BCT-C 5 Repetition and substitution	0.07 (-0.01 to 0.15) ((**BCT 29**))					**0.18 (0.05 to 0.31)**
BCT-C 6 Antecedents	((BCT 31))					
BCT-C 11 Goals and planning	((BCT 63, BCT 65))			***-0.14 (-0.27 to -0.004)***		
BCT-C12 Comparison of outcomes					0.24 (-0.01 to 0.49)	0.12 (-0.03 to 0.27)
BCT-C 14 Natural consequences	((*BCT 80*))					
Light grey shading indicates that the variable was not included in the final primary multivariate model for the given behaviour area; bold indicates statistically significant effects in the primary multivariate analysis; italics indicate a negative direction of effect; double brackets in the "Overall" column indicate those individual BCTs in the clusters that were included in the overall multivariate analysis of individual BCTs.						

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Table 48: Comparison of effects (regression coefficients and 95% CI) associated with intervention functions and BCT clusters across behaviour areas in long term (>6 months) sensitivity analysis

	Overall	Sexual health	Alcohol	Smoking	Diet	Physical activity
Intervention functions						
IF 2 Persuasion		No multivariate sensitivity analysis	-0.09 (-0.19 to 0.003)			
IF 5 Training					-0.19 (-0.41 to 0.04)	
IF 7 Environmental restructuring	**0.22 (0.09 to 0.36)**			0.13 (-0.11 to 0.38)		**0.27 (0.10 to 0.44)**
BCT clusters						
BCT-C 1 Social support		No multivariate sensitivity analysis		0.13 (-0.51 to 0.25)		-0.17 (-0.40 to 0.05)
BCT-C 2 Regulation	0.11 (-0.0003 to 0.22)			0.10 (-0.14 to 0.35)		
BCT-C 3 Feedback and monitoring			**0.11 (0.01 to 0.20)**			**-0.24 (-0.40 to -0.07)**
BCT-C 5 Repetition and substitution	0.07 (-0.06 to 0.20)					**0.32 (0.15 to 0.48)**
BCT-C 11 Goals and planning				-0.23 (-0.47 to 0.01)		
BCT-C12 Comparison of outcomes					No long term studies reported use	**0.34 (0.07 to 0.61)**

Light grey shading indicates that the variable was not included in the final primary multivariate model for the given behaviour area; bold indicates statistically significant effects in the primary multivariate analysis; italics indicate a negative direction of effect; double brackets in the “Overall” column indicate those individual BCTs in the clusters that were included in the overall multivariate analysis of individual BCTs.

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4.7.4 Evidence statements

Evidence statement 6.1 – Effectiveness of behaviour change techniques, clusters, intervention function and theory across sexual health, alcohol, smoking, diet and physical activity trials

Evidence from 197 comparisons suggests that the following BCTs and intervention function may be associated with increased intervention effectiveness when analysed across behaviours (sexual health, alcohol, smoking, diet, and physical activity):

- IF 7 Environmental restructuring (regression coefficient [β]=0.08, 95% CI -0.02 to 0.18; p=0.134)
- BCT 4 Pharmacological support (β=0.13, 95% CI 0.03 to 0.22; p=0.013)
- BCT 29 Graded tasks (β=0.24, 95% CI 0.08 to 0.40; p=0.004)
- BCT 65 Review behaviour goal(s) (β=0.09, 95% CI -0.02 to 0.20; p=0.115)
- BCT 31 Restructuring the social environment (β=0.15, 95% CI -0.11 to 0.41; p=0.254)
- BCT 63 Goal setting (outcome) (β=0.07, 95% CI -0.02 to 0.16; p=0.133)

The associations reached statistical significance for BCTs 4 and 29.

These comparisons also provided evidence that the following BCTs may be associated with reduced intervention effectiveness:

- BCT 80 Information about social and environmental consequences (β=-0.07, 95% CI -0.16 to 0.02; p=0.130)
- BCT 14 Biofeedback (β=-0.15, 95% CI -0.42 to 0.11; p=0.257)

Sensitivity analysis of studies with 6 months of follow up or longer (71 comparisons) suggested that the BCTs retain the same direction effects in the long term. In the longer term BCT 63 Goal setting (outcome) was associated with a larger positive effect than in the overall analysis and the association

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became significant (β=0.17, 95% CI 0.01 to 0.32; p=0.037). The positive effect associated with intervention function 7 Environmental restructuring also increased in size and became statistically significant (β=0.16, 95% CI 0.008 to 0.31; p=0.039).

Meta-regression at the level of the BCT clusters supports a positive effect for BCT cluster 2 Regulation and BCT cluster 5 Repetition and substitution, which contains the two BCTs in the BCT level meta-regression with significant associations with intervention effectiveness (BCT 4 Pharmacological support in Cluster 2, and BCT 29 Graded tasks in Cluster 5).

Meta-regression suggests that the use of theory has no significant association with intervention effectiveness (SMD -0.04, 95% CI -0.12 to 0.03, p=0.273). This non-significant association was seen among the 71 comparisons in the sensitivity analysis (SMD -0.06, 95% CI -0.21 to 0.09, p=0.421).

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6 Discussion

This review aimed to inform four main questions (see Section 2). The evidence pertinent to each of these questions is described in Sections 6.1 to 6.5, along with limitations of the approach, and how these limitations influence conclusions that may be drawn.

6.1 Specific and general effects of BCTs

Which behaviour change techniques are effective for changing and/or sustaining change in specific behaviours only, such as alcohol or smoking, and which are more generalisable (i.e. effective across a range of behaviours)?

Individual behaviour change techniques (BCTs) were considered across all five topic areas combined, while BCT clusters were considered at the level of individual behaviours; Section 4.7.3 offers a comparison of the results.

The BCTs which had a positive effect in the overall multivariate analysis were:

- BCT 4 Pharmacological support, which involves providing or encouraging the use of or adherence to drugs in order to facilitate behaviour change
- BCT 29 Graded tasks, which involves setting easy-to-perform tasks achievable tasks, and making them increasingly difficult until desired behaviour is performed
- BCT 65 Review behaviour goal(s), which involves jointly reviewing behavioural goals, *and* consideration of modifying the goal or behaviour change strategy in light of achievement (including re-setting the same goal, a small change in that goal, or setting a new goal instead of, or in addition to, the previous goal)
- BCT 31 Restructuring the social environment, which involves changing, or advising the individual to change, the social environment in order to facilitate performance of the wanted behaviour, or creating barriers to the unwanted behaviour

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- BCT 63 Goal setting (outcome), which involves setting or agreeing to a goal defined in terms of a positive outcome of the desired behaviour

In addition, intervention function 7 Environmental restructuring had a positive effect. This function is seen in interventions that report changing the physical or social context in which the behaviour is or could be performed. This IF is linked with BCT 34 Adding objects to the environment (among other BCTs) and also showed a correlation with this BCT, which showed association in the univariate analysis, but was not retained in the final model.

These overall results may be based on effectiveness of the BCT across all behaviour areas, or within individual behaviour areas. Comparison of the overall BCT results with the BCT cluster results suggests that the more generalisable BCTs may be:

- BCT-Cluster 12 Comparison of outcomes – this BCT cluster shows an effect in diet and physical activity, but not an overall effect. Commonly reported techniques in this cluster include:
  - BCT 70 Persuasive source, which occurs when a credible figure, such as a health professional, provides information in favour of or against a given behaviour.
  - BCT 71 Pros and cons, which involves advising the individual to identify and compare reasons for wanting and not wanting to change their behaviour.

  The only BCT in this cluster which showed an effect in the overall analysis was BCT 70 Persuasive source, which had an effect in the univariate analysis but was not retained in the final multivariate model.

- Intervention function 7 Environmental restructuring (and by extension possibly the linked BCTs 31 Restructuring the social environment and 34 Adding objects to the environment) seem to have an effect in physical activity, smoking, and an overall effect

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Less generalisable BCTs and clusters may include:

- BCT 4 Pharmacological support, which does have an overall effect, but this is largely due to its effect in smoking, where it generally indicates recommendation or provision of nicotine replacement therapy
- BCT 29 Graded tasks, which is associated with an overall effect, this may relate to the effect of its cluster (BCT-C 5 Repetition and substitution) in physical activity. This cluster also showed an association with effectiveness in univariate analyses for alcohol, but did not have sufficient spread of data for inclusion in the multivariate analyses. BCT 29 may be less relevant/applicable in certain areas e.g. sexual health where graded tasks are less likely to be used to encourage changes in sexual behaviour
- BCTs 63 Review behaviour goal(s) and 65 Goal setting (outcome) have a positive effect in the overall analysis, but their cluster (BCT-Cluster 11 Goals and planning) has a negative effect in smoking and no identified effect in other behaviours. This may indicate that in the non-smoking areas these BCTs are associated with a positive effect that is not large enough to be detected. While this cluster is associated with significant negative effects (that is, interventions reporting BCTs from this cluster are associated with a significantly smaller effect on smoking behaviour than interventions not reporting use of techniques in this cluster), cluster level meta-regression cannot identify which techniques account for this association. Cluster 11 includes nine discrete techniques, eight of which were reported in smoking interventions; the meta-regression results indicate that these techniques may warrant further investigation when being used in smoking trials: BCT 61 Problem solving, BCT 62 Goal setting (behaviour), BCT 63 Goal setting (outcome), BCT 64 Action planning, BCT 65 Review behaviour goals, BCT 66 Review outcome goals, BCT 68 Commitment, BCT 69 Discrepancy between current behaviour and goal. In the case of significant negative associations, interpreting the results

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conservatively may be warranted, and these associations may help identify intervention content that deserves closer consideration.

- BCT cluster 1 Social support, which involves care, assistance, help or support provided by others for performance of the behaviour. This cluster is associated with a positive effect in smoking, but a negative effect in physical activity
- BCT cluster 3 Feedback and monitoring is associated with a positive effect in alcohol, but a negative effect in physical activity
- Intervention function 5 Training, which involves imparting skills to aid in the performance of the desired behaviour, was associated with a negative effect in diet but not other areas
- Intervention function 2 Persuasion, which involves using communication to induce positive or negative feelings, or to stimulate action, was associated with a negative effect in alcohol but not other areas

In terms of other effects:

- BCT 80 Information about social and environmental consequences has a negative effect in the overall analysis, but its cluster (BCT-C 14 Natural consequences) did not have a detectable effect in the individual behaviour areas. This technique can include the provision of information about unspecified consequences, in addition to that surrounding any potential social or environmental consequences of the behaviour.

Limitations

The comparison of the overall analysis and individual areas would ideally be based on BCT level meta-regression in all areas. However, BCT level analyses in the individual areas were unlikely to have sufficient power to detect effects, and based on expert advice these were not carried out. Such an approach is intended to reduce the risk of a real effect going undetected. However, analysis at the cluster level has limitations, especially in the case of

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significant negative associations where additional detail at the BCT level would aid in the interpretation of such results.

Meta-regression provides a means to investigate heterogeneous findings across multiple studies, and to assess the association between study characteristics and effect sizes. It is, however, prone to false-positives, and this risk increases as more covariates are added to the analysis. Additionally, meta-regression is observational in nature, as such the results cannot be interpreted as identifying causal relationships, and are prone to confounding (Thompson and Higgins 2002).Thus, there is a risk that a significant association between a given covariate (BCTs, BCT clusters or intervention function) and effect is either spurious or a reflection of a true association with other correlated characteristics, such as intervention type, population, intensity, or other unknown factors.

It is important that when interpreting the BCT/BCT cluster/Intervention function findings, that reference is made to the full descriptions of the types of activities which fall into these categories (see Appendix D), rather than just the brief titles which are used in this report.

Our approach to categorising the components of interventions has several key limitations. First, the sensitivity of the BCT taxonomy is reliant upon accurate and detailed reporting of interventions within published descriptions. Yet, many intervention descriptions are poorly specified. This means that some BCTs may be undetected. For instance, the smoking intervention described in Sutton 2007 [+] involved the provision of a computer generated tailored letter following usual Quitline care (see Section 4.4.4). The description of this letter was based on the variables used by the computer programme to generate the letters, and not the letters' specific contents. While this descriptive approach is likely due to the variable content of possible letters (the programme was capable of generating over 3,000 unique letters) it is unfortunately not amenable to BCT coding, thus the techniques present in any given letter remain undetected.

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Conversely, some BCTs tend to be more likely to be described in the study methods than others, or are so broad in their scope that they are more likely to be coded, making it likely that these BCTs will be over-represented in the analysis. For example, interventions featuring any counselling component are coded as including BCT 3 Social support (unspecified), making it a very common code in both intervention and comparator arms. This leads to low variability in terms of this particular technique as well as BCT Cluster 1 (social support) across trials, and limits the potential to discriminate between the trials. As with all BCTs, the presence of BCT 3 does not distinguish between varying 'doses' of counselling. Depending on how the counselling is described, further BCTs may also be coded. These problems make it difficult to reliably identify and compare components across interventions. We also observed a generally poor standard of reporting of the content of control arms. This may have led to an under detection of BCTs in the control arms, leading in turn to inaccuracies in comparisons of the presence of BCTs across arms. Calls for routine publication of detailed study protocols for intervention studies, and more widespread use of the behaviour change taxonomy system may lead to more robust syntheses of future studies at the BCT level.

Secondly, analyses based on BCT and intervention function coding can generate recommendations only on the basis of the BCTs and functions that have been adopted in previous interventions. Yet, many of the 89 items within the BCT taxonomy were not reported to be present in any interventions, and so it is not possible to evaluate the effectiveness of these techniques, or to encourage or discourage their use in future interventions on the basis of empirical evidence. It remains possible that some techniques which are not commonly used (or reported) will be effective in changing behaviour.

Thirdly, the BCT coding approach used in this review is reductionist. The coding of BCTs involves extracting and decontextualizing intervention elements. Intervention effectiveness may also depend on the provider, format, setting, recipient, and duration of the intervention, and fidelity to the

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intervention (Davidson 2003). Additionally, coding of intervention elements in our reviewed followed a ‘vote count’ procedure, in which a BCT is coded as present or absent. While this reflects the usual procedure for BCT coding, it risks overlooking important differences in the intensity with which BCTs are administered, which may perhaps determine effectiveness. For instance, the peer counselling intervention described in Malchodi 2003 [+] is provided in addition to usual care, and the two arms are coded identically (see Section 4.4.4). The peer counselling sessions were intended to provide support and reinforce the stop smoking messages delivered as part of the foundation usual care intervention; this reinforcement is linked more closely to the intensity or dose of the techniques, and not to additional content itself.

Notwithstanding these limitations, the BCT taxonomy approach nonetheless offers a technological advance on previous methods for understanding behaviour change interventions, by providing a standardised nomenclature for the description of intervention components.

6.2 Long term effectiveness of BCTs

Which specific behaviour change techniques and combinations of behaviour change techniques are effective at changing behaviour in the long term (over 6 months) and/or sustaining behaviour change in individual-level interventions?

All topics

In the overall meta-regression, the following BCTs/Intervention functions were significant (positive effect) in the sensitivity analysis of studies with long term (>6 month) follow up:

- BCT 4 Pharmacological support
- BCT 63 Goal setting (outcome)

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- IF 7 Environmental restructuring (linked with BCTs 31 Restructuring the social environment and 34 Adding objects to the environment among others)

Although the following variables did not reach significance (which may be as a result of not enough power), they did maintain a similar or increased magnitude of positive effect:

- BCT 29 Graded tasks (which was significant in overall analysis)
- BCT 31 Restructuring the social environment (linked with IF 7 Environmental restructuring)
- BCT-Cluster 5 Repetition and substitution (contains BCT 29 Graded tasks)
- BCT-Cluster 2 Regulation (contains BCT 4 Pharmacological support)

Alcohol

Within alcohol, sensitivity analysis of studies with long term follow up found that:

- BCT-Cluster 3 Feedback and monitoring remained significantly associated with a positive effect. The most frequently reported BCTs in this cluster across alcohol trials included:
  - BCT 8 Feedback on behaviour, which involves monitoring and providing feedback on the performance of the behaviour itself (e.g. the form, frequency, duration, intensity) as opposed to the outcome of the behaviour (e.g. injuries, liver disease etc.). In alcohol trials, this may involve monitoring and informing the individual about the number of drinks consumed over a certain time period
  - BCT 14 Biofeedback, which involves providing feedback about the body (e.g. physiological or biochemical state) using an external monitoring device as part of a behaviour change strategy. In alcohol interventions

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this may involve providing information on blood alcohol content in order to encourage reducing alcohol consumption

- IF 2 Persuasion retained the magnitude of its negative effect, but this became non-significant

Smoking

Within smoking, sensitivity analysis of studies with long term follow up found that none of the variables showed a significant association with effectiveness but the following showed similar or increased magnitudes of effect:

- BCT-Cluster 2 Regulation (non-significant positive effect)
- IF 7 Environmental Restructuring (non-significant positive effect)
- BCT-Cluster 11 Goals and planning (non-significant negative effect)
- Theory use (non-significant negative effect)

Diet

Within diet, sensitivity analysis of studies with long term follow up found that:

- IF 5 Training increased the magnitude of its non-significant negative effect
- The effect of BCT-Cluster 12 Comparison of outcomes could not be determined as no long term studies used it

Physical activity

Within physical activity, sensitivity analysis of studies with long term follow up found that the magnitude of effects of all of the included variables increased, including:

- BCT-Cluster 5 Repetition and substitution (significant positive effect). The most commonly reported techniques in this cluster include:

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  - BCT 23 Behavioural practice/rehearsal, which involves prompting the practice or rehearsal of the behaviour one or more times in a context or at a time when the performance may not be necessary, in order to increase habit and skill. In physical activity trials this could take the form of having an individual attend an exercise class
  - BCT 29 Graded tasks. In physical activity trials graded tasks may involve having an inactive individual initially set a small, easy to achieve goal e.g. of taking a ten minute walk each morning for a week, then increasing to e.g. twenty or thirty minutes in subsequent weeks
- IF 7 Environmental Restructuring (significant positive effect). While specific BCTs do not need to be present for an intervention to involve environmental restructuring, certain techniques are linked to this function, including:
  - BCT 34 Adding objects to the environment, which was reported commonly in physical activity interventions. In this behaviour change area, the technique may take the form of providing an individual with a pedometer which they can use to track the number of steps they take each day
- BCT-Cluster 12 Comparison of outcomes (significant positive effect). The most commonly reported technique in this cluster was:
  - BCT 71 Pros and cons. In physical activity trials this may include asking an inactive, overweight individual to assess the possible benefits of becoming more physically active as well as possible harms of remaining inactive
  - BCTs 70 Persuasive source and 72 Comparative imagining of future outcomes were reported less frequently in physical activity interventions
- BCT-Cluster 3 Feedback and monitoring (significant negative effect). While this cluster is associated with decreased effects, it includes seven discrete BCTs, five of which were used in the interventions with long term follow-up. The analysis cannot identify which techniques account for this association, and interpreting this result conservatively may be warranted. This

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association may help identify intervention content that deserves closer consideration, however, more robust evidence at the BCT level should be acquired before removing feedback and monitoring techniques from physical activity interventions. The most commonly reported techniques in this cluster among interventions with long term follow-up include:

  - BCT 8 Feedback on behaviour. In physical activity trials, this may involve informing the individual about the number of steps taken during a day, or the number of minutes spent physically active in a week
  - BCT10 Self monitoring of behaviour, which involves establishing a method by which the person monitors and records their behaviour as part of an overall behaviour change strategy. In physical activity trials this may involve keeping a diary in which to records all activity throughout the week
  - BCTs 9 Feedback on outcome(s) of the behaviour, 11 Self monitoring of outcomes, 12 Monitoring of behaviour by others without feedback were also reported, although were less common
- BCT-Cluster 1 Social support (non-significant negative effect)

6.3 Effective behaviour change interventions

<u>Which interventions are effective at changing behaviour and/or sustaining behaviour change in individual-level interventions?</u>

Interventions were described according to their type (brief, extended, multi-session) and delivery methods (face to face, remote, one on one and/or group).

