The cost-effectiveness of weight management interventions following childbirth

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About the ScHARR Public Health Collaborating Centre

The School of Health and Related Research (ScHARR), in the Faculty of Medicine, Dentistry and Health, University of Sheffield, is a multidisciplinary research-led academic department with established strengths in health technology assessment, health services research, public health, medical statistics, information science, health economics, operational research and mathematical modelling, and qualitative research methods. It has close links with the NHS locally and nationally and an extensive programme of undergraduate and postgraduate teaching, with Masters courses in public health, health services research, health economics and decision modelling.

ScHARR is one of the two Public Health Collaborating Centres for the Centre for Public Health Excellence (CPHE) in the National Institute for Health and Clinical Excellence (NICE) established in May 2008. The Public Health Collaborating Centres work closely with colleagues in the Centre for Public Health Excellence to produce evidence reviews, economic appraisals, systematic reviews and other evidence based products to support the development of guidance by the public health advisory committees of NICE (the Public Health Interventions Advisory Committee (PHIAC) and Programme Development Groups).

Contribution of Authors

Alejandra Duenas was lead modeller, and Andrew Rawdin was an additional economic modeller. Josie Messina was the systematic review lead. Maxine Johnson, Fiona Campbell and Emma Everson-Hock were reviewers on the project. Louise Guillaume developed and undertook literature searches. Elizabeth Goyder and Jim Chilcott were the senior leads.

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Contents

Tables and figures

1. Glossary of terms

Body Fat Percentage: the percentage of total body weight that is comprised of fat (Concepts of Fitness and Wellness).

Body Mass Index: A key index for relating a person's body weight to their height. The body mass index (BMI) is a person's weight in kilograms (kg) divided by their height in meters (m) squared (kg/m2). (Concepts of Fitness and Wellness)

Calorie: A unit of energy supplied by food; the quantity of heat necessary to raise the temperature of a kilogram of water one degree centigrade. A kilocalorie is usually called a Calorie for weight control purposes (Concepts of Fitness and Wellness)

Fat-free Mass: the mass (weight) of the body (muscle, bone, skin and organs) that is not fat

Gestational diabetes: Carbohydrate intolerance of varying severity which is diagnosed in pregnancy and may or may not resolve after pregnancy.

Metabolic equivalent (METs): a unit of energy expenditure, or metabolic cost, of physical activity. One MET is the rate of energy expenditure while sitting at rest (Fitness Glossary).

Physical activity is any force exerted by skeletal muscle that results in energy expenditure above resting level (Caspersen, Powell, & Christenson 1985). It includes the full range of human movement and can encompass everything from competitive sport and active hobbies to walking, cycling and the general activities involved in daily living (such as housework).

Physical activity: measured in terms of:

- the time it takes (duration)
- how often it occurs (frequency)
- its intensity (the rate of energy expenditure – or rate at which calories are burnt). The intensity of an activity is usually measured either in kcals per kg per minute or in METs (metabolic equivalents – multiples of resting metabolic rate). Depending on the intensity, the activity will be described as: moderate-intensity or vigorous-intensity. Moderate-intensity activities increase the heart and breathing rates but, at the same time, allow someone to have a normal conversation. An example is brisk walking.

Post Partum: the period after birth

List of Abbreviations

BMI: body mass index
CEAC: cost-effectiveness acceptability curve
GWG: gestational weight gain
IOM: Institute of Medicine
Kcal: calorie, or kilocalorie
LTPA: leisure time physical activity
NRS: non randomised studies
NA: not applicable
NR: not reported
OECD: Organisation for Economic Co-operation and Development
OR: odds ratio
QALY: quality-adjusted life-year
RR: risk ratio
RCTs: randomised control trials

2. Executive summary

2.1 Background

Effective weight management following childbirth may reduce the long term risks of heart disease, cancer, obesity and diabetes among childbearing women, as well as reduce the risk of entering future pregnancies overweight or obese (Gore et al. 2003). The National Institute for Health and Clinical Excellence has been asked by the Department of Health to develop public health guidance to promote weight management following childbirth.

An economic model was developed in order to estimate the cost-effectiveness of weight management interventions targeted at women who have given birth within 2 years. This present model is based on the effectiveness review aimed to identify and synthesise evidence on the effectiveness of dietary and/ or physical activity interventions and any other intervention after childbirth that may impact on weight management. The outcomes considered were weight related outcomes, diet and physical activity, breastfeeding, access to and use of services, harms of interventions and long term overweight and obesity rates (outcomes).

2.2 Objectives

The primary objective of this evaluation is to appraise the cost-effectiveness of weight management after childbirth interventions.

2.3 Methods

Economic analyses were performed to model the cost-effectiveness and cost utility of weight management interventions targeted at women who have given birth within 2 years.

The model was designed in order to assess different outcomes. It assessed the effectiveness of dietary interventions and or physical activity interventions for either post natal weight management or any dietary or physical activity following pregnancy that may impact on weight management. It has a NHS and personal social services (PSS) perspective.

The results are presented in terms of incremental cost-effectiveness ratios (ICERs). Detailed reviews were undertaken to obtain the most recent evidence on costs and utilities for the different states modelled. UK specific data were used although the

effectiveness of dietary and physical activity interventions were taken from US setting studies.

2.4 Results

The mean incremental cost effectiveness ratio of the diet and exercise interventions as estimated from the trial by Lovelady was £44,144 per QALY over a 15 year time horizon with a 95% confidence interval ranging from £15,000 per QALY to dominated (e. g. less effective and costs more). Over a lifetime horizon this cost effectiveness improves to £9,096, ranging from £4,000 to dominated.

2.5 Discussion and conclusion

The review of effectiveness concluded that interventions to manage weight gain after childbirth were shown to be effective in the short term. In contrast the economic results were highly dependent on the long term impact of these short term effects. These long term effects are dependent on key assumptions within the modelling. For example, the 15 year impact on weight change and the lifelong impact on survival are estimated from observational studies that demonstrate associations rather than causative effects. The long term economic estimates are thus prone to high levels of structural uncertainty not represented in the probabilistic sensitivity analysis.

Studies examining interventions in weight management after childbirth are required in a UK population. Future research in interventions to managing weight gain after childbirth should ensure that follow up is sufficient to demonstrate health and economic advantages. Where trials are designed to collect short term surrogate outcomes, the relationship between these and long term final health outcomes should be explicit and quantifiable. Observation studies in a UK population are required to assist in determining long term effects of interventions in this area.

3. Introduction

This study was undertaken in parallel with a systematic review on the effectiveness of weight management interventions targeted at women who have given birth within 2 years. The systematic review aimed to identify and synthesise evidence on the effectiveness of dietary and/ or physical activity interventions and any intervention after childbirth that may impact on weight management. It also included interventions focussed on assessments, monitoring, and support/advice for post partum weight management. The purpose of this economic review was to evaluate the cost effectiveness and applicability of interventions identified as being effective in the systematic review. The outcomes considered were weight related outcomes, diet and physical activity, breastfeeding, access to and use of services, harms of interventions and long term overweight and obesity rates (outcomes). A review of cost-effectiveness of weight management after childbirth interventions was also undertaken with the primary objective of systematically identifying and evaluating methodologies used in economic evaluations.

4. Review of previous economic studies

4.1 Search strategy

Studies were identified through searches of economic databases: EconLit and NHS EED. All searches were undertaken in August 2009. A list of the keyword strategies and the sources consulted are given in Appendix 1. Where additional information requirements were identified, targeted searches were undertaken for model parameters.

4.2 Inclusion and exclusion strategy

The titles and abstracts of papers identified through the searches outlined above were assessed for inclusion using the following criteria:

Inclusion criteria

- Cost-effectiveness, cost-benefit or cost minimisation analyses.
- Dietary interventions and or physical activity interventions for either post natal weight management or any dietary or physical activity following pregnancy that may impact on weight management. These interventions may be targeted at individuals, families, communities or whole population.

- Community weight management interventions.
- Comparator current postnatal care.
- Mothers, up to at least two years with a BMI greater than 18.5 kg/m2 following the birth of their baby, both those who are breast feeding and those who are not breast feeding.
- Mothers, up to at least two years following the birth of their baby who are planning a subsequent pregnancy.
- Women from vulnerable groups such as those diagnosed with gestational diabetes and those with a BMI greater than 25 kg/m2 who are at risk of excess weight retention following pregnancy.

Exclusion criteria

- Publications in languages other than English
- Pharmaceutical or surgical interventions for overweight and obese women.
- Complementary interventions for overweight and obese women.

4.3 Results of review

Data Extraction, critical appraisal and data synthesis

It had been planned for one economic modeller to extract previous model structures with no blinding to author or journal for the purpose of providing a narrative account of previous economic modelling for the reader. Planned quality assessment was with criteria based on those provided by the NHS centre for reviews and dissemination for randomised controlled trials, or using the Downs and Black checklist for randomised and non-randomised studies for the other studies accepted into the review.