The majority of interventions were provided over multiple sessions. Intervention type tended to vary according to the population receiving the intervention – for example, brief interventions were more common among individuals identified on the basis of behaviour alone (e.g. smoking) rather than health status and behaviour (e.g. smokers with CVD).

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Trends in effectiveness by intervention type and mode of delivery are described below. These findings should be considered in the context of existing NICE public health guidance within the individual behaviour areas, which may provide more in depth analysis of the interventions in these individual areas.

Table 49 summarises the frequency with which BCTs were reported in each category of intervention type and mode of delivery. While intervention type represents mutually exclusive categories (an intervention can not be both brief and multi-session), the three overarching mode of delivery categories (face to face one on one, face to face group, and remote) can overlap when different delivery methods are combined within a single intervention. A BCT reported in an intervention with both face to face one on one and remote components is therefore tallied for both categories in Table 49.

The final multivariate model found that interventions reporting the use of BCTs 4 Pharmacological support or 29 graded tasks significantly more effective at changing behaviour than interventions that did not report use of these techniques.

BCT 4 was most often reported in multi-session interventions and in those delivered either face to face and one on one, or with remote components. This remote delivery was generally in combination with a face to face component, although a third of the reported occurrences of this technique were in interventions with solely a remote delivery mechanism. The high frequency of use in multi-session interventions may be due in part to the need for monitoring when pharmacological treatments are provided or prescribed, although the presence of the BCT in remotely delivered interventions underscores that encouraging the use of available pharmacological treatments (such as NRT) is sufficient for this technique to be considered present in an intervention.

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BCT 29 was only reported in multi-session interventions, which likely reflects the setting of increasingly difficult tasks that build on each other; although this technique could conceivably be used in single session interventions (with all levels of the task outlined in one session). No division was evident according to mode of delivery for this technique.

BCTs 14 Biofeedback, 31 Changing the social environment, 63 Setting outcome goals, 65 Reviewing behavioural goals, and 80 Information about social and environmental consequences were included in the overall multivariate analysis, but interventions reporting use of these techniques were to be no more or less effective at changing behaviour than interventions that did not report their use.

BCT 14 was reportedly used in both brief and multi-session interventions, and was most often reported those delivered face to face and one on one. BCT 31 was infrequently reported, but used most often in multi-session interventions delivered face to face and one on one. BCT 63 was most frequently used in multi-session interventions, and does not appear to be restricted by delivery methods. BCT 65 was reported only in multi-session interventions, and mainly used those delivered face to face and one on one; this aligns with the need for follow-up and re-evaluation of behaviour goals in light of progress. Finally, BCT 80 was reported in both brief and multi-session interventions, generally among those delivered face to face and one on one, but also in remotely delivered interventions. The use of this technique across interventions types and delivery methods likely reflects its educational function, and the ease with which this technique can be incorporated into a diverse range of interventions.

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Table 49: Frequency of BCT reports across types of interventions and modes of delivery

BCTs and clusters	Intervention type			Mode of delivery		
	Brief (43 total)	Extended (18 total)	Multi-session (174 total)	FTF one on one (147 total)	FTF Group (48 total)	Remote (115 total)
Social Support - Care, assistance, help or support provided by others for performance of the behaviour						
1 Social support – practical	0	1	12	7	5	4
2 Social support – emotional	3	1	2	5	1	2
3 Social support – unspecified	31	15	154	131	43	93
Regulation - Controlling one's emotions, thoughts or impulses						
4 Pharmacological support†*	7	2	38	33	6	29
5 Reduce negative emotions	0	1	25	14	11	11
6 Conserving mental resources	0	0	1	1	0	1
Feedback and Monitoring - Recording behaviour or its outcomes, and/or providing feedback on behaviour or its outcomes						
8 Feedback on behaviour	17	9	49	50	7	40
9 Feedback on outcome	3	1	12	10	1	9
10 Self-monitoring of behaviour	1	0	47	26	13	31
11 Self-monitoring of outcome	0	0	7	6	3	2
12 Monitoring of behaviour by others without feedback	0	0	2	1	1	1
13 Monitoring of outcome by others without feedback	0	0	2	2	1	0
14 Biofeedback†	5	1	7	8	4	3
Associations - Making new associations between behaviour and cues or rewards, or managing existing associations						
15 Prompts/cues	2	0	4	1	0	6

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BCTs and clusters	Intervention type			Mode of delivery		
	Brief (43 total)	Extended (18 total)	Multi-session (174 total)	FTF one on one (147 total)	FTF Group (48 total)	Remote (115 total)
Repetition and Substitution - Practising, rehearsing or repeating a behaviour, or directly replacing a new wanted behaviour for an existing unwanted behaviour						
23 Behavioural rehearsal/practice	0	2	17	12	11	3
24 Habit formation	0	0	1	0	1	1
25 Behaviour substitution	3	1	13	12	6	8
28 Generalisation of a target behaviour	0	0	8	6	7	1
29 Graded tasks†*	0	0	11	5	5	6
Antecedents - Managing social and environmental situations and events, emotions, or thoughts that elicit existing unwanted behaviour, or have the potential to elicit new wanted behaviour						
30 Restructuring the physical environment	0	0	4	3	0	1
31 Restructuring the social environment†	1	0	3	3	0	1
32 Avoidance/reducing exposure to cues for the behaviour	0	0	2	1	0	2
33 Distraction	0	0	1	0	0	1
34 Adding objects to the environment	7	4	63	55	13	38
35 Body changes	0	0	13	5	7	6
Shaping Knowledge - Providing information, instructions, or explanations around the behaviour						
36 Instruction on how to perform a behaviour	6	2	51	34	20	27
37 Information about antecedents	0	2	10	8	6	4
39 Behavioural experiments	0	1	0	0	1	0
Self-Belief - Fostering confidence in one's ability to perform the behaviour						
40 Verbal persuasion about capability	3	0	5	7	0	2
41 Mental rehearsal	0	0	1	0	0	1

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BCTs and clusters	Intervention type			Mode of delivery		
	Brief (43 total)	Extended (18 total)	Multi-session (174 total)	FTF one on one (147 total)	FTF Group (48 total)	Remote (115 total)
42 Focus on pas success	1	0	2	2	0	2
43 Self-talk	0	0	3	2	0	3
Scheduled Consequences - Emphasising or changing rewards or punishments arising from the behaviour						
50 Reward incompatible behaviour	1	0	0	1	0	0
Reward & Threat - Rewarding or punishing new or old behaviours						
54 Material reward for behaviour	0	0	2	2	2	0
56 Social reward	0	1	6	4	0	6
57 Non-specific reward	0	0	3	0	1	2
58 Self-reward	0	0	1	0	1	0
59 Future punishment	0	0	2	2	0	1
Goals & Planning - Managing behaviour or outcome goals, and/or how behaviour or outcomes will be achieved						
61 Problem solving	4	3	73	42	26	47
62 Setting goal – behaviour	11	3	100	68	32	64
63 Setting goal – outcome†	4	1	47	35	17	22
64 Action planning	6	4	84	52	28	53
65 Review behaviour goal†	0	0	24	19	8	13
66 Review outcome goal	0	0	4	1	0	4
67 Behavioural contract	2	0	14	11	2	14
68 Commitment	1	0	15	13	4	5
69 Discrepancy between current behaviour and goal	0	0	14	7	0	13

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BCTs and clusters	Intervention type			Mode of delivery		
	Brief (43 total)	**Extended (18 total)**	**Multi-session (174 total)**	**FTF one on one (147 total)**	**FTF Group (48 total)**	**Remote (115 total)**
Comparison of Outcomes - Considering relative pros and cons of outcomes of various behaviours						
70 Persuasive source	9	0	12	15	1	8
71 Pros and cons	8	6	25	33	5	14
72 Comparative imagining of future outcomes	0	0	2	0	0	2
Identity - Managing how one sees, thinks or feels about oneself or the behaviour						
75 Framing/reframing	1	0	6	4	0	3
76 Incompatible beliefs	0	1	3	2	1	2
Natural Consequences - Providing information about the naturally-occurring consequences of the behaviour						
78 Information about health consequences	18	7	43	50	8	34
79 Information about emotional consequences	2	0	2	3	0	1
80 Information about social and environmental consequences†	18	8	20	38	4	14
82 Monitoring of emotional consequences	0	0	1	0	0	1
Comparison of Behaviour - Comparing own behaviour to an ideal performance or to others' beliefs or behaviour						
84 Demonstration of the behaviour	0	1	8	4	5	2
85 Social comparison	15	4	16	19	3	16
86 Information about others approval	0	0	1	0	0	1
Covert Learning - Imagining consequences of behaviour, or observing consequences of the behaviour for others						
89 Vicarious consequences	0	0	2	1	1	0

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Intervention Type

Overall, studies found that brief interventions (single sessions lasting less than thirty minutes) were no more effective than comparators at altering behaviour. Many of these studies targeted alcohol consumption among university students in the United States or heavy/at risk drinkers presenting in the Emergency Department or primary care. The lack of observed effectiveness may be due to particular difficulties altering drinking behaviour in these populations (other intervention types also largely resulted in no significant differences in alcohol consumption in these populations/settings, see Section 5.4.1).

Brief interventions may be incompatible with certain BCTs, and this may influence effectiveness. For instance, smoking interventions which provide or prescribe smokers nicotine replacement therapy (coded as BCTs 4 and 34) generally require follow-up sessions to monitor effects and make dosage adjustments if needed. Among alcohol interventions, BCT cluster 3 (feedback and monitoring) was associated with intervention effectiveness, many trials that include participants monitoring their alcohol consumption and providing feedback on such behaviour do so over multiple sessions.

Few studies assessed extended interventions. These were mainly provided to heavy/risky drinking university students with the aim of reducing alcohol consumption. The lack of effectiveness seen among these interventions may be due to difficulties in addressing alcohol consumption in this group, rather than due to the intervention type itself.

Across the five topic areas, multi-session interventions were more likely to be used and more likely to be effective than the other types of intervention. This effectiveness varied across population groups and delivery method, however. Interventions provided to individuals with clinical disease (CVD, T2DM) were most likely to be provided over multiple sessions, and most likely to address multiple behaviours. The effectiveness of these interventions may be due to a

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combination of intervention intensity, content, context and population characteristics.

While the categorisation of intervention type used in this review provides a proxy measure of intensity (with brief interventions being les intense and multiple sessions more intense), it does not capture all aspects of it. Frequency and duration of the intervention varied considerably among the identified trials, and within intervention types. Further assessment examining the effectiveness of multi-session interventions across varying levels of intensity and other intervention characteristics could further clarify what aspects of these multi-session interventions are effective for altering behaviour within a given population.

Delivery method

Frequency of use and effectiveness of each delivery method varied across the topic areas and population groups. Face to face, one on one interventions were most common in the sexual health, alcohol and smoking topics, and among interventions delivered in clinical settings such as primary care or Emergency Departments. Remotely delivered interventions (alone or as a follow-up to face to face interventions) were used most frequently in the smoking and physical activity topics.

No clear trends in effectiveness among different delivery methods were seen.

6.4 Variation across different population groups

<u>How do the effects of individual interventions vary across different population groups?</u>

Trials in each behaviour area were grouped according to key participant characteristics in trials in that area. Some of these population groups were specific to the individual areas of interest (e.g. individuals with HIV or other STI in the sexual health section), while others applied to several behavioural

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areas (e.g. individuals with or at risk for CVD in the alcohol, smoking, diet and physical activity sections).

The population groups outlined in Section 4.2.4, 4.3.4, 4.4.4, 4.5.4 and 4.6.4 were selected based on the trials included within each behavioural area. These groups were not defined a priori, but largely aligned with the individual level selection criteria utilised during the search and sifting processes (see Appendix C). That is, populations with a health status (e.g. cardiovascular disease, type 2 diabetes) or health behaviours (e.g. engaging in unprotected sex, drinking above recommended alcohol limits) which suggested that they could benefit from a behaviour change intervention. Others were grouped according to recruitment setting (i.e. Emergency Department, hospital or primary care patients exhibiting risky behaviours).

It should be noted that these broad groupings do not describe all of the participants' characteristics, but reflect the most pertinent and common factors when considering both the individual intervention aim and the behaviour change topic area. This sometimes led to differential population categorisation of studies across topics. For instance, Dermen 2011* [+] enrolled university students exhibiting both risky sexual and drinking behaviours: in the sexual health summary (Section 4.2.4) the most pertinent population group which this study fell in to was individuals at risk for STIs, while in the alcohol summary (Section 4.3.4) this study was grouped with other studies among university students, as this was the most defining characteristic of this population in this topic area.

The effectiveness of behaviour change interventions across population groups within each topic area is discussed in Section 5.4.1, and intervention effectiveness in socioeconomically disadvantaged and minority ethnic groups is discussed in Section 5.4.2. As these groups were not considered in the meta-regression, assessment and discussion is limited to a narrative synthesis.

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6.4.1 Effectiveness across population groups within behaviour change topics

Sexual Health

The number of studies within sexual health area limits the ability to detect strong patterns across populations. Overall, interventions among men who have sex with men were found to have no significant effect on changing sexual health behaviour (Evidence Statement 1.5). Some individual interventions were found to be effective among women at risk of unintended pregnancy (Evidence Statement 1.6), individuals at risk of acquiring HIV or other STI (Evidence Statements 1.7) and individuals with HIV or other STIs (Evidence Statements 1.8). There was variation within each of these populations in terms of the type and delivery of the interventions, and considerable heterogeneity in participant characteristics across the studies (see Section 4.2.4). Among women at risk of unintended pregnancy, two trials enrolled women whose risk was determined based on their presenting at an abortion clinic, one defined risk as not using an IUD or being sterilised/having a sterilised partner. The effective intervention in women at risk of unintended pregnancy enrolled university students reporting ineffective contraception use while binge drinking, and aimed to reduce the risk of alcohol exposed pregnancy. Similar variation in terms of participant characteristics and recruiting were seen within the individuals with or at risk for HIV/other STI groups.

Alcohol

The major population groups identified within this topic included heavy/risky/harmful drinkers presenting to the ED or treated in hospital, drinkers recruited in primary care, individuals with or at risk for cardiovascular conditions, and university students. This review excluded individuals with alcohol dependency, thus conclusions drawn about intervention effectiveness (or lack thereof) should be confined to individuals considered to be heavy,

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risky or harmful drinkers, and not extended to those with more severe addiction or dependency. Very few interventions in this topic area were effective, thus, the general pattern across populations is a lack of significant effect on drinking behaviour.

Overall, trials among hospitalised drinkers or those presenting in the ED were found to be no more effective than usual care, regardless of intervention type and mode of delivery (Evidence Statements 2.5). There was considerable variation in participant characteristics in this group, with some studies targeting injured ED patients, while others were conducted among relatively deprived hospital patients. A similar lack of effectiveness was seen among drinkers identified in primary care settings (Evidence Statement 2.10).The evidence suggests that the opportunistic interventions used in these trials were not effective at altering drinking behaviour in these populations groups.

Alcohol interventions among individuals with or at risk for cardiovascular conditions were found to be no more effective than usual care at reducing consumption (Evidence Statement 2.9). There was some variation in this population in terms of health status, with some interventions engaging individuals in cardiovascular risk management programmes, others among congestive heart failure patients. All of the trials in this group used usual care as a comparator. Given the difficulties encountered regarding the coding of comparators, it is possible that fairly robust alcohol interventions were being provided in usual care, and that the lack of effect arises due to this unreported content.