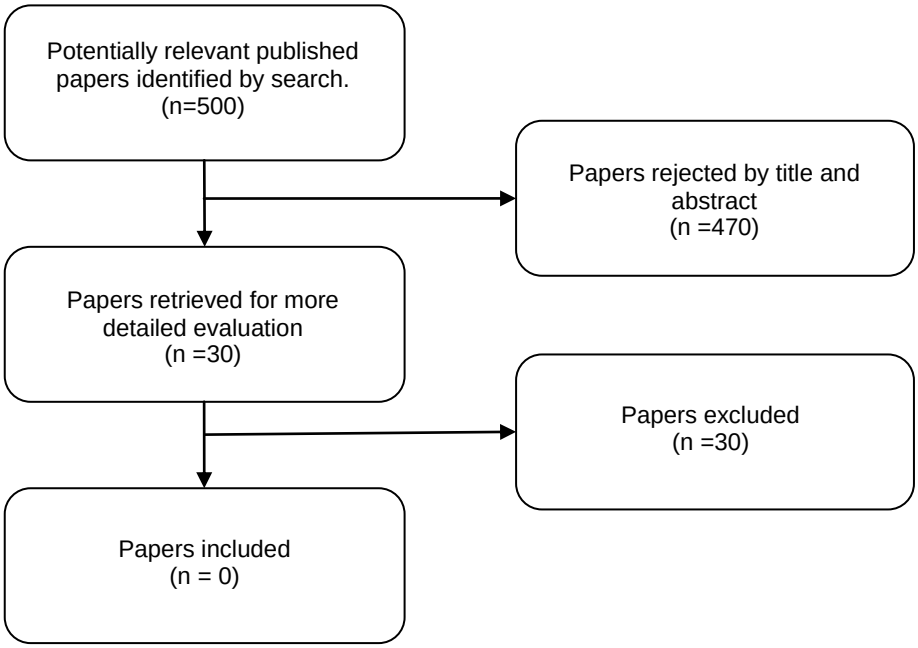
Results

The search yielded 500 citations, of which 470 were rejected from titles and abstracts. Of the remaining 30 papers only one looked at the costs and effectiveness of a postnatal intervention (Morrell et al. 2000). However, the postnatal intervention was aimed to help women rest and recover after childbirth. This intervention did not

meet the inclusion criteria and therefore was rejected. This is illustrated in the flow diagram (Figure 1).

The lack of evidence made use of prior knowledge as a source of information for the model structure impossible. It had been planned that previous model structures would be discussed and quality assessed within a descriptive synthesis. However, the lack of evidence made this impossible.

Figure 1: Flow diagram of study selection.



Discussion

There were no studies available describing model structures used to evaluate the cost-effectiveness of weight management interventions in women following pregnancy. Thus there were no studies meeting the inclusion criteria that could have informed our choice of model structure. A potential limitation of the search was that it excluded publications in languages other than English.

5. Economic Assessment

5.1 Objective

The primary objective of this evaluation is to appraise the cost-effectiveness of weight management after childbirth interventions.

5.2 Methods

A model was developed to explore the economic outcomes associated with weight management interventions targeted at women who have given birth within 2 years. This model was used to determine the cost and benefits over a lifetime horizon. The effectiveness of interventions was obtained from the systematic review conducted by ScHARR on the effectiveness of weight management after childbirth interventions. The results are presented in terms of costs per quality adjusted life year gained.

Population considered in the economic evaluation

The population comprised women who have given birth within two years with no pre-existing medical complications relating to pregnancy or the post partum period that may affect weight management. No age limits at the time of intervention were applied.

Comparator

The comparator was conventional postnatal care.

Outcomes

Outcomes included in the systematic review were classed into 5 categories: weight related outcomes, diet and physical activity, breastfeeding, access to and use of services, harms of interventions. The following outcomes were of particular interest for the economic evaluation: changes in measures of body weight and BMI and long term overweight and obesity rates.

Effectiveness of interventions

This model was informed with evidence of interventions' effectiveness and their link with outcomes found in the systematic review. A total of five randomised control trials (RCT) (Dewey et al. 1994; Leermakers et al. 1998; Lovelady et al. 2006; McCrory et al. 1999, O'Toole et al. 2003) and two non-randomised studies (NRS) (Albright et al. 2009; Kinnunen et al. 2007) were identified. All the identified studies were conducted

in the United States (US). The effectiveness evidence of these studies is presented in the systematic review conducted by ScHARR. The two main effectiveness outcomes needed to model the economic evaluation are changes in measures of body weight and BMI. For effects of this economic evaluation only the RCTs (Dewey et al. 1994; Leermakers et al. 1998; Lovelady et al. 2006; McCrory et al. 1999, O'Toole et al. 2003) reported the main effectiveness outcomes and are summarised below in Table 1 and 2.