A large proportion of alcohol behaviour change trials were conducted among university students; all of these trials were carried out in the United States. Overall, these interventions had no significant impact on the drinking behaviour of students. This pattern held across intervention types and delivery methods (Evidence Statements 2.6 to 2.8).

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Interventions among pregnant or postpartum women appear to be effective at changing alcohol consumption (Evidence Statement 2.12). This population was represented in two trials only, and may be an area of interest for future research.

Smoking

The effectiveness of smoking interventions varies considerably across different population groups. Overall, opportunistic interventions appear to be no more effective than usual care at changing smoking behaviour among patients presenting in to the Emergency Department, or those hospitalised for non-cardiovascular conditions (Evidence Statement 3.8), or identified in primary care settings (Evidence Statement 3.14). Interventions that specifically target smokers who are motivated to or interested in quitting tend to be effective, although there is variability by intervention type and mode of delivery in this group (Evidence Statements 3.12 to 3.13). The relative role played by individual motivation vs. intervention design in the observed effectiveness within this population is unclear. Interventions targeting smoking behaviour among those with or at risk for cardiovascular or respiratory conditions (Evidence Statements 3.5 to 3.7), and among pregnant and postpartum women (Evidence Statements 3.9 to 3.11) had some success.

There was considerable heterogeneity within these populations (e.g. the ED/hospital patients group was made up of individuals identified as smokers during Emergency Department visits that were not necessarily related to a smoking-related condition, as well as surgical patients who were at increased risk of perioperative complications due to their smoking behaviour).

Additional differences occurred in terms of selected comparator across these groups. Interventions among CVD/COPD, hospital/ED patients and pregnant women subgroups were assessed with usual care as the comparator. These usual care arms were generally sparsely described, with the majority not reporting any codeable BCTs. Strong anti-smoking messages may be

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included in usual care, but not described in the trials; this may account for the lack of a statistically significant difference between the arms. At the currently reported levels of detail, discerning differences in content between the interventions being tested and usual care is difficult in the majority of the smoking trials.

Diet

The subpopulations in this topic area were represented by only a handful of studies, which limits the conclusions that can be drawn within or across the groups. The major population groups identified in the dietary trials were those with clinical conditions and those at risk for such conditions based on either clinical or behavioural markers. Among cardiovascular patients, interventions that also addressed other behavioural areas were effective at changing dietary behaviours (Evidence Statement 4.4). This effect was seen over a variety of dietary outcomes relevant to cardiovascular patients, including oily fish consumption, and consuming a Mediterranean or low fat diet.

Among the other major clinical group, Type 2 Diabetes patients, the effectiveness of diet interventions was inconsistent (Evidence Statement 4.5), with no clear patterns of effectiveness emerging even when taking into consideration the intervention type and delivery method.

Among populations with clinical cardiovascular risk factors, dietary intervention had inconsistent effects (Evidence Statement 4.6). Most of these trials assessed interventions addressing multiple behaviours, generally diet and physical activity together. There was considerable heterogeneity in participant characteristics in this subgroup, with type and severity of risk, employment status, ethnicity, age, and medication use varying, among other factors.

Trials which assessed non-behavioural outcomes were excluded across all five behaviour change topic in this review. For dietary interventions, this

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exclusion criterion considerably reduced the pool of included studies, as trials examining non-behavioural outcomes (e.g. calorie counts, grams of fat, % of total energy intake) were not eligible. In total, four trials that addressed diet only and met inclusion criteria were identified, while an additional 20 that addressed diet in combination with another behaviour change topic (primarily physical activity) met inclusion criteria .

In the area of diet, the strict definition of what constitutes a behaviour excludes outcomes such as calorie or fat intake, which without further information cannot be pinpointed to specific behaviours. For example, calorie reduction could result from a range of different behaviours, such as eating less fatty food or reducing alcohol consumption or reducing snacking between meals. This criterion resulted in exclusion of a number of diet studies.

Despite these exclusions, there was still considerable heterogeneity of dietary behaviour outcomes, as different trials assessed the effect of behaviour change interventions on various aspects of individual dietary habits (e.g. fruit, vegetable, or fatty food intake). Effectiveness may vary across different outcomes, and this variability was not assessed. Given the topic area, removing this outcome heterogeneity is not feasible without focusing on a single dietary behaviour. Such an approach would, however, further reduce the quantity of available evidence available, and the overall utility of a dietary behaviour change review.

Physical activity

Aside from the three studies that recruited pregnant women at risk for gestational diabetes, the proportion of interventions targeting physical activity that were found to be effective at changing behaviour was generally consistent across population groups. As with diet, however, each subpopulation was represented in a limited number of studies, making it difficult to draw conclusions on the link between effectiveness and population targeted. Among individuals with cardiovascular conditions, some trials were

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effective at improving activity, but this varied with type of intervention and mode of delivery (Evidence Statements 5.5 to 5.7)

Similarly inconsistent effects were seen among individuals with Type 2 Diabetes (Evidence Statements 5.8 to 5.9), those with cardiovascular risk factors (Evidence Statements 5.10 to 5.11), and individuals with increased risk for T2DM (Evidence Statement 5.12).

Studies which addressed diet as well as physical activity suggest that intervention among overweight or obese individuals can be effective (Evidence Statement 5.13), although which interventions are best suited for effecting change in this population could not be determined, given the limited number of trials in this group.

The only population in this behaviour area selected solely on the basis on behaviour was inactive/underactive individuals. There was variation in both the effectiveness of interventions in this population, as well as underlying patient characteristics. Identifying effective intervention by type or mode of delivery in this group is hampered by the limited number of studies in each subset of interventions (Evidence Statements 5.14 to 5.15).

6.4.2 Social Inequalities

This section summarises the effectiveness of behaviour change interventions for those studies that reported recruiting participants based on socioeconomic status, were reported to be carried out in areas of high socioeconomic deprivation, or where the majority of the participants were considered by the paper to be of low-income status. For ethnicity, studies are discussed which recruited on the basis ethnicity, or predominately included ethnic-minority participants.

The majority of included studies did not target low SES or BME groups, nor specify the socioeconomic or ethnic characteristics of their participants. This limits the number of studies available for synthesis in this section, and thus

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the conclusions that can be drawn regarding the effectiveness of behaviour change interventions in these populations.

Different studies used different categorisations of sociodemographic characteristics across countries, and this also complicates synthesis of these studies. For example, assessment based on educational attainment and income in the USA is difficult to directly translate to the UK categorisation of social class or SES. Similarly, ethnic categories of black or African American may not map directly onto UK relevant ethnicities. Other ethnicities (Hispanic or Latino) may have limited applicability to UK public health practice.

Socioeconomic Status

Fourteen interventions (described in ten trials) recruited on the basis of low socioeconomic status, were conducted in areas of deprivation. The effectiveness of these interventions varied across behaviour change areas.

Ten smoking interventions were performed in studies which recruited low income pregnant women, and focused on either smoking cessation or relapse prevention in this population. Overall, the evidence of effectiveness was inconsistent across these trials, with two studies (Pbert 2004 [+], El-Mohandes 2011 [+]) reporting significant effects on smoking behaviour. One trial (O'Connor 2007 [+]) recruited low-income pregnant drinkers, and resulted in a significant effect on drinking during the third trimester. Two alcohol interventions (Holloway_SEE 2007 [+], Holloway_SHB 2007 [+]) among hospitalised patients, the majority of whom were classified as being 'relatively deprived', resulted in no significant changes in alcohol consumption. One trial (Eakin 2010* [+]) addressed both dietary and physical activity behaviour change, and reported recruiting T2DM or hypertensive patients from a socioeconomically disadvantaged community. There was inconsistent effect across outcomes in this trial, with significant changes seen in dietary behaviour, but not in physical activity.

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This evidence suggests that interventions among individuals in low-socioeconomic or low-income groups can be effective at altering health behaviour. The results of the intervention described in Eakin 2010* [+] suggest that the same intervention can result in different effects depending on the behaviour area assessed.

Given the limitations of this synthesis, it is unclear whether the variation in effectiveness seen across these studies is related to target behaviours, intervention content and design, participant SES, or other participant characteristics.

Ethnicity

Several trials recruited on the basis of either ethnicity, or predominately included ethnic-minority participants. These trials included black and/or Hispanic/Latino participants. The applicability of these studies to UK public health practice may vary, depending on the ethnicity represented.

Twelve interventions in nine trials included black or African American participants. Eleven of the 12 interventions resulted in non significant difference in health related behaviour versus the comparator (sexual health: Koblin 2012 [++], Crosby 2009 [+], Golin 2012 [+]; alcohol: Field_BP 2009 [+]; smoking: Nollen 2007 [++], Ondersma_CM-Lite 2012 [++], Ondersma_CD-5As+CM-Lite 2012 [++], Ondersma_CD-5As 2012 [++], Hyman_Sec 2007* [++], Hyman_Sic 2007* [++]; diet: Stolley 2008 [+]; physical activity: Hyman_Sec 2007* [++], Hyman_Sic 2007* [++]). One smoking intervention was significantly more effective than the comparator at encouraging smokers to quit (El-Mohandes 2001 [+]).

Eight interventions recruited or included Hispanic or Latino participants. As with trials among black participants, the majority of these resulted in no significant behaviour change (sexual health: Langston 2010 [++], alcohol: Field_HP 2009 [+]; smoking: Dornelas 2006 [+], Malchodi 2003 [+]; diet:

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Osborn 2010 [+]; physical activity: Eakin 2007 [+],Toobert 2011 [+]). One intervention resulted in a significant difference in average weekly physical activity among obese Hispanic Americans who had undergone gastric bypass surgery (Nijamkin 2012 [++]).

Eight interventions included mainly black and Hispanic participants (these two groups made up at least 50% of the participants). Four of these interventions resulted in no significant changes to behaviour (sexual health: Mansergh 2010 [+]; smoking: Bernstein 2011 [++], Gordon_3As 2010a [+], Reid 2008 [++]), three were effective at altering behaviour (alcohol: O'Connor 2007 [+]; smoking: Gordon_5As 2010a [+], Vidrine 2012 [+]), and one resulted in inconsistent effects, depending on the behaviour targeted (the intervention in Gilbert 2008* [++] had a no significant effect on alcohol consumption, but was effective at changing sexual health behaviour among HIV positive adults).

Additionally, one trial (Petersen 2007 [++]) did not recruit based on ethnicity, or have a majority of participants who were considered part of ethnic minority groups, but it did include subgroup analysis by ethnicity. In this analysis, black women (27% of the included participants) reported an improvement in contraceptive use or maintenance of a high level of use at 2 month follow-up with the intervention (72% with intervention vs. 55% with control; $p<0.05$). This difference was maintained at 12 months (60% vs. 54%, p value not reported).

These studies suggest that some interventions can be effective at altering health behaviour among ethnic minority groups. Similar to the Eakin 2010* [+] study discussed in the socioeconomic section, the intervention described in Gilbert 2008* [++] had a differential effect depending on the behavioural area targeted.

Overall, there were a limited number of studies that reported participant characteristics in a manner suitable for assessing the effect of these behaviour change interventions among economically disadvantaged individuals, or individuals in minority ethnic groups. While these studies

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suggest that behaviour change interventions can be effective among these populations, given the limitations of this synthesis, it is unclear whether the variation in effectiveness seen is related to target behaviours, intervention content and design, participant SES, ethnicity, or other characteristics.

6.5 Theory use

Which theories explain when, why and how behaviour change is maintained?

We adopted two approaches to investigate which theoretical explanations best apply to change in each of the behaviour domains. Firstly, we assessed whether and which named theories had been used to inform behaviour change interventions, based on whether the theory had been mentioned anywhere in the published description of an intervention. Coding for theories in this way can reveal intervention developers' assumptions around the causal processes that lead to behaviour change. For example, the Transtheoretical Model was most popular in smoking and physical activity interventions, and so suggests that smoking and physical activity are commonly conceived of as outcomes of a series of sequential stages, beginning with (not) considering changing behaviour (pre-contemplation), progressing through contemplation and initiation of action, and culminating in long-term change (maintenance). For diet interventions, social cognitive theory was most popular, and reflects the predominance of a belief among researchers that dietary change is the product of motivation and self-confidence in being able to bring about change. No single theory dominated sexual health or alcohol interventions. Theories were used in a minority of interventions, and the absence of positive effects of theory use in our meta-regression analyses suggested there was no clear advantage to using theory to inform interventions. This conclusion is however qualified by a key limitation of our coding of theory use..

Theory can be used in multiple ways to inform the basis of an intervention. For example, theory can: identify constructs that predict behaviour and so offer targets for change as a mechanism to behaviour change (e.g. self-

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efficacy); select recipients for the intervention based on their scores on theoretical variables (e.g. those low in self-efficacy); select and tailor intervention techniques to recipients (e.g. encouraging repeated performance, to promote self-confidence gains among those low in self-efficacy); and suggest psychological variables for measurement as a means of detecting psychological change (e.g. measuring self-efficacy; Michie & Prestwich, 2010). A 19-item coding frame is available to assess the 'theory-basedness' of interventions according to these criteria (Michie & Prestwich, 2010). This coding frame was intended to be used in this review, but early applications to published interventions showed that interventions were insufficiently described for many of the items to be coded. Therefore a single-item assessment of theory use was used instead.

This assessment of theory use would not be able to distinguish between instances in which, for example, a theory was mentioned in the introduction to an intervention description but not used to inform intervention content, versus the integration of theory into all parts of the intervention development, implementation and evaluation processes. Coding is reliant upon the quality of intervention reporting, and poor reporting makes it difficult to identify whether and which theories are associated with effectiveness.

Secondly, the general theoretical approaches taken by the intervention were inferred from the BCTs present in each intervention, in the form of the BCT clusters. Although no clusters were found to predict effects for sexual health, and findings were inconclusive for alcohol consumption, some theoretical clusters were observed to account for unique variance in the effectiveness of diet, physical activity and smoking interventions. Diet interventions based on 'comparisons of outcomes' tended to be more effective, suggesting that conscious deliberation over the pros and cons of available options may be important in energising dietary change. Physical activity interventions had increased effectiveness where they used 'repetition and substitution', techniques which are central to learning theory accounts of behaviour.

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Surprisingly, interventions based on ‘goals and planning’, which are self-regulatory approaches to behaviour change, were associated with reduced effectiveness of smoking interventions. This suggests that smoking cessation interventions may perhaps be hindered by focusing on self-regulation, and that other techniques or approaches may be more effective.

The use of theory to inform the content of interventions varied across the five behaviour change areas. Theory was reported least frequently in alcohol trials (12% of all interventions) and most frequently in physical activity trials (55% of all interventions). Theory use in the intervention was included as a covariate in each of the topic specific meta-regressions, to control for any potential effect. This approach differed from that taken with BCT clusters and intervention functions, which were only included in the meta-regression if the univariate analysis indicated that they accounted for a proportion of between study variance. The only topic in which this occurred was smoking, where theory use accounted for approximately 10% of the between study variance. However, theory use was not statistically significant predictor of effectiveness in the multivariate analysis, and the regression coefficient was very small and indicated a negative direction of effect for theory use.

The meta-regression suggests that the overall effect in each behaviour change area is not predicted by the use of theory to develop the intervention. This lack of association was also seen in the subset of studies with long term follow-up, across all five topic areas (see Table 50).

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Table 50: : Meta-analysis results – theory use - overall and topic specific effect sizes and heterogeneity

Topic	Primary meta-regression		Long term sensitivity analysis (>6 months)	
	Effect size (SMD, 95% CI)	p-value	Effect size (SMD, 95% CI)	p-value
Sexual health	No meta-regression		No meta-regression	
Alcohol	0.03 (-0.12 to 0.18)	0.684	0.09 (-0.10 to 0.28)	0.342
Smoking	-0.07 (-0.22 to 0.08)	0.364	-0.22 (-0.59 to 0.16)	0.242
Diet	-0.03 (-0.22 to 0.16)	0.739	-0.11 (-0.50 to 0.28)	0.513
Physical activity	-0.03 (-0.16 to 0.09)	0.594	-0.12 (-0.33 to 0.08)	0.201
Overall	-0.04 (-0.12 to 0.03)	0.273	-0.06 (-0.21 to 0.09)	0.421

6.6 General limitations

The current review is part of an update of PH6 guidance published in 2007. The evidence review underlying this guidance included only systematic reviews, and the search was carried out in February 2006. To cover the lag period between studies being published and being included in systematic reviews, the search for the current evidence review went back to 2003 rather than 2006. The evidence should be interpreted in light of the fact that it only includes studies from 2003.

Due to the large amount of research on behaviour change in the five behaviour areas being assessed, a number of pragmatic approaches were taken to make the review feasible. The evidence review for the original PH6 guidance included only systematic reviews for this reason. However, as BCT coding requires in depth information about what was done in an intervention, it would be difficult to identify BCT level information from systematic reviews, which usually do not provide full descriptions of study interventions.

The pragmatic approaches used were:

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- To exclude studies with fewer than 100 participants, as well as pilot and feasibility studies. This reduces the amount of data available for the meta-analysis and meta-regression, and therefore power. This removal of smaller studies could explain why there was some indication of publication bias in some of the analyses (sexual health, alcohol, and the overall analysis), which was predicted to inflate the effect size.
- To exclude studies performed in the developing world. These studies could have provided additional information, however, their interventions and results would be likely to have lower applicability to the UK setting than studies performed in the developed world.
- To select an individual outcome from each study for extraction rather than generating an average effect size across all relevant outcomes. The individual outcome selected may not be representative of the effects across all outcomes in the study. The outcome hierarchy was determined in advance, based on judgements about the importance of the individual outcomes, without reference to study results, which should reduce the likelihood of biased selection of outcomes.
- Not to contact study authors for additional information about the interventions. Additional published sources of information (webpages or journal articles) about the interventions were sought when these were referenced in the original papers.
- To double code only a subset (10%) of the interventions. This sample suggested that the level of agreement was high, but full double coding and generation of consensus across studies may be a more robust approach.
- To include only BCTs, BCT clusters, intervention functions, and theory use in the meta-regression. These variables were a main focus of the questions being covered in this behaviour change guidance. The BCTs and BCT clusters in particular are difficult to assess in other ways, as many different combinations of BCTs are used in the interventions. Other variables relating to e.g. delivery setting, treatment fidelity could have been included

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in the model, but this would have complicated the analyses and their interpretation.

Other limitations include that the analyses in this review use standardised mean differences calculated from study data for the outcome selected from the study as being the highest ranking on the outcome hierarchy. This approach was used to maximise data entered into the meta-analysis and meta-regression, rather than focusing on a single outcome for each behaviour area (e.g. sustained smoking abstinence at 3 months). Because varying outcome measures were included, this introduces heterogeneity into the analyses. Populations, interventions and comparators also varied and this also introduces heterogeneity into the analyses.

Across all behaviour areas we focused on behavioural outcomes rather than clinical outcomes, as this guidance is specifically relating to methods effective for behaviour change. Although a long term improvement in clinical outcomes is what is desired, fewer studies will have looked at these outcomes than at the underlying behaviours, and focusing on these outcomes only would reduce the amount of data available for meta-regression.

Acknowledgements
This work was produced by Bazian Ltd in collaboration with Dr Benjamin Gardner from the Department of Epidemiology and Public Health, University College London, and Dr Craig Whittington, Department of Clinical, Educational & Health Psychology, University College London.

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7 Appendix A: Scope of review

Interventions that will be covered	Individual-level interventions aimed at behaviour change in five areas: • Alcohol • Smoking • Diet • Physical activity • Sexual health An individual-level intervention is defined as one where someone is selected for the intervention on the basis of an existing health status or behaviour (e.g. high alcohol consumption; smoking; overweight or obesity; risky sexual behaviour) This includes health promotion and disease prevention interventions aimed at changing an individual's health-related behaviour in the five areas specified. These interventions must include enough detail for the specific behaviour-change techniques used to be identified. Interventions may be delivered by humans or automatic systems.
Interventions that will not be covered	Community- and population-level interventions Interventions that bring about change via social processes or changes to the environment Screening programmes Interventions targeting behaviours not related to the five areas of interest (alcohol, smoking, diet, physical activity, sexual health) Clinical or pharmacological methods of achieving behaviour change with no public health or health promotion element Psychiatric interventions delivered as part of the

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	therapeutic process for people with a mental health problem. Interventions with only a clinical or pharmacological focus (e.g. diet for diabetes care or coeliac disease.) i.e. that aim to treat a condition rather than change behaviour Interventions aimed at the treatment of substance use disorders (except smoking and alcohol)
Populations (groups) that will be covered	Adults aged 16 and over with an existing health status or behaviour that implies the need for behaviour change relating to one of the five areas described above.
Populations (groups) that will not be covered	Children and young people aged <16 years Families
Comparators that will be covered	No intervention Waiting list Usual/standard care
Outcomes that will be covered	Behaviour changes in: • Alcohol use • Smoking behaviour • Diet • Physical activity • Sexual practices • Duration of behaviour changes Behavioural outcome associated with the behaviour intervention focuses on (i.e. change in smoking, alcohol, diet, physical activity, sexual practice) reported as described within the study.

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Outcomes that will not be covered	Clinical outcomes (e.g. liver disease, lung cancer) Other non-behavioural outcomes (e.g. knowledge)
Study types that will be covered	Systematic reviews and RCTs
Study types that will not be covered	Uncontrolled studies Economic analyses Non English language studies

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8 Appendix B: Search strategies

MEDLINE

1 food habits/

2 food preferences/

3 nutrition therapy/

4 diet*.ti.

5 ((health* or unhealthy or poor* or chang* or behav* or advic* or recommend*) adj3 (eat* or diet* or food* or nutrition)).ab,ti.

6 ((fruit* or vegetable*) adj2 (intake* or consum* or eat* or ate)).ab,ti.

7 or/1-6

8 smoking/

9 smoking cessation/

10 "tobacco use cessation"/

11 "tobacco use disorder"/

12 (smok* or tobacco or cigar* or nicotine).ti.

13 or/8-12

14 exp alcohol-related disorders/pc

15 alcohol drinking/

16 (alcohol* adj3 (consum* or misuse or abuse or intoxication or harmful or excess* or binge or hazardous or heavy or temperance or abstinence)).ti.

17 or/14-16

18 exp exercise/

19 exercise movement techniques/

20 exp sports/

21 exp exercise therapy/

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22 ((physical* or keep* or cardio* or aerobic or fitness) adj3 (fit* or activit* or train*)).ti.

23 (sedentary or exercis*).ti.

24 or/18-23

25 safe sex/

26 (contracep* or condom*).ti.

27 exp sexually transmitted diseases/pc

28 ((sex* or intercourse) adj3 (risk* or protected or unprotected or safe* or unsafe or behavi*)).ti.

29 (std* or sti or "sexually transmitted disease*" or "sexually transmitted infection*").ti.

30 pregnancy in adolescence/

31 (pregnan* adj5 (teen* or adolescen* or pupil* or underage or youth or young or student or college* or school* or universit* or unwanted or unintended or unplanned)).ti.

32 or/25-31

33 7 or 13 or 17 or 24 or 32

34 interview, psychological/

35 directive counseling/

36 counseling/

37 motivation/

38 health behavior/

39 health knowledge, attitudes, practice/

40 ((behavio?r* or lifestyle or "life style" or brief) and (change* or changing or modification* or modify or modifying or therapy or therapies or program* or intervention*)).ti.

41 ((behavio?r* or lifestyle or "life style" or brief) adj2 (change* or changing or modification* or modify or modifying or therapy or therapies or program* or intervention* or counsel*)).ab.

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42 (counsel* or motiva*).ti.

43 or/34-42

44 33 and 43

45 ((change* or changing or modification* or modify or modifying) adj2 (behavio?r* or lifestyle or "life style") adj2 (intervention* or therapy or therapies or program*)).ti,ab.

46 ("physical activity" or "healthy eating" or fruit* or vegetable* or exercis* or fitness or condom* or contracept* or alcohol or (smok* adj5 (stop* or cessation)) or (sex and (risk* or unsafe or safe))).ti,ab.

47 44 or (45 and 46)

48 exp review/

49 (scisearch or psychinfo or psycinfo or medlars or embase or psychlit or psyclit or cinahl or pubmed or medline).ti,ab,sh.

50 ((hand adj2 search*) or (manual* adj2 search*)).ti,ab,sh.

51 ((electronic or bibliographic or computeri?ed or online) adj4 database*).ti,ab.

52 (pooling or pooled or mantel haenszel).ti,ab,sh.

53 (peto or dersimonian or der simonian or fixed effect).ti,ab,sh.

54 or/49-53

55 48 and 54

56 meta analysis/

57 (meta-analys* or meta analys* or metaanalys*).ti,sh.

58 ((systematic* or quantitativ* or methodologic*) adj5 (review* or overview* or synthesis*)).ti,sh.

59 or/56-58

60 55 or 59

61 (randomized controlled trial or controlled clinical trial).pt.

62 ((control* or clinical*) adj2 (trial* or study or studies)).ti.

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63 random*.ab.

64 or/61-63

65 (animal* not human*).sh.

66 64 not 65

67 47 and 60

68 47 and 66

69 limit 67 to (english language and yr="2003 -current")

70 limit 68 to (english language and yr="2003 -current")

71 69 or 70

72 (comment or editorial or letter or news).pt.

73 71 not 72

EMBASE

1 food preference/

2 diet therapy/

3 diet*.ti.

4 ((health* or unhealthy or poor* or chang* or behav* or advic* or recommend*) adj3 (eat* or diet* or food* or nutrition)).ab,ti.

5 ((fruit* or vegetable*) adj2 (intake* or consum* or eat* or ate)).ab,ti.

6 or/1-5

7 smoking/

8 smoking cessation/

9 (smok* or tobacco or cigar* or nicotine).ti.

10 or/7-9

11 exp drinking behavior/

Company Registered in England and Wales No: 3724527. VAT Registration No. 752 5287 20.

12 (alcohol* adj3 (consum* or misuse or abuse or intoxication or harmful or excess* or binge or hazardous or heavy or temperance or abstinence)).ti.

13 or/11-12

14 exp exercise/

15 exp kinesiotherapy/

16 exp sport/

17 ((physical* or keep* or cardio* or aerobic or fitness) adj3 (fit* or activit* or train*)).ti.

18 (sedentary or exercis*).ti.

19 or/14-18

20 safe sex/

21 (contracep* or condom*).ti.

22 exp sexually transmitted diseases/pc

23 ((sex* or intercourse) adj3 (risk* or protected or unprotected or safe* or unsafe or behavi*)).ti.

24 (std* or sti or "sexually transmitted disease*" or "sexually transmitted infection*").ti.

25 pregnancy in adolescence/

26 (pregnan* adj5 (teen* or adolescen* or pupil* or underage or youth or young or student or college* or school* or universit* or unwanted or unintended or unplanned)).ti.

27 or/20-26

28 6 or 10 or 13 or 19 or 27

29 counseling/

30 motivation/

31 health behavior/

32 attitude to health/

Company Registered in England and Wales No: 3724527. VAT Registration No. 752 5287 20.

33 ((behavio?r* or lifestyle or "life style" or brief) and (change* or changing or modification* or modify or modifying or therapy or therapies or program* or intervention*)).ti.

34 ((behavio?r* or lifestyle or "life style" or brief) adj2 (change* or changing or modification* or modify or modifying or therapy or therapies or program* or intervention* or counsel*)).ab.

35 (counsel* or motiva*).ti.

36 or/29-35

37 28 and 36

38 ((change* or changing or modification* or modify or modifying) adj2 (behavio?r* or lifestyle or "life style") adj2 (intervention* or therapy or therapies or program*)).ti,ab.

39 ("physical activity" or "healthy eating" or fruit* or vegetable* or exercis* or fitness or condom* or contracept* or alcohol or (smok* adj5 (stop* or cessation)) or (sex and (risk* or unsafe or safe))).ti,ab.

40 37 or (38 and 39)

41 exp review/

42 (scisearch or psychinfo or psycinfo or medlars or embase or psychlit or psyclit or cinahl or pubmed or medline).ti,ab,sh.

43 ((hand adj2 search*) or (manual* adj2 search*)).ti,ab,sh.

44 ((electronic or bibliographic or computeri?ed or online) adj4 database*).ti,ab.

45 (pooling or pooled or mantel haenszel).ti,ab,sh.

46 (peto or dersimonian or der simonian or fixed effect).ti,ab,sh.

47 or/42-46

48 41 and 47

49 meta analysis/

50 (meta-analys* or meta analys* or metaanalys*).ti,sh.

51 ((systematic* or quantitativ* or methodologic*) adj5 (review* or overview* or synthesis*)).ti,sh.

Company Registered in England and Wales No: 3724527. VAT Registration No. 752 5287 20.

52 or/49-51

53 48 or 52

54 randomized controlled trial/

55 ((control* or clinical*) adj2 (trial* or study or studies)).ti.

56 random*.ab.

57 or/54-56

58 (animal* not human*).sh.

59 57 not 58

60 40 and 53

61 40 and 59

62 limit 60 to (english language and yr="2003 -current")

63 limit 61 to (english language and yr="2003 -current")

64 62 or 63

65 (comment or editorial or letter or news).pt.

66 64 not 65

CINAHL

S58 S56 or S57

S57 S46 and S55

S56 S46 and S51

S55 S52 or S53 or S54

S54 AB random*

S53 TI ((control* or clinical*) N2 (trial* or study or studies))

S52 (MH "Randomized Controlled Trials")

S51 S47 or S48 or S49 or S50

Company Registered in England and Wales No: 3724527. VAT Registration No. 752 5287 20.

S50 TI (meta-analys* or meta analys* or metaanalys*)

S49 TI ((systematic* or quantitativ* or methodologic*) N5 (review* or overview* or synthesis*))

S48 (MH "Meta Analysis")

S47 (MH "Systematic Review")

S46 S41 or ((S42 or S43) and (S44 or S45))

S45 AB ("physical activity" or "healthy eating" or fruit* or vegetable* or exercis* or fitness or condom* or contracept* or alcohol or (smok* N5 (stop* or cessation)) or (sex and (risk* or unsafe or safe)))

S44 TI ("physical activity" or "healthy eating" or fruit* or vegetable* or exercis* or fitness or condom* or contracept* or alcohol or (smok* N5 (stop* or cessation)) or (sex and (risk* or unsafe or safe)))

S43 AB ((change* or changing or modification* or modify or modifying) N2 (behavio?r* or lifestyle or "life style") N2 (intervention* or therapy or therapies or program*))

S42 TI ((change* or changing or modification* or modify or modifying) N2 (behavio?r* or lifestyle or "life style") N2 (intervention* or therapy or therapies or program*))

S41 S32 and S40

S40 S33 or S34 or S35 or S36 or S37 or S38 or S39

S39 TI (counsel* or motiva*)

S38 ((behavio?r* or lifestyle or "life style" or brief) N2 (change* or changing or modification* or modify or modifying or therapy or therapies or program* or intervention* or counsel*))

S37 TI ((behavio?r* or lifestyle or "life style" or brief) and (change* or changing or modification* or modify or modifying or therapy or therapies or program* or intervention*))

S36 (MH "Attitude to Health")

S35 (MH "Health Behavior")

S34 (MH "Motivation")

S33 (MH "Counseling")

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S32 S9 or S13 or S17 or S23 or S31

S31 S24 or S25 or S26 or S27 or S28 or S29 or S30

S30 TI (pregnan* N5 (teen* or adolescen* or pupil* or underage or youth or young or student or college* or school* or universit* or unwanted or unintended or unplanned))

S29 (MH "Pregnancy in Adolescence")

S28 TI (STD* or STI or "sexually transmitted disease*" or "sexually transmitted infection*")

S27 TI ((sex* or intercourse) N3 (risk* or protected or unprotected or safe* or unsafe or behavi*))

S26 (MH "Sexually Transmitted Diseases+/PC")

S25 TI (contracep* or condom*)

S24 (MH "Safe Sex")

S23 S18 or S19 or S20 or S21 or S22

S22 TI (sedentary or exercis*)

S21 TI ((physical* or keep* or cardio* or aerobic or fitness) N3 (fit* or activit* or train*))

S20 (MH "Sports+")

S19 (MH "Therapeutic Exercise+")

S18 (MH "Exercise+")

S17 S14 or S15 or S16

S16 TI (Alcohol* N3 (consum* or misuse or abuse or intoxication or harmful or excess* or binge or hazardous or heavy or temperance or abstinence))

S15 (MH "Alcohol Drinking")

S14 (MH "Alcohol-Related Disorders+/PC")

S13 S10 or S11 or S12

S12 TI (smok* or tobacco or cigar* or nicotine)

Company Registered in England and Wales No: 3724527. VAT Registration No. 752 5287 20.

S11 (MH "Smoking Cessation")

S10 (MH "Smoking")

S9 S1 or S2 or S3 or S4 or S5 or S6 or S7 or S8

S8 AB ((fruit* or vegetable*) N2 (intake* or consum* or eat* or ate))

S7 TI ((fruit* or vegetable*) N2 (intake* or consum* or eat* or ate))

S6 AB ((health* or unhealthy or poor* or chang* or behav* or advic* or recommend*) N3 (eat* or diet* or food* or nutrition))

S5 TI ((health* or unhealthy or poor* or chang* or behav* or advic* or recommend*) N3 (eat* or diet* or food* or nutrition))

S4 TI diet*

S3 (MH "Diet Therapy")

S2 (MH "Food Preferences")

S1 (MH "Food Habits")

PsycINFO

1 food preferences/

2 eating behavior/

3 *diets/

4 ((health* or unhealthy or poor* or chang* or behav* or advic* or recommend*) adj3 (eat* or diet* or food* or nutrition)).ab,ti.

5 ((fruit* or vegetable*) adj2 (intake* or consum* or eat* or ate)).ab,ti.

6 or/1-5

7 *obesity/

8 exp *prevention/

9 7 and 8

10 6 or 9

11 tobacco smoking/

Company Registered in England and Wales No: 3724527. VAT Registration No. 752 5287 20.

12 smoking cessation/

13 (smok* or tobacco or cigar* or nicotine).ti.

14 or/11-13

15 drinking behavior/

16 *alcohol drinking patterns/

17 (alcohol* adj3 (consum* or misuse or abuse or intoxication or harmful or excess* or binge or hazardous or heavy or temperance or abstinence)).ti.

18 or/15-17

19 exp *physical activity/

20 exp sports/

21 ((physical* or keep* or cardio* or aerobic or fitness) adj3 (fit* or activit* or train*)).ti.

22 (sedentary or exercis*).ti.

23 or/19-22

24 safe sex/

25 *sexual risk taking/

26 (contracep* or condom*).ti.

27 sexually transmitted diseases/

28 ((sex* or intercourse) adj3 (risk* or protected or unprotected or safe* or unsafe or behavi*)).ti.

29 (std* or sti or "sexually transmitted disease*" or "sexually transmitted infection*").ti.

30 (pregnan* adj5 (teen* or adolescen* or pupil* or underage or youth or young or student or college* or school* or universit* or unwanted or unintended or unplanned)).ti.

31 or/24-30

32 10 or 14 or 18 or 23 or 31

33 behavior change/

Company Registered in England and Wales No: 3724527. VAT Registration No. 752 5287 20.

34 change strategies/

35 lifestyle changes/

36 *health behavior/

37 counseling/

38 motivation/

39 ((behavio?r* or lifestyle or "life style" or brief) and (change* or changing or modification* or modify or modifying or therapy or therapies or program* or intervention*)).ti.