Table 1: Body weight changes for intervention and control group

Dewey *et al* (RCT)	**Exercise Group (mean ± SD)**	**Control Group (mean ± SD)**
Pre-pregnancy weight (kg)	61.3 ± 6.5	61.6 ± 6.5
Start of Intervention	6 – 8 weeks	6 – 8 weeks
Duration of intervention (follow-up)	12 weeks	12 weeks
Nature of intervention	Aerobic exercise	None
Weight gained during pregnancy (kg)	15.2 ± 5.3	17.5 ± 5.4
Weight lost by six months (kg)	Not reported	Not reported
Weight at end of study (kg)	65.7 ± 10.7	65.4 ± 8.3
Infant birth weight (kg)	3.66 ± 0.36	3.89 ± 0.54
Height	163.2 ± 6.9 cm	167.6 ± 6.5 cm
Leermakers *et al* (RCT)	**Exercise Group (mean ± SD)**	**Control Group (mean ± SD)**
Pre-pregnancy weight (kg)	67.0 ± 8.4	67.0 ± 8.4
Start of intervention	3 – 12 months	3 – 12 months
Duration of intervention (follow-up)	6 months	6 months
Nature of intervention	Behavioural weight loss by correspondence	None
Weight gained during pregnancy (kg)	17.5 ± 5.7	19.8 ± 6.7
Weight lost by six months (kg)	7.8 ± 4.5	4.9 ± 5.4
Weight at end of study (kg)	Not reported	Not reported
Infant birth weight (kg)	Not reported	Not reported
Height	Not reported	Not reported
Lovelady *et al* (RCT)	**Exercise Group (mean ± SD)**	**Control Group (mean ± SD)**
Pre-pregnancy weight (kg)	68.6 ± 2.3	70.5 ± 2.9
Start of intervention	4 weeks	4 weeks
Duration of intervention (follow-up)	10 weeks	10 weeks

Nature of intervention	Diet and exercise	None
Weight gained during pregnancy (kg)	15.5 ±1.0	14.8 ± 1.3
Weight lost by six months (kg)	Not reported	Not reported
Weight at end of study (kg)	72.2 ± 2.8	73.7 ± 2.3
Infant birth weight (kg)	3.61 ± 0.21	3.51 ± 0.10
Height	166.5 ± 1.9 cm	164.8 ± 1.3

Table 2: Body weight changes for intervention and control group

O'Toole *et al* (RCT)	**Structured Diet & Physical Activity Programme**		**Self Directed Programme**
Pre-pregnancy weight (kg)	79.8 ± 5.2		83.9 ± 10.2
Start of intervention	6 – 26 weeks		6 – 26 weeks
Duration of intervention (follow-up)	1 year		1 year
Nature of intervention	Structured diet and physical activity programme		Self directed diet and physical activity
Weight gained during pregnancy (kg)	> 15		>15
Weight lost by six months (kg)	Not reported		Not reported
Weight at end of study (kg)	71.3 ± 2.2		84.1 ± 4.3
Infant birth weight (kg)	Not reported		Not reported
Height	164 ± 5.4		167 ± 6.6
McCrory *et al* (RCT)	**Diet**	**Diet & exercise**	**Control**
Pre-pregnancy weight (kg)	67.3 ± 14.0	64.9 ±14.2	66.4 ± 8.7
Start of intervention	8 – 16 weeks		8 – 16 weeks
Duration of intervention (follow-up)	11 days		11 days
Nature of intervention	Diet	Diet and exercise	None
Weight gained during pregnancy (kg)	15.2 ± 5.0	16.1 ± 4.8	16.4 ± 6.0
Weight lost by six months (kg)	Not reported	Not reported	Not reported
Weight at end of study (kg)	66.4 ± 9.8	67.8 ± 12.7	68.3 ± 8.6
Infant birth weight (kg)	3.58 ± 0.53	3.54 ± 0.49	3.52 ± 0.41
Height	165.0 ± 10.01	164.6 ± 7.7	166.5 ± 7.1

Structure of the model

All of the comparative effectiveness studies investigated short term outcomes of weight management intervention. Weight gain after pregnancy however has a lifelong impact on both economic and effectiveness outcomes. A model is used to extrapolate short term outcomes over a longer time horizon. Searches were undertaken to identify evidence upon which to base this extrapolation.

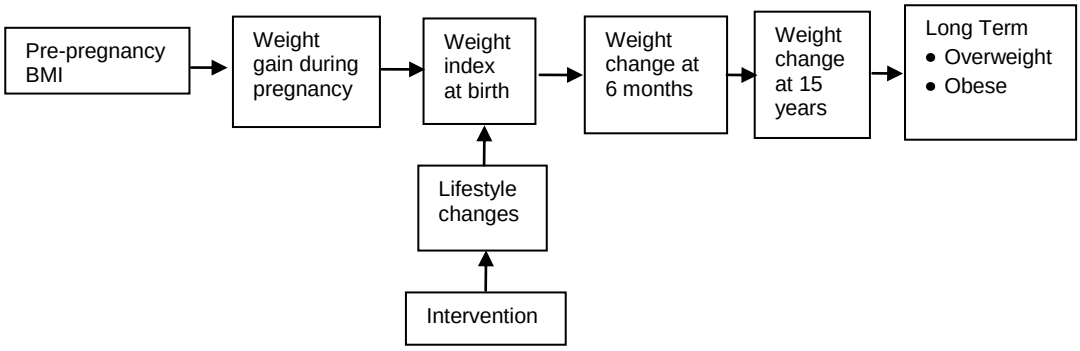
The model is based on a study undertaken by Rooney et al. (2005). The objective of the Rooney study was to estimate the impact of perinatal weight on obesity-related diseases. 484 women in the US (Wisconsin) were available for a 15-year follow-up. The dependent variable was weight gain from first prenatal visit to follow-up after 15 years. Key variables included in this observational study were marital status, weight gain during pregnancy, duration of breastfeeding, BMI at the index birth (pre-pregnancy), retained pregnancy weight at 6 months and aerobic exercise participation after childbirth. The multivariable model used to predict weight gain after 15 years is presented in Table 3.