40 ((behavio?r* or lifestyle or "life style" or brief) adj2 (change* or changing or modification* or modify or modifying or therapy or therapies or program* or intervention* or counsel*)).ab.

41 (counsel* or motiva*).ti.

42 or/33-41

43 32 and 42

44 ((change* or changing or modification* or modify or modifying) adj2 (behavio?r* or lifestyle or "life style") adj2 (intervention* or therapy or therapies or program*)).ti,ab.

45 ("physical activity" or "healthy eating" or fruit* or vegetable* or exercis* or fitness or condom* or contracept* or alcohol or (smok* adj5 (stop* or cessation)) or (sex and (risk* or unsafe or safe))).ti,ab.

46 43 and (44 or 45)

47 meta analysis/

48 (((meta-analys$ or meta) and analys$) or metaanalys$).ti.

49 ((systematic$ or quantitativ$ or methodologic$) adj5 (review$ or overview$ or synthesis$)).ti.

50 47 or 48 or 49

51 ((control* or clinical*) adj2 (trial* or study or studies)).ti.

52 random*.ab.

53 51 or 52

Company Registered in England and Wales No: 3724527. VAT Registration No. 752 5287 20.

54 46 and 50

55 46 and 53

56 54 or 55

57 limit 56 to (english language and yr="2003 -current")

Cochrane CENTRAL, + Cochrane Database Syst Rev + DARE (via Cochrane library)

#1 (change* or changing or modification* or modify or modifying or therapy or therapies or program* or intervention*) and (behaviour* or behavior* or lifestyle or "life style" or brief):ti

#2 (counsel* or motiva*):ti

#3 MeSH descriptor counseling

#4 MeSH descriptor motivation

#5 MeSH descriptor health behavior

#6 MeSH descriptor health knowledge, attitudes, practice

#7 (#1 or #2 or #3 or #4 or #5 or #6)

#8 ("healthy eating" or fruit* or vegetable* or diet* or nutrition or smok* or tobacco or nicotine or alcohol* or drinking or "physical activity" or exercis* or fitness or sedentary or condom* or contracept* or sex*):ti,ab,kw

#9 (#7 and #8), from 2003 to 2012

HMIC (Health Management Information Consortium)

1 exp behavioural control/

2 health behaviour/

3 lifestyle/

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4 ((behavio?r* or lifestyle or "life style" or brief) and (change* or changing or modification* or modify or modifying or therapy or therapies or program* or intervention*)).ti.

5 ((behavio?r* or lifestyle or "life style" or brief) adj2 (change* or changing or modification* or modify or modifying or therapy or therapies or program* or intervention* or counsel*)).ab.

6 (counsel* or motiva*).ti.

7 or/1-6

8 systematic reviews/

9 meta analysis/

10 (((meta-analys* or meta) and analys*) or metaanalys*).ti.

11 ((systematic* or quantitativ* or methodologic*) adj5 (review* or overview* or synthesis*)).ti.

12 or/8-11

13 ((control* or clinical*) adj2 (trial* or study or studies)).ti.

14 random*.ab.

15 13 or 14

16 7 and 12

17 7 and 15

18 16 or 17

19 limit 18 to (yr="2003 -current" and english)

ERIC

Title: (change* or changing or modification* or modify or modifying or therapy or therapies or program* or intervention*) AND (behaviour* or behavior* or lifestyle or "life style" or brief)

AND

Company Registered in England and Wales No: 3724527. VAT Registration No. 752 5287 20.

Keywords: ("healthy eating" or fruit* or vegetable* or diet* or nutrition or smok* or tobacco or nicotine or alcohol* or drinking or "physical activity" or exercis* or fitness or sedentary or condom* or contracept* or sex*)

AND

Publication Type: ("Journal Articles")

AND

Publication Date: (2003-2012)

Social Policy & Practice

1 (change* or changing or modification* or modify or modifying or therapy or therapies or program* or intervention*) and (behaviour* or behavior* or lifestyle or "life style" or brief).ti,de.

2 (counsel* or motiva*).ti,de.

3 ("healthy eating" or fruit* or vegetable* or diet* or nutrition or smok* or tobacco or nicotine or alcohol* or drinking or "physical activity" or exercis* or fitness or sedentary or condom* or contracept* or sex*).ti,ab,de.

4 (1 or 2) and 3

5 ((systematic* or quantitativ* or methodologic*) adj5 (review* or overview* or synthesis*)).ti,ab,de.

6 (((meta-analys* or meta) and analys*) or metaanalys*).ti,ab,de.

7 ((control* or clinical*) adj2 (trial* or study or studies)).ti,de.

8 random*.ti,ab,de.

9 or/5-8

10 9 and 4

11 limit 10 to yr="2003 -Current"

Applied Social Sciences Index and Abstracts (ASSIA)

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S1 TI(((change* or changing or modification* or modify or modifying or therapy or therapies or program* or intervention*) and (behaviour* or behavior* or lifestyle or "life style" or brief)) or (counsel* or motiva*))

S2 SU(Eating behaviour OR Health behaviour OR Health compromising behaviour OR Planned behaviour OR Sexual behaviour)

S3 ALL(("healthy eating" or fruit* or vegetable* or diet* or nutrition or smok* or tobacco or nicotine or alcohol* or drinking or "physical activity" or exercis* or fitness or sedentary or condom* or contracept* or sex*))

S4 ALL((systematic* and review*) or meta-analysis or (meta and analy*) or random*)

S5 (S1 or S2) and S3 and S4

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9 Appendix C: Inclusion/exclusion criteria

Detailed inclusion/exclusion criteria are described in Tables A and B below. Recorded reasons for exclusion are summarised in Table C.

Table A: Additional comments on inclusion/exclusion criteria based on scope

Scope		Additional comments on inclusion/exclusion
Interventions that will be covered	Individual-level interventions aimed at behaviour change in five areas: • Alcohol • Smoking • Diet • Physical activity • Sexual health An individual-level intervention is defined as one where someone is selected for the intervention on the basis of an existing health status or behaviour (e.g. high alcohol consumption; smoking; overweight or obesity; risky sexual behaviour) This includes health promotion and disease prevention interventions aimed at changing an individual's health-related behaviour in the five areas specified. These interventions must include enough detail for the specific behaviour-change techniques used to be identified. Interventions may be delivered by humans or automatic systems.	If a trial selects individuals based on their health status only, this health status must imply the presence of a risk behaviour in one of the five areas, e.g. overweight suggests either lack of physical activity or unhealthy diet; unwanted pregnancy or STIs suggests risky sexual behaviour. Conversely, for example: • Pregnancy • Old/young age do not necessarily imply risky/unhealthy physical activity/diet/sexual health/alcohol/smoking behaviours. Also, for example: • Low income is not a health status or behaviour. Trials in these populations should select participants based on presence of a risk behaviour or related health status to be classed as an individual level intervention. Studies in unselected populations will be excluded (i.e. those in adults with no specified risk behaviours or related health status). Only having a family member with a related disease (e.g. cardiovascular disease) was not considered as having an "existing health status or behaviour"

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Interventions that will not be covered	Community- and population-level interventions Interventions that bring about change via social processes or changes to the environment Screening programmes Interventions targeting behaviours not related to the five areas of interest (alcohol, smoking, diet, physical activity, sexual health) Clinical or pharmacological methods of achieving behaviour change with no public health or health promotion element Psychiatric interventions delivered as part of the therapeutic process for people with a mental health problem. Interventions with only a clinical or pharmacological focus (e.g. diet for diabetes care or coeliac disease; rehabilitative physical activity etc.) i.e. that aim to treat a condition rather than change behaviour Interventions aimed at the treatment of substance use disorders (except smoking and alcohol)	Exclude interventions which are combinations of community/population and individual level interventions Exclude trials assessing the effectiveness of drug treatments which do not assess the effectiveness of any behaviour change component to the intervention (e.g. which give the same non-drug behaviour change interventions to both arms of the trial) Exclude psychiatric interventions aimed at diet-related mental health disorders such as binge eating disorder and anorexia nervosa, even if they assess diet related behavioural outcomes Exclude studies where behaviour change is not the aim of the intervention, (e.g. studies may include a diet/exercise intervention and assess compliance with this intervention, but focus on clinical outcomes e.g. pain, HbA1c, rather than sustained behaviour change)
Populations (groups) that will be covered	Adults aged 16 and over with an existing health status or behaviour that implies the need for behaviour change relating to one of the five areas described above.	Include studies which specifically target those aged 16 and over in schools/colleges
Populations (groups) that will not be covered	Children and young people aged <16 years Families	Exclude studies in school settings which do not state that they focus specifically on individuals aged 16-18
Comparators that will be covered	No intervention Waiting list Usual/standard care	The comparator should be explicitly stated as “no intervention”, “waiting list”, or “usual/standard care” for inclusion Standard versions of therapies were not considered as standard care unless explicitly stated Include the following minimal control groups:

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		• Assessment only • Advice only (not related to behaviour area(s) being targeted) • Information only (not related to behaviour area(s) being targeted) • Attention control (not related to behaviour area(s) being targeted) Information only may include provision e.g. of access to the internet without specifically pointing to resources related to the targeted behaviour. Comparators providing information on "general health" issues were also included
Outcomes that will be covered	Behaviour changes in: • Alcohol use • Smoking behaviour • Diet • Physical activity • Sexual practices • Duration of behaviour changes Behavioural outcome associated with the behaviour intervention focuses on (i.e. change in smoking, alcohol, diet, physical activity, sexual practice) reported as described within the study	See Table B below Changing these behaviours should be the aim of the intervention and they should be measured as an outcome
Outcomes that will not be covered	Clinical outcomes (e.g. liver disease, lung cancer) Other non-behavioural outcomes (e.g. knowledge)	See Table B below
Study types that will be covered	Systematic reviews and RCTs	
Study types that will not be covered	Uncontrolled studies Economic analyses	Excluded conference abstracts, quasi-randomised, quasi-experimental, feasibility, pilot and exploratory studies, dissertations

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	Non English language studies	

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Table B: Examples of populations and behavioural outcomes which would be included, and clinical outcomes which would be excluded

Areas covered	Examples of populations that would meet inclusion criteria*	Examples of behavioural outcomes that would be included	Examples of clinical outcomes (Exclude papers that ONLY include clinical outcomes and no behavioural outcomes)
Alcohol	Those who drink above a pre-specified levels Those who have been arrested for drink driving/have attended A&E for an alcohol related injury	Alcohol consumption behaviour, e.g. • Amount of alcohol consumed (self-report or by objective measure e.g. blood alcohol/breathalyser) • Drinking within recommended levels • Drinking on fewer days of the week • Getting drunk	Cirrhosis Liver cancer Death from alcohol related causes
Smoking	Smokers	Smoking behaviour, e.g. • Abstinence (may be measured by salivary cotinine) • Number of cigarettes smoked	Lung cancer Death from smoking related causes Lung function
Diet	Those not meeting healthy eating recommendations Overweight/obese people	Diet behaviours, e.g. • Amount of fruit and veg a day	Measures of macronutrient intake (e.g. proteins/fats/ carbohydrates)

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Areas covered	Examples of populations that would meet inclusion criteria*	Examples of behavioural outcomes that would be included	Examples of clinical outcomes (Exclude papers that ONLY include clinical outcomes and no behavioural outcomes)
	Those with cardiovascular risk factors (e.g. diabetes/pre-diabetes, high blood pressure/pre-hypertension, high cholesterol)	consumed • Red meat consumption • Addition of salt to food in cooking/at table • Consumption of processed foods • Consumption of fried foods	Calorie intake Vitamin/mineral intake Weight Cardiovascular outcomes
Physical activity	Those not meeting physical activity recommendations Overweight/obese people Those with cardiovascular risk factors (e.g. diabetes/pre-diabetes, high blood pressure/pre-hypertension, high cholesterol)	Physical activity behaviours, e.g. • Meeting recommended levels of activity • Frequency of physical activity • Amount of physical activity • METs	Fitness (e.g. strength, stamina, exercise tolerance) Weight Cardiovascular outcomes
Sexual health	Those with a previous STI Those with previous unintended pregnancy Those who have had unprotected sex	Sexual health behaviours, e.g. • Use of contraception e.g. condoms • Number of sexual partners	Pregnancy STIs

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Areas covered	Examples of populations that would meet inclusion criteria*	Examples of behavioural outcomes that would be included	Examples of clinical outcomes (Exclude papers that ONLY include clinical outcomes and no behavioural outcomes)
		• Abstinence	

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Table C: Recorded reasons for study exclusion

Reason for exclusion	Explanation	Additional comments
Wrong study design	Not a systematic review or RCT	This includes studies that do not provide enough information about their methods to classify them as RCTs or SRs Includes quasi-experimental or quasi-randomised controlled trials and conference abstracts
Wrong study design - feasibility study	RCTs described as feasibility, pilot or exploratory studies	
Wrong study size	For studies with less than 100 participants	Does not include feasibility, pilot or exploratory studies (these fall into the category above)
Not developed world setting	Not conducted in the UK, USA, Canada, Europe, Australia or New Zealand	
Wrong level of intervention	Not an individual level behaviour change intervention	This includes studies which are community or population level, including those that do not select participants based on their behaviour or health status
Wrong type of intervention	Not a behaviour change intervention	This includes: studies not targeting behaviour change, e.g. those targeting a clinical/health outcome studies assessing the effects of drugs, or therapies such as acupuncture, acupressure, yoga

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Reason for exclusion	Explanation	Additional comments
		studies aimed at treating a psychiatric condition (e.g. anorexia nervosa, bulimia)
Wrong population	Not in adults aged 16 and over	This does not include non-individual level intervention studies
Wrong population - alcohol dependence	Participants recruited based on alcohol dependence or alcoholism diagnosis	Does not need to be described in the abstract as DSM diagnosis, just described as participants with alcohol dependence or alcoholism
Wrong comparator	Studies comparing two different behaviour change interventions and no "No intervention/Waiting list/usual/standard care" or information only or attention control are included if content is clearly stated to be unrelated to target behaviour	Includes • studies with a behavioural intervention comparator (including different doses of interventions, and standard intervention format compared to enhanced intervention) • information/advice only where the information/advice is directly related to target behaviour(s)– if more than one behaviour area is targeted (e.g. alcohol and sexual health or diet ad physical activity), then if information/advice targets either of these areas the study was excluded
Wrong outcome	Studies not reporting on the behavioural outcome targeted by the intervention	This includes: studies which describe a behavioural outcome which is not the target of the intervention

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Reason for exclusion	Explanation	Additional comments
		studies reporting non-behavioural outcomes only studies not reporting any outcomes (e.g. RCT rationale and methods descriptions only)
Wrong question	Study does not assess the efficacy of a behaviour change intervention in the areas of diet, physical activity, smoking, alcohol, or sexual health	Includes studies that do not match any of the other reasons for exclusion, but are non-relevant. E.g.: studies not addressing the five target behaviour areas analyses using data from an RCT, but that are not comparing the groups as randomised (e.g. only looking at predictors of response in one group or in both groups combined)

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10 Appendix D: Coding frames

Behaviour change techniques (BCTs)

BCT coding was based on an 89-item BCT taxonomy 'BCT taxonomy v1.0 (May 2012)' (Michie et al. 2011a)(Michie et al. 2012). This taxonomy contains explicit definitions of individual BCTs, which are defined as “replicable components of an intervention designed to alter or redirect causal processes that regulate behaviour; that is, a technique is proposed to be an ‘active ingredient”.(Michie et al. 2011a) Each technique is classified into one of 16 theoretical clusters (e.g. BCT Cluster 1 “Social Support”). The clusters are listed below, followed by the individual BCTs.

Code	Cluster Name	Definition	Number of BCTs in this cluster
BCT-C 1	Social support	Care, assistance, help or support provided by others for performance of the behaviour.	3
BCT-C 2	Regulation	Controlling one’s emotions, thoughts or impulses.	4
BCT-C 3	Feedback and monitoring	Recording behaviour or its outcomes, and/or providing feedback on behaviour or its outcomes.	7
BCT-C 4	Associations	Making new associations between behaviour and cues or rewards, or managing existing associations.	8

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Code	Cluster Name	Definition	Number of BCTs in this cluster
BCT-C 5	Repetition and substitution	Practising, rehearsing or repeating a behaviour, or directly replacing a new wanted behaviour for an existing unwanted behaviour	7
BCT-C 6	Antecedents	Managing the social and environmental situations and events, emotions, or thoughts that elicit an existing unwanted behaviour, or have the potential to elicit a new wanted behaviour.	6
BCT-C 7	Shaping knowledge	Providing information, instructions, or explanations around the behaviour.	4
BCT-C 8	Self-belief	Fostering confidence in one's ability to perform the behaviour.	4
BCT-C 9	Scheduled consequences	Emphasising or changing rewards or punishments arising from the behaviour.	10
BCT-C 10	Reward and threat	Rewarding or punishing new or old behaviours.	7
BCT-C 11	Goals and planning	Managing behaviour or outcome goals, and/or how behaviour or outcomes will be achieved	9
BCT-C 12	Comparison of outcomes	Considering relative pros and cons of outcomes of various behaviours	3
BCT-C 13	Identity	Managing how one sees, thinks or feels about oneself or the behaviour.	5

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Code	Cluster Name	Definition	Number of BCTs in this cluster
BCT-C 14	Natural consequences	Providing information about the naturally-occurring consequences of the behaviour	6
BCT-C 15	Comparison of behaviour	Comparing own behaviour to an ideal performance or to others' beliefs or behaviour	3
BCT-C 16	Covert learning	Imagining consequences of behaviour, or observing consequences of the behaviour for others.	3

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The 89 Item BCT taxonomy

In coding BCTs a conservative approach was taken. The coding guidance stated "never infer the presence of a BCT. The description must correspond to the definition of the BCT given in the taxonomy" (Michie et al. 2012).

No.	Label	Definition	Examples	Notes	Also code	*Linked intervention functions*
Social support ***Care, assistance, help or support provided by others for performance of the behaviour.***						
1	***Social support (practical)***	Advise on, arrange, or provide social support in the form of practical help for performance of the behaviour	*Ask the partner of the patient to put their tablet on the breakfast tray so that the patient remembers to take it*	*If support is emotional, code **2 (Social support (emotional))*** *If support is general or unspecified, code **3 (Social support (unspecified))***		IF9
2	***Social support (emotional)***	Advise on, arrange, or provide emotional social support for performance of the behaviour.	*Ask the patient to take a partner or friend with them to their colonoscopy appointment*	*If support is practical, code **1, Social support (practical).*** *If support is general or unspecified, code **3, (Social support (unspecified))***		IF9
3	***Social support (unspecified)***	Advise on, arrange or provide social support *(e.g. friends, relatives, colleagues,' buddies')* or non-contingent praise or reward for performance of the behaviour. It	*Advise the person to call a 'buddy' when they experience an urge to smoke* *Arrange for a housemate to*	*Attending a group class does not necessarily imply this BCT – support must be explicitly mentioned.*		IF9

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No.	Label	Definition	Examples	Notes	Also code	*Linked intervention functions*
		includes encouragement and counselling, but only when it is directed at the **behaviour**	*encourage continuation with the behaviour change programme* *Give information about a self-help group that offers support for the behaviour*	*If support is practical, code **1, Social support (practical).*** *If support is emotional, code **2, Social support (emotional)***		
Regulation ***Controlling one's emotions, thoughts or impulses.***						
4	***Pharmacological support***	Provide, or encourage the use of or adherence to, drugs to facilitate behaviour change	*Suggest the patient asks the family physician for nicotine replacement therapy to facilitate smoking cessation*			IF9
5	***Reduce negative emotions*** (includes '**stress management'**)	Advise on ways of reducing negative emotions to facilitate performance of the behaviour	*Advise on the use of stress management skills, e.g. to reduce anxiety about joining Alcoholics Anonymous*			IF9
6	***Conserving mental resources***	Advise on ways of minimising demands on mental resources to facilitate behaviour change	*Advise smokers on how to minimise work-related stress during the first weeks of quitting*			IF9
7	***Paradoxical instructions***	Advise to engage in some form of the unwanted behaviour with the aim of reducing motivation to engage in that behaviour	*Advise a smoker to smoke twice as many cigarettes a day as they usually do* *Tell the person to stay awake as long as possible in order to reduce insomnia*			IF3
Feedback and monitoring						

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No.	Label	Definition	Examples	Notes	Also code	*Linked intervention functions*
Recording behaviour or its outcomes, and/or providing feedback on behaviour or its outcomes.						
8	***Feedback on behaviour***	Monitor and provide feedback on performance of the behaviour itself *(e.g. form, frequency, duration, intensity)* , NOT the outcome of the behaviour.	*Inform the person of how many steps they walked each day (as recorded on a pedometer) or how many calories they ate each day (based on a food consumption questionnaire)*	*If feedback is on OUTCOME(S) of behaviour, code* ***9, Feedback on outcome(s) of behaviour.*** ***If unclear*** *whether feedback is on behaviour or OUTCOME(S) of behaviour,* ***code 9, Feedback on outcome(s) of behaviour.*** *If there is no clear evidence that feedback was given, code* ***12, Monitoring of behaviour by others without feedback.*** *If Biofeedback, code only* ***14 Biofeedback*** *and* *not* ***8, Feedback on behaviour****.*		IF1 IF2 IF3 IF4 IF5
9	***Feedback on outcome(s) of behaviour***	Monitor and provide feedback on the outcome of performance of the behaviour.	*Inform the person of how much weight they have lost following the implementation*	*If feedback is on BEHAVIOUR itself, code* ***8, Feedback on***		IF1 IF2 IF3

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No.	Label	Definition	Examples	Notes	Also code	*Linked intervention functions*
			of a new exercise regime	***behaviour**.* ***If unclear** whether feedback is on behaviour or OUTCOME(S) of behaviour, **code 9, Feedback on outcome(s) of behaviour.*** *If there is no clear evidence that feedback was given code **13, Monitoring outcome(s) of behaviour by others without feedback.*** *If Biofeedback, code only **14, Biofeedback** and <u>not</u> **9, Feedback on outcome(s) of behaviour***		IF4 IF5
10	***Self-monitoring of behaviour***	Establish a method for the person to monitor and record their behaviour(s) <u>as part of a behaviour change strategy.</u>	*Ask the person to record daily, in a diary, whether they have brushed their teeth for at least two minutes before going to bed* *Give patient a pedometer and a form for recording daily total*	*If monitoring is only part of a data collection procedure rather than a strategy aimed at changing behaviour, do not code.* *If monitoring is of*		IF1 IF3 IF4 IF5 IF9

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No.	Label	Definition	Examples	Notes	Also code	*Linked intervention functions*
			number of steps	*OUTCOME of behaviour, code **11, Self-monitoring of outcome(s) of behaviour.*** ***If unclear** whether monitoring is of behaviour or OUTCOME(S) of behaviour, **code 11, Self-monitoring of outcome(s) of behaviour.*** *If monitoring is by someone else (without feedback), code **12, Monitoring of behaviour by others without feedback**.*		
11	***Self-monitoring of outcome(s) of behaviour***	Establish a method for the person to monitor and record the **outcome(s)** of their behaviour <u>as part of a behaviour change strategy</u>	*Ask the person to weigh themselves at the end of each day, over a two week period, and record their daily weight on a graph to increase exercise behaviours*	*If monitoring is only part of a data collection procedure rather than a strategy aimed at changing behaviour, do not code.* *If monitoring is of behaviour itself, code **10, Self-monitoring of behaviour.***		IF1 IF3 IF4 IF5 IF9

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No.	Label	Definition	Examples	Notes	Also code	*Linked intervention functions*
				If unclear *whether monitoring is of behaviour or OUTCOME(S) of behaviour,* ***code 11, Self-monitoring of outcome(s) of behaviour.*** *If monitoring is by someone else (without feedback), code* ***13, Monitoring outcome(s) of behaviour by others without feedback.***		
12	***Monitoring of behaviour by others without feedback***	Observe or record behaviour with the person's knowledge <u>as part of a behaviour change strategy</u>	Watch hand washing behaviours among health care staff and make notes on context, frequency and technique used	*If monitoring is part of a data collection procedure rather than a strategy aimed at changing behaviour, do not code* *If feedback is given, code only* ***8, Feedback on behaviour****, and <u>not</u>* ***12, Monitoring of behaviour by others without feedback****.* *If monitoring is of OUTCOME(S), code* ***13,***		IF3 IF4

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No.	Label	Definition	Examples	Notes	Also code	*Linked intervention functions*
				Monitoring outcome(s) of behaviour by others without feedback. *If* ***unclear*** *whether monitoring is of behaviour or OUTCOME(S), code* ***13, Monitoring outcome(s) of behaviour by others without feedback***. *If SELF-monitoring behaviour, code* ***10, Self-monitoring of behaviour***		
13	***Monitoring outcome(s) of behaviour by others without feedback***	Observe or record outcomes of behaviour with the person's knowledge as part of a behaviour change strategy.	*Record blood pressure, blood glucose, weight loss, or physical fitness*	*If monitoring is only part of a data collection procedure rather than a strategy aimed at changing behaviour, do not code.* *If feedback is given, code only* ***9, Feedback on outcome(s) of behaviour*** *If monitoring is of BEHAVIOUR code* ***12, Monitoring of behaviour***		IF3 IF4

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No.	Label	Definition	Examples	Notes	Also code	*Linked intervention functions*
				by others without feedback. *If* ***unclear*** *whether monitoring is of behaviour or OUTCOME(S), code* ***13, Monitoring outcome(s) of behaviour by others without feedback***. *If SELF-monitoring outcome(s), code* ***11, Self-monitoring of outcome(s) of behaviour***		
14	***Biofeedback***	Provide feedback about the body (e.g. physiological or biochemical state) using an external monitoring device as part of a behaviour change strategy	*Inform the person of their blood pressure reading to improve adoption of health behaviours*	*If Biofeedback ONLY, code only* ***14, Biofeedback*** *and not* ***8, Feedback on behaviour*** *or* ***9, Feedback on outcome(s) of behaviour***		IF1 IF2 IF3 IF4
Associations ***Making new associations between behaviour and cues or rewards, or managing existing such associations.***						
15	***Prompts/cues***	Introduce or define an environmental or social stimulus* with the purpose of prompting or cueing the behaviour. The prompt or cue would normally occur at the time or place of	*Put a sticker on the bathroom mirror to remind people to brush their teeth*	*When a stimulus* is linked to a specific action in an 'if-then' plan*, code only* ***64, Action planning****, and not* ***15,***		IF1 IF3 IF7

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No.	Label	Definition	Examples	Notes	Also code	*Linked intervention functions*
		performance.		***Prompts/cues.***		
16	***Reduce prompts/cues*** (includes '**fading'**)	Gradually withdraw prompts to perform the behaviour	*Reduce gradually the number of reminders used to take medication*			IF7
17	***Cue signalling reward*** (includes '**discriminative cue'**)	Identify an environmental stimulus* that reliably predicts that reward will follow the behaviour	*Advise that a fee will be paid to dentists for a particular dental treatment of 6-8 year old children to encourage delivery of that treatment (the 6-8 year old children are the environmental stimulus*)*			IF1 IF3 IF7
18	***Remove access to the reward*** (includes '**time out'**)	In order to reduce the behaviour, advise or arrange for the person to be separated from situations in which unwanted behaviour can be rewarded	*Arrange for cupboard containing high calorie snacks to be locked for a specified period to reduce the consumption of sugary foods in between meals*			IF4 IF7
19	***Remove aversive stimulus**** (includes ***'Escape learning'***)	Advise or arrange for the removal of an aversive stimulus* to facilitate behaviour change	*Arrange for a gym-buddy to stop nagging the person to do more exercise in order to increase the desired exercise behaviour*			IF3 IF7
20	***Satiation***	Advise or arrange repeated exposure to a stimulus* that reduces or extinguishes a drive for the unwanted behaviour	*Arrange for the person to eat large quantities of chocolate, in order to reduce the person's appetite for sweet foods*			IF1 IF7
21	***Exposure***	Provide systematic confrontation with a feared stimulus* to reduce the response to a later encounter	*Agree a schedule by which the person will e.g. make a telephone call to their boss,*			IF7

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No.	Label	Definition	Examples	Notes	Also code	*Linked intervention functions*
			spend an evening without snacking			
22	***Associative learning*** (includes '**Classical conditioning', 'Pavlovian conditioning'**)	Present a neutral stimulus* jointly with a stimulus* that already elicits the behaviour repeatedly until the neutral stimulus* elicits that behaviour	*Repeatedly present fatty foods with a disliked flavoured sauce to discourage the consumption of fatty foods*	*When a BCT involves reward or punishment, do not code **22, Associative learning***		IF7
Repetition and substitution ***Practising, rehearsing or repeating a behaviour, or directly replacing a new wanted behaviour for an existing unwanted behaviour***						
23	***Behavioural practice/ rehearsal***	Prompt practice or rehearsal of the performance of the behaviour one or more times in a context or at a time when the performance may not be necessary, in order to increase habit and skill	*Prompt asthma patients to measure their peak flow regularly*	*If aiming to associate performance with the context, also code **24, Habit formation***	**24**? (see notes)	IF5
24	***Habit formation***	Prompt rehearsal and repetition of the behaviour in the same context repeatedly so that the context elicits the behaviour	*Prompt patients to always take their statin tablet before brushing their teeth in the evening*		**23**	IF5
25	***Behaviour substitution***	Prompt substitution of the unwanted behaviour with a wanted or neutral behaviour	*Suggest that the person carries a piece of fruit to eat instead of biscuits or cake if they are offered them*	*If substitution occurs regularly, also code **26, Habit reversal***	**26**? (see notes)	IF9
26	***Habit reversal***	Prompt rehearsal and repetition of an alternative behaviour to **replace** an unwanted habitual behaviour	*Ask the person to walk up stairs every time they consider taking a lift or escalator*		**25**	IF5
27	***Overcorrection***	Ask to repeat the wanted behaviour	*Ask to eat only fruit and*			IF9

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No.	Label	Definition	Examples	Notes	Also code	*Linked intervention functions*
		in an exaggerated way following an unwanted behaviour	*vegetables the day after a poor diet*			
28	***Generalisation of a target behaviour***	Advise to perform the wanted behaviour already performed in a particular situation, in another situation	*Advise to repeat toning exercises learned in the gym when at home*			IF9
29	***Graded tasks***	Set easy-to-perform tasks, making them increasingly difficult, but achievable, until behaviour is performed	*Ask the person to walk for 100 yards a day for the first week, then half a mile a day after they have successfully achieved 100 yards, then two miles a day after they have successfully achieved one mile*			IF5 IF9
Antecedents* ***Managing the social and environmental situations and events, emotions, or thoughts that elicit an existing unwanted behaviour, or have the potential to elicit a new wanted behaviour.***						
30	***Restructuring the physical environment***	Change, or advise to change the physical environment in order to facilitate performance of the wanted behaviour or create barriers to the unwanted behaviour (other than prompts/cues, rewards and punishments)	*Advise to keep biscuits and snacks in a cupboard that is inconvenient to get to*	*This may also involve **32, Avoidance/reducing exposure to cues for the behaviour**.* *If restructuring of the SOCIAL environment code **31, Restructuring the social environment***	**32**? (see notes)	IF7 IF9
31	***Restructuring the social environment***	Change, or advise to change the social environment in order to facilitate performance of the wanted behaviour or create barriers to the	*Advise to minimise time spent with friends who drink heavily to reduce alcohol consumption*	*This may also involve **32, Avoidance/reducing exposure to cues for the behaviour**.*	**32**? (see notes)	IF7 IF9

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No.	Label	Definition	Examples	Notes	Also code	*Linked intervention functions*
		unwanted behaviour (other than prompts/cues, rewards and punishments)		*If restructuring of the PHYSICAL environment code **30, Restructuring the physical environment***		
32	***Avoidance/reducing exposure to cues for the behaviour***	Advise on how to avoid exposure to specific social and contextual/physical cues for the behaviour, including changing daily or weekly routines	*Suggest to a person who wants to quit smoking that their social life focus on activities other than pubs and bars which have been associated with smoking*	*This may also involve **30, Restructuring the physical environment*** and/or ***31, Restructuring the social environment***. *If the BCT includes analysing the behavioural problem, <u>only</u> code **61, Problem solving.***	**30**? **31**? (see notes)	IF9
33	***Distraction***	Advise or arrange to use an alternative focus for attention to avoid triggers for unwanted behaviour	*Suggest to a person who is trying to avoid between-meal snacking to focus on a topic they enjoy (e.g. holiday plans) instead of focusing on food when they are feeling hungry*			IF9
34	***Adding objects to the environment***	Add objects to the environment in order to facilitate performance of the behaviour	*Provide free condoms to facilitate safe sex* *Provide attractive toothbrush to improve tooth brushing technique*	*If this is accompanied by social support, also code **1, Social support (practical)**.* *If the environment is changed beyond the*	**1**? **30**? (see notes)	IF7 IF9

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No.	Label	Definition	Examples	Notes	Also code	*Linked intervention functions*
				*addition of objects, also code **30, Restructuring the physical environment***		
35	***Body changes***	Alter body structure, functioning or support **directly** to facilitate behaviour change	*Prompt strength training, relaxation training or provide assistive aids*			IF9
Shaping knowledge ***Providing information, instructions, or explanations around the behaviour.***						
36	***Instruction on how to perform a behaviour*** (includes '**Skills training**')	Advise or agree on how to perform the behaviour	*Advise the person how to put a condom on a model of a penis correctly*	*When the person attends classes such as exercise or cookery, code **36, Instruction on how to perform the behaviour, 23, Behavioural practice/rehearsal** and **84, Demonstration of the behaviour***	**36**? **23**? **84**? (see notes)	IF5
37	***Information about antecedents****	Provide information about antecedents* that reliably predict performance of the behaviour	*Advise to keep a record of snacking and of situations or events occurring prior to snacking*			IF1
38	***Re-attribution***	Elicit perceived causes of behaviour and suggest alternative explanations *(e.g. external or internal and stable or unstable)*	*If the person attributes their over-eating to the frequent presence of delicious food, suggest that the 'real' cause may be the person's inattention to bodily signals of hunger and satiety*			IF1 IF2
39	***Behavioural***	Advise on how to identify and test	*Ask a family physician to give*			IF1

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No.	Label	Definition	Examples	Notes	Also code	*Linked intervention functions*
	experiments	hypotheses about the behaviour, its causes and consequences, by collecting and interpreting data	*evidence-based advice rather than prescribe antibiotics and to note whether the patient is grateful or annoyed*			IF5 IF9
Self-belief ***Fostering confidence in one's ability to perform the behaviour.***						
40	***Verbal persuasion about capability***	Tell the person that they can successfully perform the wanted behaviour, arguing against self-doubts and asserting that they can and will succeed	*Tell the person that they can successfully increase their frequency of physical activity, arguing against self-doubts and asserting that they can and will succeed*	*There is a distinction between **89, Vicarious consequences,** and **40, Verbal persuasion about capability**: 40 is NOT about the consequences of performing the behaviour*		IF2 IF9
41	***Mental rehearsal of successful performance***	Advise to practise imagining performing the behaviour successfully in relevant contexts	*Advise to imagine eating a salad in a work canteen*			IF5 IF9
42	***Focus on past success***	Advise to think about or list previous successes in performing the behaviour (or parts of it)	*Advise to describe or list the occasions on which a doctor advised a patient with acute low back pain to stay active to manage this condition*			IF2 IF9
43	***Self-talk***	Prompt positive self-talk (aloud or silently) before and during the behaviour	*Prompt the person to tell themselves that a walk will be energising*			IF5 IF9
Scheduled consequences						