Table 3: Multivariable model 15-year body weight change (kg), Rooney (2005)

Characteristic	Regression Coefficient	95% CI
Y axis intercept	-2.00	(-6.11 to 2.10)
Marital Status at index birth (pre-pregnancy)		
Single	3.36	(0.13 to 6.60)
Married	Reference category	
Gestational weight gain categories		
Less than recommended	0.43	(-1.87 to 2.73)
Recommended	Reference category	
More than recommended	4.19	(1.88 to 6.51)
Weight loss by six months		
Lost weight gained in pregnancy	Reference category	
Retained weight gained in pregnancy	5.44	(3.34 to 7.55)
Duration of breast feeding		
Did not breast feed	2.02	(-0.22 to 4.26)
Breast fed for between 2 and 12 weeks	2.44	(0.01 to 4.87)
Breast fed beyond 12 weeks	Reference category	
Postpartum participation in aerobic exercise		
Yes	Reference category	
No	2.59	(0.21 to 4.97)
BMI at birth (pre-pregnancy)		
Underweight	Reference category	
Normal weight	1.83	(-1.20 to 4.85)
Overweight	4.76	(1.24 to 8.29)
Obese	8.31	(4.12 to 12.49)
R^2	0.167	

Figure 2 shows the economic model structure. This model could be used as an indicator of obesity in mother at midlife.

Figure 2: Model structure



The classifications used in the model are based on the American Institute of Medicine (IOM) re-examined guidelines (Rasmussen and Yaktine, 2009) on weight management in pregnancy (Table 4).

Table 4: IOM recommendations for Weight Gain During Pregnancy

Weight Category	BMI (kg/m^2)	Recommended Total Weight Gain (kg)
Underweight	< 18.5	12.5 - 18.0
Normal weight	18.5 - 24.9	11.5 - 16.0
Overweight	25.0 - 29.9	7.0 - 11.5
Obese	$\geq$ 30	5.0 - 9.0

This model links the outcomes reported by Lovelady et al. (2006) effectiveness study with the multivariable model developed by Rooney et al. (2005). The Lovelady study was selected because it is the only one that reports short term outcomes that match the inputs needed by the Rooney and a statistically significant difference between the intervention and control group weight change (Appendix 2) at a baseline of 4 to 6 weeks postpartum. Dewey et al. (1994) reported not statistically significant difference between the intervention and control arms. Leermakers et al. (1998) recruited women who were between 3 to 12 months postpartum and therefore the effectiveness is not suitable for the model. The RCT conducted by O'Toole et al. (2003) recruited women

who had given birth in the past 6 weeks to 6 months postpartum making unsuitable to include the intervention's effectiveness in the economic model. McCrory et al. (1999) conducted an 11-day follow up after baseline consequently the effectiveness of the intervention on longer term cannot be concluded.

Pre-Pregnancy Body Mass Index.

The mean pre-pregnancy BMI in the control and experimental groups of the Lovelady trial were estimated from the reported pre-pregnancy weight and height (Lovelady, 2001), the standard error on pre-pregnancy BMI being assumed to be the same as that at baseline measurement, i.e. at 4-6 weeks postpartum. The mean pre-pregnancy BMI for women in the experimental and control groups respectively are thus estimated as 24.75 kg/m2 (se 0.8) and 25.96 kg/m2 (se 0.7). It should be noted that the mean BMIs are either side of the threshold for the 'normal' and 'overweight' BMI categories, given in Table 4.

To determine the proportions of each trial arm population in each BMI category it was assumed that BMI was normally distributed according to the above sample characteristics. In order to facilitate the probabilistic sensitivity analysis a Dirichlet distribution, with continuity correction, was assumed for the proportion in each BMI category.

Gestational Weight Gain.

Gestational weight gain was reported in the trial paper Lovelady et al. (2001) in order to facilitate extrapolation of the trial results to BMI 15 years post-partum. Gestational weight gain is categorised into 'less than recommended', 'recommended' or 'more than recommended' according to the pre-pregnancy BMI specific IOM guidelines detailed in Table 4.

In order to estimate the proportions of women in each category gestational weight gain was assumed to be normally distributed. A Dirichlet distribution was used to facilitate probabilistic sensitivity analysis of the proportion of women in each gestational weight gain category.

Weight Loss in the Initial Six Months Postpartum.

In order to estimate the proportion of women who would return to pre-pregnancy weight within 6 months of childbirth, it was assumed that the rate of weight loss in the ten weeks of the trial period would be maintained to twenty six weeks postpartum. A

ten week target weight loss was then estimated from the difference between pre-pregnancy weight and weight at baseline measurement (4-6 weeks post partum) and the proportion achieving this target was estimated assuming that weight loss was normally distributed. A beta distribution was used to estimate the proportion achieving weight loss target in the probabilistic sensitivity analysis.

Time horizon

The model explores the cost and benefits accrued through the measured outcomes over a 15 years post-partum time horizon and over a lifetime horizon. The shorter time horizon is reported as there would be considerable structural uncertainties in the lifetime model associated with the long term extrapolation of outcomes beyond the evidence used from the Lovelady and Rooney studies. The PSA results will underestimate the true uncertainty

Perspective

A UK NHS perspective is used. Therefore, production lost through illness or costs incurred directly by patients are not included. Discount rates of 3.5% per year are applied to both costs and health benefits, according to current NICE guidelines (National Institute for Health and Clinical Excellence 2008). Costs are at 2008 prices**.**

Costs and resources used

The costs of weight management after childbirth interventions are based on resource use reported by Lovelady (2001) and Lovelady et al (2006). The intervention was defined by three components: exercise, dietary restriction, and measurements and examinations. A total cost of doing supervised exercise during 6 months was estimated to be £6,015. This cost was calculated considering the cost of exercise supervision plus the travel costs (Table 5). Lovelady (2001) reported a supervised exercise intervention of 42 minutes, four times a week. This gives an estimated of 59 hours of exercise supervision during 6 months (21 weeks, since the intervention starts at week 4 after childbirth). Assuming that the cost per hour of exercise supervision was the same as the cost of a health visitor (£101 per hour, Table 7) reported in the Unit costs of health and social care 2008 (Curtis and Netten 2008), the cost of supervised exercise is £5,959 per 6 months (duration of intervention). For the travel cost, it was assumed 40 visits in 6 months (Lovelady, 2001) at a travel cost per visit of £1.40 (Table 7).

Table 5: Cost of supervised exercise (6 months)

Cost of exercise supervision	Excl qualification cost
Number of hours	59
Cost per hour[1]	£101.00
Total Cost	£5,959.00
Travel Costs	
Number of visits	40
Travel cost per visit	£1.40
Total Travel cost	£56.00
Total cost of exercise supervision	**£6,015.00**

Notes: [1] Assume health visitor (see Table 7).

Table 6 contains the costs of dietary supervision. Energy intake prescription was determined by subtracting 500 calories from the average of the reported daily baseline consumption and estimated energy requirements (after adding an extra 630 calories for lactation and using an activity factor of 1.35). Women were prescribed a diet containing approximately 25% of energy from fat, 20% from protein and 55% from carbohydrate. Although no mention is made in Lovelady et al. (2001) from which population and intervention details were extracted, a paper by the same authors (Lovelady 2006) reports that participants were instructed by trained graduate research assistants to meet their dietary requirements using the food guide pyramid and that behavioural modification strategies were discussed at individual weekly sessions. We have assumed that participants have an initial individual dietary counselling session of 60 minutes duration and follow up sessions every week of 15 minutes duration (Table 6).

Table 6: Cost of dietary supervision (6 months)

Cost of dietary supervision	Excl qualification cost
Number of hours	6
Cost per hour[2]	£51.00
Total Cost	£306.00
Travel Costs	
Number of visits	22
Travel cost per visit	£2.60
Total Travel cost	£57.20
Total cost of dietary supervision	**£363.20**

Notes: [2] Assume dietitian (see Table 7).

Table 7 presents the cost for professions, used to calculate the three cost components exercise, diet and examination. These costs were taken from the Unit costs of health and social care 2008 (Curtis and Netten 2008).

Table 7: Unit cost of health and social health used in the ScHARR model taken from Curtis and Netten 2008

Profession	Cost per hour spent on home visit	Travel Cost
Health Visitor	£101.00	£1.40
Dietitian	£51.00[1]	£2.60

Notes
[1] Per hour of client contact
[2] Per hour of face to face contact

The cost of examination was calculated using the results present by Lovelady (2006). Although it would not be necessary for women using this programme to undergo the amount of measurement and testing that women in the trial experienced, some initial measurements would be necessary to determine the participants' heart rate reserve (necessary for the exercise programme) and the baseline diet. It would be expected that continued measurements of weight would be carried out by the woman herself or by heath visitors during the exercise supervision visits. Measurement and Examination cost: £250. Therefore, the total cost for the diet and exercise intervention modelled was £6,628 per 6 months.