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No.	Label	Definition	Examples	Notes	Also code	*Linked intervention functions*
Emphasising or changing rewards or punishments arising from the behaviour.						
44	***Punishment***	Identify and provide aversive consequence contingent on the performance of the unwanted behaviour	*Arrange for the person to wear unattractive clothes following consumption of fatty foods*			IF4
45	***Behaviour cost*** (includes **'response cost'**)	Withdraw something valued (not a contingent reward) if and only if an unwanted behaviour is performed	*Subtract money from a prepaid refundable deposit when a cigarette is smoked*			IF4
46	***Remove reward*** (includes '**extinction'**)	Discontinue contingent reward for performing the unwanted behaviour	*Arrange for the other people in the household to ignore the person every time they eat chocolate (rather than attending to them by criticising or persuading)*			IF4
47	***Reward approximation*** (includes '**shaping'**)	Reward any approximation to the target behaviour, gradually rewarding only performance closer to the wanted behaviour	*Arrange for or reward the person for any reduction in daily calories, gradually requiring the daily calorie count to become closer to the planned calorie intake*		**54** or **55** or **56** or **57**	IF3
48	***Rewarding completion*** (includes '**backward chaining'**)	Build up behaviour by rewarding final component of the behaviour; gradually add the components of the behaviour that occur earlier in the behavioural sequence	*Reward eating a supplied low calorie meal; then make reward contingent on cooking and eating the meal; then make reward contingent on purchasing, cooking and eating the meal*		**54** or **55** or **56** or **57**	IF3
49	***Situation-specific reward*** (includes	Reward the behaviour in one situation but not in another.	*Arrange for or reward eating sweet foods at mealtimes but not between meals*		**54** or **55** or **56** or	IF3

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No.	Label	Definition	Examples	Notes	Also code	*Linked intervention functions*
	'**discrimination training'**)				**57**	
50	***Reward incompatible behaviour*** (includes '**counter-conditioning'**)	Reward for responding to a stimulus* in a manner that is incompatible with a previous response to that stimulus*	*Arrange for or reward the person for ordering a soft drink at the bar rather than an alcoholic beverage*		**54** or **55** or **56** or **57**	IF3
51	***Reward alternative behaviour*** (includes '**differential reinforcement'**)	Arrange reward for performance of an alternative to the unwanted behaviour *Note: consider also coding **61, Problem solving***	*Reward for consumption of low fat foods but not consumption of high fat foods*		**54** or **55** or **56** or **57** **61**?	IF3
52	***Reduce reward frequency*** (includes '**thinning'**)	Arrange for rewards to be made contingent on increasing duration or frequency of the behaviour	*Arrange for or reward for each day without smoking, then each week, then each month, then every 2 months and so on*		**54** or **55** or **56** or **57**	IF3
53	***Remove punishment*** (includes '**negative reinforcement'**)	Arrange for removal of an unpleasant consequence contingent on performance of the wanted behaviour	*Arrange for someone else to do housecleaning only if the person has adhered to the medication regimen for a week*			IF3
Reward and threat ***Rewarding or punishing new or old behaviours.***						
54	***Material reward for behaviour*** (includes **'positive reinforcement'**)	Arrange for the delivery of money, vouchers or other valued objects if and only if there has been effort and/or progress made towards performing the behaviour	*Arrange for the person to receive money that would have been spent on cigarettes if and only if the smoker has not smoked for*	*If the reward is social, code **56, Social reward.*** *If the reward is unspecified code **57,***		IF3

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No.	Label	Definition	Examples	Notes	Also code	*Linked intervention functions*
			one month	***Non-specific reward***, *and not* ***54, Material reward (behaviour)*** *If the reward is for* ***outcome***, *code* ***55, Material reward (outcome)***		
55	***Material reward for outcome*** (includes '**positive reinforcement'**)	Arrange for the delivery of a reward if and only if there has been effort and/or progress made towards achieving the behavioural **outcome**	*Arrange for the person to receive money if and only if a certain amount of weight is lost*	*This includes social, material, self- and non-specific rewards for outcome.* *If reward is for the BEHAVIOUR code* ***56***, ***Social reward***, *or* ***54 Material reward (behaviour)***, *or* ***57 Non-specific reward*** *or* ***58***, ***Self-reward,*** *and not* ***55, Material reward (outcome)***		IF3
56	***Social reward*** (includes '**positive reinforcement'**)	Arrange verbal or non-verbal reward if and only if there has been effort and/or progress made towards performing the behaviour	*Congratulate the person for each day they eat a reduced fat diet*	*If reward is material, code* ***54, Material reward (behaviour)***, *and not* ***56, Social reward*** *If reward is unspecified code* ***57, Non-specific reward***, *and not* ***56,***		IF3

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No.	Label	Definition	Examples	Notes	Also code	*Linked intervention functions*
				Social reward *If reward is for OUTCOME, code **55, Material reward (outcome)***		
57	***Non-specific reward*** (includes '**positive reinforcement'**)	Arrange delivery of a reward if and only if there has been effort and/or progress made towards performing the behaviour	*Identify something (e.g. an activity such as a visit to the cinema) that the person values and arrange for this to be delivered if and only if they attend for health screening*	*If reward is material, code **54, Material reward (behaviour)**, and not **57, Non-specific reward*** *If reward is social, code **56, Social reward**, and not **57, Non-specific reward*** *If reward is for **outcome** code **55, Material reward (outcome)***		IF3
58	***Self-reward***	Prompt self-praise or self-reward if and only if there has been effort and/or progress made towards the behaviour	*Encourage to reward self with material (e.g., new clothes) or other valued objects if and only if they have adhered to a healthy diet*	*If self-reward is material, also code **54, Material reward (behaviour)*** *If self-reward is social, also code **56, Social reward*** *If self-reward is unspecified, also code **57, Non-specific reward***	**54**? **56?** **57?** (see notes)	IF3 IF5 IF9

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No.	Label	Definition	Examples	Notes	Also code	*Linked intervention functions*
				*If reward is for **outcome** code **55, Material reward (outcome)***		
59	***Future punishment*** (includes '**threat**')	Inform that future punishment or removal of reward will be a consequence of performance of an unwanted behaviour (may include fear arousal)	*Inform that continuing to consume 30 units of alcohol per day is likely to result in liver disease and early death*			IF4
60	***Incentive***	Inform that future rewards or removal of future punishment will be contingent on performance of behaviour	*Ask the person to make a financial deposit at the beginning of the intervention and promise to give this money back on achievement of specified, agreed behavioural targets* *Inform that a financial payment will be made each month in pregnancy that the woman has not smoked*			IF3
Goals and planning ***Managing behaviour or outcome goals, and/or how behaviour or outcomes will be achieved***						
61	***Problem solving*** (includes '**relapse prevention'** and '**coping planning'**)	Analyse factors influencing the behaviour and generate or select strategies that include overcoming barriers and/or increasing facilitators	*Identify specific triggers (e.g. being in a pub, feeling anxious) that generate the urge/want/need to drink and develop strategies for avoiding environmental triggers or for managing*	*Barrier identification without solutions is NOT sufficient.* *If the BCT does NOT include analysing the behavioural problem,*		IF9

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No.	Label	Definition	Examples	Notes	Also code	*Linked intervention functions*
			negative emotions, such as anxiety, that motivate drinking	*consider **32**, **Avoidance/changing exposure to cues for the behaviour, 30, Restructuring the physical environment, 31, Restructuring the social environment,** or **5, Reduce negative emotions***		
62	***Goal setting (behaviour)***	Set or agree a goal defined in terms of the behaviour to be achieved	*Invite the person to propose a daily walking goal (e.g. to walk for at least 30 minutes every day) and reach agreement about the goal* *Set the goal of eating 5 pieces of fruit per day as specified in public health guidelines*	*Only code guidelines if set as a goal in an intervention context.* *If goal is unspecified or is a behavioural outcome, code **63, Goal setting (outcome)*** *If the goal defines a specific context, frequency, duration or intensity for the behaviour, also code **64, Action planning***	**64**? (see notes)	IF9
63	***Goal setting (outcome)***	Set or agree a goal defined in terms of a positive **outcome** of wanted behaviour	*Invite the person to set a weight loss goal (e.g. 0.5 kilogram over one week) as an outcome of changed eating patterns*	*Only code guidelines if set as a goal in an intervention context* *If goal is a behaviour,*		IF9

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No.	Label	Definition	Examples	Notes	Also code	*Linked intervention functions*
				*code **62, Goal setting (behaviour)*** *If goal is unspecified code **63, Goal setting (outcome)***		
64	***Action planning*** (includes **'implementation intentions'**)	Prompt detailed planning of performance of the behaviour (must include at least one of context, frequency, duration and intensity). Context may be environmental (physical or social) or internal (physical, emotional or cognitive)	*Following prompting, plan to carry condoms when going out socially at weekends* *Plan the performance of a particular physical activity (e.g. running) at a particular time (e.g. before work) on certain days of the week*	*Evidence of action planning does not necessarily imply goal setting. Only code goal setting if sufficient evidence*		IF9
65	***Review behaviour goal(s)***	Review behaviour goal(s) jointly with the person and consider modifying goal(s) or behaviour change strategy in light of achievement. This may lead to re-setting the same goal, a small change in that goal or setting a new goal instead of, or in addition to, the first	*Review how well a person's performance corresponds to agreed goals e.g. whether they consumed less than one unit of alcohol per day, and consider modifying future behavioural goals accordingly e.g. by increasing or decreasing alcohol target or changing type of alcohol consumed*	*If goal is specified in terms of behaviour, code **65, Review behaviour goal(s)*** *If goal is unspecified, code **66, Review outcome goal(s)*** *If discrepancy is created consider also **69, Discrepancy between current behaviour and goal***	**69**? (see notes)	IF9
66	***Review outcome***	Review outcome goal(s) jointly with	*Review how much weight has*	*If goal is specified in*	**69**?	IF9

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No.	Label	Definition	Examples	Notes	Also code	*Linked intervention functions*
	goal(s)	the person and modify goal(s) or behaviour change strategy in light of achievement. This may lead to re-setting the same goal, a small change in that goal or setting a new goal instead of, or in addition to the first	*been lost and consider modifying outcome goal(s) accordingly e.g., by increasing or decreasing subsequent weight loss targets*	*terms of behaviour, code* ***65, Review behaviour goal(s)*** *If goal is unspecified, code* ***66, Review outcome goal(s)*** *If discrepancy created consider also* ***69, Discrepancy between current behaviour and goal***		
67	***Behavioural contract***	Create a written specification of the behaviour to be performed, agreed by the person, and witnessed by another	*Sign a contract with the person e.g. specifying that they will not drink alcohol for one week*		**62**	IF3 IF4 IF9
68	***Commitment***	Ask the person to make statements indicating strong commitment to change the behaviour	*Ask the person to use an "I will" statement to affirm or reaffirm a strong commitment (i.e. using the words "strongly", "committed" or "high priority") to start, continue or restart the attempt to reduce alcohol use*	*If defined in terms of the behaviour to be achieved also code* ***62, Goal setting (behaviour)***	**62**? (see notes)	IF3 IF4 IF9
69	***Discrepancy between current behaviour and goal***	Draw attention to discrepancies between a person's current behaviour (in terms of the *form, frequency, duration, or intensity* of that behaviour) and the person's	*Point out that the recorded exercise fell short of the goal set*	*If discomfort is created only code* ***76, Incompatible beliefs*** *and not* ***69, Discrepancy between current***	**65**? **66**? **8**?	IF3 IF4 IF9

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No.	Label	Definition	Examples	Notes	Also code	*Linked intervention functions*
		previously set outcome goals, behavioural goals or action plans (goes beyond self-monitoring of behaviour)		***behaviour and goal*** *If goals are modified, also code **65, Review behaviour goal(s)** and/or **66, Review outcome goal(s)*** *If feedback is provided, also code **8, Feedback on behaviour***	(see notes)	
Comparison of outcomes ***Considering relative pros and cons of outcomes of various behaviours***						
70	***Persuasive source***	Present verbal or visual communication from a **credible source** in favour of or against the behaviour	*Present a speech given by a high status professional to emphasise the importance of not exposing patients to unnecessary radiation by ordering x-rays for back pain*	*Code this BCT only if source generally agreed on as credible e.g., health professionals, celebrities or words are used to indicate expertise or leader in field.* *If information about health consequences, also code **78, Information about health consequences*** *If information about emotional consequences, also code **79,***	**78**? **79**? **80**? (see notes)	IF2

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No.	Label	Definition	Examples	Notes	Also code	*Linked intervention functions*
				Information about emotional consequences *If information about social, environmental or unspecified consequences also code* ***80, Information about social and environmental consequences***		
71	***Pros and cons***	Advise the person to identify and compare reasons for wanting (discuss) and not wanting to (cons) change the behaviour	*Advise the person to list and compare the advantages and disadvantages of prescribing antibiotics for upper respiratory tract infections*	*If information about health consequences, also code* ***78, Information about health consequences*** *If information about emotional consequences, also code* ***79, Information about emotional consequences*** *If information about social, environmental or unspecified consequences also code* ***80, Information about***	**78**? **79**? **80**? (see notes)	IF9

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No.	Label	Definition	Examples	Notes	Also code	*Linked intervention functions*
				social and environmental consequences		
72	***Comparative imagining of future outcomes***	Prompt or advise the imagining and comparing of future outcomes of changed versus unchanged behaviour	*Prompt the person to imagine and compare likely or possible outcomes following attending versus not attending a screening appointment*			IF9
Identity ***Managing how one sees, thinks or feels about oneself or the behaviour.***						
73	***Identification of self as role model***	Inform that one's own behaviour may be an example to others	*Inform the person that healthy eating may be a good example for their children*			IF2 IF9
74	***Valued self-identity*** (includes **'Self-affirmation')**	Advise the person to write or complete rating scales about a cherished value or personal strength as a means of affirming the person's identity as part of a behaviour change strategy	*Advise the person to write about their personal strengths before they receive a message advocating the behaviour change*			IF9
75	***Framing/ reframing*** (includes '**cognitive structuring**')	Suggest the deliberate adoption of a perspective or new perspective on behaviour in order to change cognitions or emotions about performing the behaviour	*Suggest that the person might reduce sedentary behaviour (rather than increasing activity)*			IF2 IF9
76	***Incompatible beliefs*** (includes '**cognitive dissonance**')	Draw attention to discrepancies between current or past behaviour and self-image, in order to create discomfort	*Draw attention to a critical care consultant's liberal use of blood transfusion and their self-identification as a proponent of evidence-based*			IF4 IF9

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No.	Label	Definition	Examples	Notes	Also code	*Linked intervention functions*
			medical practice			
77	***Identity associated with changed behaviour***	Advise the person to construct a new self-identity as someone who 'used to engage with the unwanted behaviour'	*Ask the person to articulate their new identity as an 'ex-smoker'*			IF2 IF9
Natural consequences ***Providing information about the naturally-occurring consequences of the behaviour.***						
78	***Information about health consequences***	Provide information about health consequences of performing the behaviour	*Explain that not finishing a course of antibiotics can increase susceptibility to future infection* *Present the likelihood of contracting a sexually transmitted infection following unprotected sexual behaviour*	*Consequences can be for any target, not just the recipient(s) of the intervention.* *If information about emotional consequences, code **79, Information about emotional consequences*** *If information about social, environmental or unspecified consequences code **80, Information about social and environmental consequences***		IF1 IF2
79	***Information about emotional consequences***	Provide information about emotional consequences of performing the behaviour	*Explain that quitting smoking increases happiness and life satisfaction*	*Excludes **83, Anticipated regret*** *Consequences can be for*	Do not code **83**	IF1 IF2

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No.	Label	Definition	Examples	Notes	Also code	*Linked intervention functions*
				any target, not just the recipient(s) of the intervention *If information about health consequences code **78, Information about health consequences*** *If information about social, environmental or unspecified code **80, Information about social and environmental consequences***		
80	***Information about social and environmental consequences***	Provide information about social and environmental consequences of performing the behaviour	*Tell family physician about financial remuneration for conducting health screening*	*Consequences can be for any target, not just the recipient(s) of the intervention* *If information about health or consequences, code **78, Information about health consequences*** *If information is about emotional consequences,*		IF1 IF2

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No.	Label	Definition	Examples	Notes	Also code	*Linked intervention functions*
				*code **79, Information about emotional consequences*** *If information is unspecified, code **80, Information about social and environmental consequences***		
81	***Salience of consequences***	Use methods to emphasise (make more memorable) the consequences of changing the behaviour (goes beyond informing about consequences)	*Produce cigarette packets showing pictures of health consequences e.g. diseased lungs*			IF2 IF9
82	***Monitoring of emotional consequences***	Prompt assessment of **feelings** after attempts at performing the behaviour	*Agree that the person will record how they feel after e.g., taking their daily walk*			IF9
83	***Anticipated regret***	Induce expectations of future regret about performance of the unwanted behaviour *Note: not including **79, Information about emotional consequences***	*Ask the person to assess the degree of regret they will feel if they do not quit smoking (e.g. on a 5 point scale)*			IF4 IF9
Comparison of behaviour ***Comparing own behaviour to an ideal performance or to others' beliefs or behaviour***						
84	***Demonstration of the behaviour*** (includes '**modelling**')	Provide an example of the behaviour being performed for the person to aspire to or imitate	*Demonstrate to nurses how to raise the issue of excessive drinking with patients via a role-play exercise*			IF8

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No.	Label	Definition	Examples	Notes	Also code	*Linked intervention functions*
85	***Social comparison***	Draw attention to others' performance to explicitly elicit comparisons	*Show the general practitioner the proportion of patients who were prescribed antibiotics for a common cold by themselves and by their colleagues*	*Being in a group setting does not necessarily mean that social comparison is actually taking place.*		IF2
86	***Information about others' approval***	Provide information about what other people think about the behaviour. The information clarifies whether others will like, approve or disapprove of what the person is doing or will do	*Tell the staff at the hospital ward that staff at all other wards approve of washing their hands according to the guidelines*			IF1 IF2
Covert learning ***Imagining consequences of behaviour, or observing consequences of the behaviour for others.***						
87	***Imaginary punishment*** (includes '**covert sensitisation**')	Advise to imagine performing the **unwanted** behaviour in a real-life situation followed by imagining an unpleasant consequence	*Advise to imagine overeating and then vomiting*			IF4 IF9
88	***Imaginary reward*** (includes '**covert conditioning**')	Advise to imagine performing the **wanted** behaviour in a real-life situation followed by imagining a pleasant consequence	*Advise the health professional to imagine giving dietary advice followed by the patient losing weight and no longer being diabetic*			IF3 IF9
89	***Vicarious consequences***	Prompt observation of the consequences (including rewards and punishments) for others when they perform the behaviour	*Draw attention to the positive comments other staff get when they disinfect their hands regularly*	*If observation of health consequences, also code* ***78, Information about health consequences*** *If observation of emotional consequences,*	**78**? **79**? **80**? (see	IF9

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No.	Label	Definition	Examples	Notes	Also code	*Linked intervention functions*
				*also code **79, Information about emotional consequences*** *If observation of social, environmental or unspecified consequences, also code **80, Information about social and environmental consequences***	notes)	

*** Glossary of key terms**
Antecedents: the social and environmental situations and events, emotions, or thoughts that precede, cause or elicit an existing unwanted behaviour, or have the potential to precede, cause or elicit a new wanted behaviour.
'If-then' plan: A detailed plan which specifies what action will be taken when a specific context or stimulus* is encountered (i.e. 'if I finish using the toilet, then I will wash my hands').
Stimulus: Anything (e.g. a thing, event, situation, etc.) that evokes a response, or has the potential to do so.