Utilities

The quality adjusted life years accrued by a woman following childbirth are calculated by determining the time after childbirth at which a woman enters and leaves the different BMI categories (underweight, normal weight, overweight and obese). The relationship between BMI and quality of life was obtained from a study conducted at the Centre for Health Economics, University of York (Macran 2004). This study explored the relationship between health-related quality of life (HRQoL) and BMI for men and women within the 1996 Health Survey for England where HRQoL was measured using EQ-5D. Table 8 presents mean utility scores by BMI and age group for women (Macran 2004).

Table 8: Utility score (standard deviation) and sample size for women according to BMI and age (adapted from Macran).

Age	<21 kg/m2	21 – 25 kg/m2	26 – 30 kg/m2	31 – 39 kg/m2	>39 kg/m2
18 – 24 years	0.90 (0.16) N = 112	0.90 (0.16) N = 341	0.90 (0.16) N = 116	0.88 (0.21) N = 48	0.93 (0.11) N = 8
25 – 34 years	0.88 (0.21) N = 116	0.92 (0.15) N = 607	0.91 (0.16) N = 295	0.88 (0.19) N = 153	0.90 (0.14) N = 22
35 – 44 years	0.89 (0.18) N = 85	0.89 (0.18) N = 591	0.86 (0.20) N = 308	0.82 (0.25) N = 176	0.81 (0.20) N = 22
45 – 54 years	0.89 (0.13) N = 44	0.86 (0.19) N = 473	0.83 (0.23) N = 403	0.83 (0.23) 186	0.76 (0.27) N = 22
55 – 64 years	0.76 (0.27) N = 35	0.83 (0.22) N = 264	0.78 (0.27) N = 322	0.74 (0.30) N = 190	0.54 (0.38) N = 18
65 – 74 years	0.79 (0.22) N = 52	0.82 (0.21) N = 242	0.76 (0.25) N = 324	0.71 (0.28) N = 172	0.68 (0.21) N = 18
75+ years	0.64 (0.31) N = 42	0.76 (0.23) N = 212	0.73 (0.26) N = 227	0.68 (0.31) N = 115	0.53 (0.28) N = 5

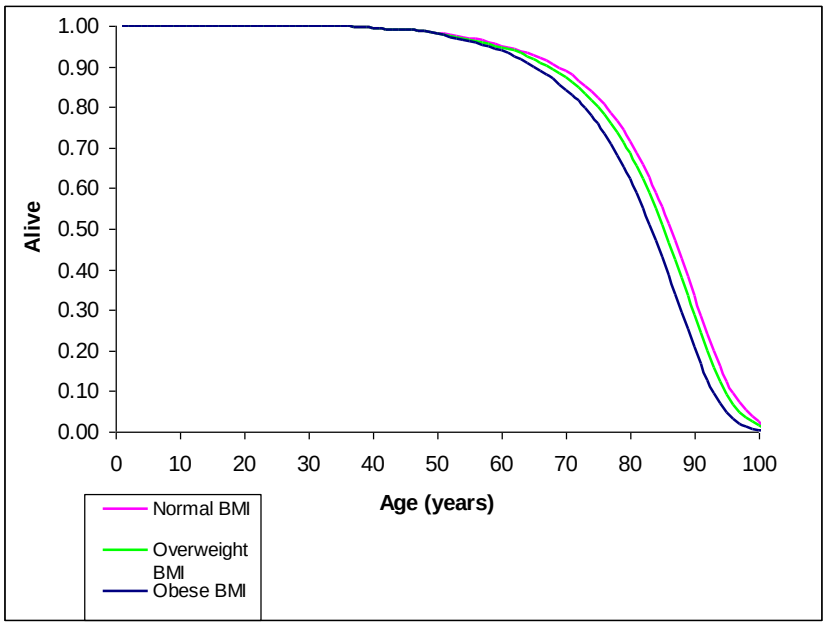
The BMI at six months postpartum and the BMI at fifteen years postpartum were obtained from the specification of the trial population and the regression model respectively. These BMI are used to determine the time it will take women to become overweight and obese. Women received a utility score for each year there were in a specific age and BMI category (Table 8).

Since BMI cannot be considered to continue to increase indefinitely and no evidence was available regarding the change in BMI following the initial 15 years postpartum it was assumed that the women remain in the same BMI category obtained at 15 years following the birth of the index child.

Mortality

BMI specific survival rates were obtained from a collaborative analysis of 57 prospective studies with 894,576 participants, mostly in Western Europe and North America (Prospective Studies Collaboration 2009). The aim of the study was to find the associations of BMI with overall and cause-specific mortality. It was found that BMI is a strong predictor of overall mortality. Figure 3 shows the survival rates for females used in the model according to the different BMI ranges (normal, overweight and obese). The excess mortality above a normal BMI (18.5-25 kg/m^2) is due to vascular disease, diabetes, renal and hepatic diseases.