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Intervention functions

The table below is adapted from the 'Behaviour Change Wheel' (Michie et al. 2011b). It aims to provide a comprehensive overview of the possible functions of behaviour change interventions.

Code	Intervention function	Definition	Example of intervention function	NOT an example of intervention function
IF1	Education	Increasing knowledge or understanding	Providing information to promote healthy eating	Providing cooking lessons (this is training as the aim is to impart skill rather than increase knowledge)
IF2	Persuasion	Using communication to induce positive or negative feelings, or to stimulate action	Using imagery to motivate increases in physical activity	Providing information on benefits of physical activity (this is education as the aim is to increase knowledge about the impact of physical activity)
IF3	Incentivisation	Creating an expectation of reward	Using prize draws to induce attempts to stop smoking	Using positive images of non-smokers to encourage smokers to quit (this is persuasion as there is no direct reward)
IF4	Coercion	Creating an expectation of punishment or cost	Raising the financial cost to reduce excessive alcohol consumption	Telling drinkers if they drink to excess they will be viewed negatively by their peers (this is persuasion not coercion as there is no direct punishment or cost to the drinker)

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Code	Intervention function	Definition	Example of intervention function	NOT an example of intervention function
IF5	Training	Imparting skills for performing the target behaviour	Advanced driver training to increase safe driving	A lecture about safe driving (this is education as the aim is to impart knowledge, i.e. the what not the practical application of this knowledge, i.e. the how to that defines training)
IF6	Restriction	Using rules to reduce the opportunity to engage in the target behaviour (or to increase the target behaviour by reducing the opportunity to engage in competing behaviours)	Prohibiting sales of solvents to people under 18 to reduce use for intoxication	Fines for the possession of solvents (this is coercion as there is a cost for the undesirable behaviour)
IF7	Environmental restructuring	Changing the physical or social context in which the behaviour is (or could be) performed	Providing on-screen prompts for GPs to ask about smoking behaviour	Creating a rewards system for GPs who ask about smoking behaviour (this is incentivisation as there is a reward for the desirable behaviour)
IF8	Modelling	Providing an example for people to aspire to or imitate	Using TV drama scenes involving safe-sex practices to increase condom use	Using TV advert to encourage condom use (this is persuasion as the aim is to induce positive feelings towards condom use)

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Code	Intervention function	Definition	Example of intervention function	NOT an example of intervention function
IF9	Enablement	Increasing means/reducing barriers to increase capability (beyond education and/or training) or opportunity (beyond environmental restructuring)	Behavioural support for smoking cessation, medication for cognitive deficits, surgery to reduce obesity, prostheses to promote physical activity	Supporting GPs to recognise the symptoms ovarian cancer with an information pamphlet (this is education as the primary aim is to inform rather than support)

Theory use

For coding theory use a single item was used. This asked “Do the authors explicitly link the intervention to one or more formal theories/models?” If the answer was yes, the theories/models mentioned were recorded.

An ’explicit link’ between an intervention and a theory was said to have been made where one or more of the following holds: (a) a construct (or constructs), which the authors have stated is part of a named formal theory, is targeted by the intervention; (b) the authors state that any component of the intervention is based on a named formal theory; (c) recipients of the intervention have been selected on the basis of a construct (or constructs) which the authors have stated is part of a named formal theory; (d) techniques have been chosen, tailored, or delivered, on the basis of one or more named formal theory, or a construct (or constructs) which the authors have stated is part of a named formal theory.

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A ‘formal theory’ was defined as a theory or model which generates specific predictions regarding the determinants of behaviour and/or behaviour change. This excludes ‘theories’ which are in fact summaries of a more general theoretical or disciplinary approach or perspective. For example, we treat ‘The Theory of Planned Behaviour’ and ‘Protection Motivation Theory’ as formal theories, but we do not view ‘behaviour change theory’ and ‘health psychology theory’ as formal theories.

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11 Appendix E: Outcome hierarchy

The general approach to results extractions was to:

- Extract results for the behaviour targeted by the intervention
- Extract results at the longest term follow up available
- Extract results for intention to treat analysis in preference to non-intention to treat analysis
- Extract results for the most adjusted analysis available
- Extract objective measures in preference to subjective measures of the same outcome
- Extract continuous outcomes in preference to dichotomous outcomes (with the exception of smoking, where quit rates are likely to be the most important outcome)
- Where a study had none of the listed outcomes, the other outcomes in the study were prioritised by internal discussion and added to the outcome hierarchy before proceeding

The outcome hierarchy

Outcomes are listed in order of preference for extraction for the meta-regression analysis. For each study the highest ranking outcome in the hierarchy was extracted. If results were not extractable for a prioritised outcome, then the next highest priority outcome was extracted.

Sexual health

- Frequency of unprotected sexual intercourse (i.e. number of sexual intercourse episodes where condom was not used) (Prioritised results for all sexual partners over most recent or serodiscordant partners, prioritised serodiscordant partners over most recent partner. Prioritised insertive

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intercourse over oral sex. Prioritised total anal sex over insertive or receptive anal sex individually, prioritised insertive over receptive anal sex for HIV positive populations and receptive anal sex for HIV negative populations)

- Frequency of condom use (i.e. number of sexual intercourse episodes where condom was used)
- Frequency of other routine contraceptive use
- Number of sexual partners
- Frequency of emergency contraceptive use
- Proportion of individuals who abstain from sex

Alcohol

- Objective measures of alcohol consumption (e.g. blood alcohol content) per day (or other time period)
- Subjective measures of alcohol consumed per day (or other time period)
- Proportion of people above/below recommended/set threshold levels of alcohol consumption
- Proportion of people with risky drinking patterns of alcohol consumption (e.g. binge drinking)
- Number of drink related accidents/incidents (e.g. drink driving, A&E attendance)
- Proportion of people with drink related accidents/incidents (e.g. drink driving, A&E attendance)

Smoking

- Objectively determined quit rates (cotinine/carbon monoxide [CO])
- Self reported quit rates
- Objectively determined relapse rates rates (cotinine/CO)

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- Self reported relapse rates
- Number of cigarettes smoked per day (or other time unit)

Diet

- Portions of fatty food consumed per day (or other time unit)
- Proportion of people consuming above/below recommended/set threshold levels of fatty foods
- Portions of fruit and veg consumed per day (or other time unit)
- Portions of veg
- Portions of fruit (Pieces and portions, not grams)
- Proportion of people consuming above/below recommended/set threshold levels of fruit and veg
- Portions of fast food consumed per day (or other time unit)
- Proportion of people consuming above/below recommended/set threshold levels of fast food
- Portions of salty food consumed per day (or other time unit)
- Proportion of people consuming above/below recommended/set threshold levels of salty food
- Portions of red meat consumed per day (or other time unit)
- Proportion of people consuming above/below recommended/set threshold levels of red meat
- Portions of fibre-rich food consumed per day (or other time unit)
- Proportion of people consuming above/below recommended/set threshold levels of fibre-rich food
- Portions of fish consumed per day (or other time unit)
- Proportion of people consuming above/below recommended/set threshold levels of fish

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- Proportion of people meeting or adhering to overall dietary recommendations for specific medical conditions (Diabetes self care diet, Mediterranean diet, etc.
- Composite measures of diet (Diabetes Self-Care Activities measure, Kristal Food Habits Questionnaire)

Physical activity

- Pedometer reading (objective measure)
- Number of minutes of total physical activity per day (or other time unit)
- Number of minutes of moderate to vigorous activity per day (or other time unit)
- Number of minutes of vigorous activity per day (or other time unit)
- Number of minutes of moderate activity per day (or other time unit)
- Number of minutes of aerobic physical activity per day (or other time unit)
- Number of minutes of light activity per day (or other time unit)
- Number of minutes leisure time activity per day (or other time unit)
- Proportion of people above/below recommended/set threshold levels of physical activity (if this is broken down into different types of activity use in the following order: total activity then moderate to vigorous activity then vigorous activity then moderate activity then light activity)
- Score on the modified Baecke Questionnaire score (sums household, sport, and leisure time activity)
- Proportion of people reporting being moderate or very physically active
- Exercise at least once a week
- Exercise for more than 1h per week
- Total metabolic equivalents (METs) per designated time period per day (or other time unit)
- Total METs per designated time period of moderate to vigorous activity per day (or other time unit)

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- Total METs per designated time period of vigorous activity per day (or other time unit)
- Total METs per designated time period of moderate activity per day (or other time unit)
- Total METs per designated time period of light activity per day (or other time unit)

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12 Appendix F: Intervention abbreviations

Trial arm	Target behaviour	Content
Armit_ES 2009	Physical activity	Individual counselling delivered by exercise scientist and general practitioner usual care
Armit_ES+P 2009	Physical activity	Individual counselling delivered by exercise scientist, plus pedometer and general practitioner usual care
Carey_BMI 2006	Alcohol	Individual basic brief motivational session
Carey_TLFB 2006	Alcohol	Time-line followback
Carey_EBMI 2006	Alcohol	Individual enhanced brief motivational session
Carey_BMI+TLFB 2006	Alcohol	Individual basic brief motivational session and time-line followback
Carey_EBMI+TLFB 2006	Alcohol	Individual enhanced brief motivational session and time-line followback
Carpenter_SR+NRT 2006	Smoking	Telephone-based smoking reduction counselling plus nicotine replacement therapy plus brief advice
Carpenter 2004_MA+NRT	Smoking	Motivational advice plus nicotine replacement therapy brief advice
Chouinard_IC 2005	Smoking	Individual inpatient counselling only
Chouinard_IC+FU 2005	Smoking	Individual inpatient counselling with telephone follow-up
Dent_BI 2008	Alcohol	Individual brief intervention in emergency department
Dent_MI 2008	Alcohol	Individual motivational interview post-discharge
Dermen_ALC 2011	Alcohol and sexual health	Individual counselling for reducing alcohol risk behaviour
Dermen_HIV 2011	Alcohol and sexual health	Individual counselling for reducing HIV risk behaviour
Dermen_H&A 2011	Alcohol and sexual health	Individual counselling for reducing alcohol and HIV risk behaviours
Field_WP 2009	Alcohol	White participants
Field_HP 2009	Alcohol	Hispanic participants
Gordon_3As 2010a	Smoking	Individual 3As intervention (ask advise, arrange)
Gordon_5As 2010a	Smoking	Individual 5As intervention (ask, assess,

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		advise, agree, arrange)
Guelinckx_B+LI 2010	Diet and physical activity	Group counselling (lifestyle intervention) sessions plus brochure
Hall_ECBT 2009	Smoking	Individual and group extended cognitive behaviour therapy
Hall_ENRT+CBT 2009	Smoking	Individual and group extended cognitive behaviour therapy and nicotine replacement therapy
Holloway_SEE 2007	Alcohol	Individual self-efficacy enhancement session
Holloway_SHB 2007	Alcohol	Self-help booklet
Hyman_Sic 2007	Physical activity and smoking	Individual simultaneous intervention with follow-up.
Hyman_Sec 2007	Physical activity and smoking	Individual sequential intervention with follow up.
Juarez_MI 2006	Alcohol	Individual motivational interviewing only
Juarez_MF 2006	Alcohol	Mailed feedback only
Juarez_MI+F 2006	Alcohol	Individual motivational interviewing including feedback
Juarez_MI+MF 2006	Alcohol	Individual motivational interviewing with mailed feedback
Kirk_PA-P 2009	Physical activity	Individual person-delivered physical activity intervention with follow up
Kirk_PA-W 2009	Physical activity	Written-delivered physical activity intervention with follow-up
Kotz_CC+Nort 2009	Smoking	Confrontational counselling with nortriptyline pharmacological treatment
Kotz_HE+Nort 2009	Smoking	Non-confrontational counselling with nortriptyline pharmacological treatment
Kulesza_10M 2010	Alcohol	Individual ‘Brief Alcohol Screening and Intervention for College Students’ (BASICS) session for 10 minutes
Kulesza_50M 2010	Alcohol	Individual ‘Brief Alcohol Screening and Intervention for College Students’ (BASICS) session for 50 minutes
Lau-Barraco_EEC 2008	Alcohol	Group experiential expectancy challenge (gender specific)
Lau-Barraco_EDU 2008	Alcohol	Education only
Lawrence_SHM 2003	Smoking	Self-help manual
Lawrence_SHM+ICI 2003	Smoking	Self-help manual plus computer intervention with feedback

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Lewis_GSF 2007	Alcohol	Computer delivered gender-specific personalised normative feedback session
Lewis_GNSF 2007	Alcohol	Computer delivered gender-non-specific personalised normative feedback session
Lorig_SM 2010	Physical activity	Internet-based diabetes self-management program
Lorig_SM+MR 2010	Physical activity	Internet-based diabetes self-management program with mailed reinforcement
Mastroleo_EEA 2010	Alcohol	'Brief Alcohol Screening and Intervention for College Students' (BASICS) with evidence based application approach (EEA)
Mastroleo_CPA 2010	Alcohol	'Brief Alcohol Screening and Intervention for College Students' (BASICS) with common practices approach (CPA)
Marcus_TB 2007	Physical activity	Telephone-based individualised feedback
Marcus_PB 2007	Physical activity	Print-based individualised feedback
McBride_WOI 2004	Smoking	Women only individual counselling with telephone follow-up
McBride_PAI 2004	Smoking	Partner assisted counselling with telephone follow-up
McMurdo_BCI 2010	Physical activity	Individual behaviour change intervention with follow-up
McMurdo_BCI+P 2010	Physical activity	Individual behaviour change intervention with follow-up and pedometer
Molyneux_Cou 2003	Smoking	Individual counselling session
Molyneux_Cou+NRT 2003	Smoking	Individual counselling session plus nicotine replacement therapy
Ondersma_CM-Lite 2012	Smoking	Computer-assisted simplified and low-intensity contingency management
Ondersma_CD-5As+CM-Lite 2012	Smoking	Computer delivered 5As-based brief intervention (ask, assess, advise, agree, arrange) plus computer-assisted simplified and low-intensity contingency management
Ondersma_CD-5As 2012	Smoking	Computer delivered 5As-based brief intervention (ask, assess, advise, agree, arrange)
Pisinger_GC 2010	Smoking	Group counselling
Pisinger_IC 2010	Smoking	Internet-based programme
Prestwich_II 2009	Physical activity	Implementation intentions only (II)
Prestwich_II+SMS 2009	Physical	Implementation intentions plus SMS text

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	activity	message(s)
Prestwich_SMS 2009	Physical activity	SMS text message(s) only
Ruger_CS 2008	Smoking	Continuing smokers
Ruger_RQ 2008	Smoking	Recent quitters
Stotts_USF 2009	Smoking	Individual best practice counselling plus ultrasonic feedback
Stotts_MI+USF 2009	Smoking	Individual motivational interview plus ultrasonic feedback
van Wier_T 2009	Diet	Individual telephone counselling
van Wier_I 2009	Diet	Internet-based counselling (interactive website and email)
Walters_WEB 2009	Alcohol	Web feedback only
Walters_MI 2009	Alcohol	Individual motivational interview only
Walters_MI+F 2009	Alcohol	Individual motivational interview with feedback
White_TB 2012	Diet	Telephone based
Wood_CP 2008	Diet and physical activity	Cardiac patients
Wood_HR 2008	Diet and physical activity	High risk primary care patients
Wright_TDF 2011	Diet	Tailored printed dietary feedback delivered electronically
Wright_NE 2011	Diet	Small group counselling

13 Appendix G: Evidence tables

See separate document

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14 Appendix G: Meta-regression results

Provided as a separate document

15 Appendix I: References of studies excluded at full text appraisal

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