Figure 3: BMI versus lifespan for females in Western Europe adapted from Prospective Studies Collaboration 2009



Cost-effectiveness Ratios

Incremental cost-effectiveness ratios (ICER) measure the additional cost per quality-adjusted life-year QALY gained of Treatment A versus Treatment B:

$$ICER = \frac{\text{Cost Treatment A - Cost Treatment B}}{\text{QALYs from Treatment A - QALYs from Treatment B}}$$

Sensitivity analysis

Comprehensive sensitivity analyses were undertaken to explore the joint uncertainty in model parameters on the economic evaluation of the intervention (Appendix 3). Monte Carlo sampling techniques (10,000 samples) were used to generate information on the probability that weight management interventions are optimal in terms of amount of net benefit. Since the regression considers whether the mothers exercise post-partum or not, data from the Active People Survey conducted by Sport England were considered. This survey took place between October 2007 and October 2008 and interviewed 191,000 adults in England (age 16+) by telephone. It was decided to consider Key Performance Indicator 1 - Participation is defined as taking part on at least 3 days a week in moderate intensity sport and active recreation (at least 12 days in the last 4 weeks) for at least 30 minutes continuously

in any one session. Participation includes recreational walking and cycling. The proportion of women between 30 and 44 years who participated in exercise was estimated to be 20%. This proportion was included in the model when running the probabilistic sensitivity analysis (PSA).

6. Results

Results for the effectiveness reported by Lovelady (2001) are modelled in this assessment and are presented in this section. Initially, the model was run to calculate the weight change in the mother after 15 years. The factors that have an impact in the weight change are pre-pregnancy BMI, weight gain during pregnancy, breast-feeding, post-partum exercise participation and pre-pregnancy marital status. The model was also run for a lifetime horizon. The results were based on a start age of the population of 25 years and are presented in discounted incremental values.

Table 9: Results at 15 years and lifetime

Time Horizon	Discounted QALYs (95% CI)	ICER (£/QALY) (95% CI)
15 years	0.1503 (-0.0267, 0.4168)	£44,144 (£15,000, dominated)
Lifetime	0.7296 (0.1565, 1.5108)	£9,096 (£4,000, dominated)

From Table 9, it can be seen that at 15 years after childbirth the ICER is above £30,000 per QALY gained while for a lifetime horizon the ICER is below £20,000. This is due to the impact of being obese as opposed to being overweight has.

The results of the probabilistic sensitivity analyses are presented as scatter plots of incremental cost and incremental QALYs for the 15-year and lifetime horizons respectively.

Figure 4: Scatter plot of incremental QALYs and incremental costs for 15-year and lifetime horizons

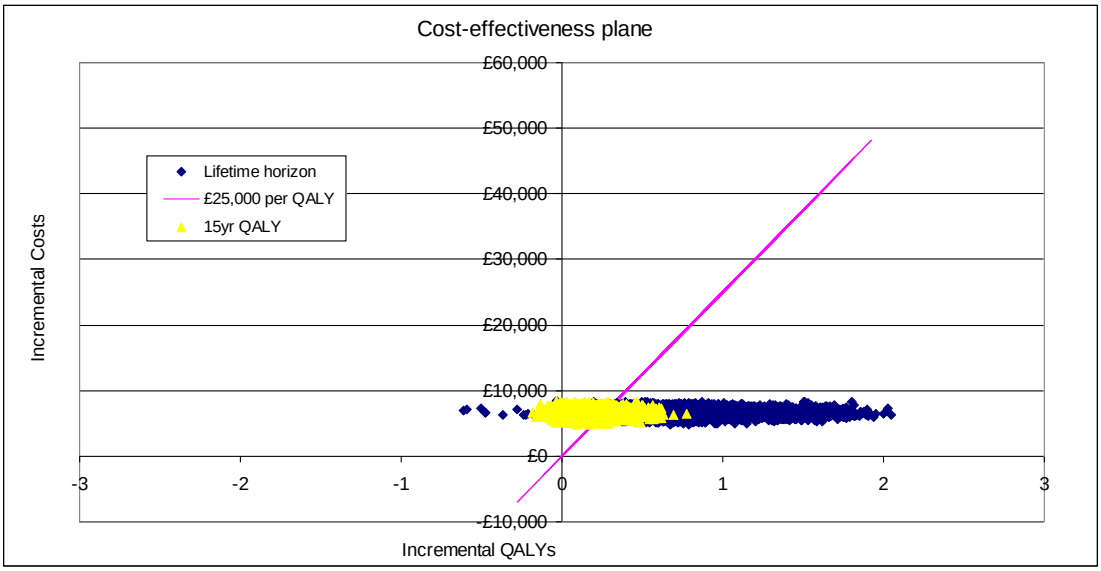
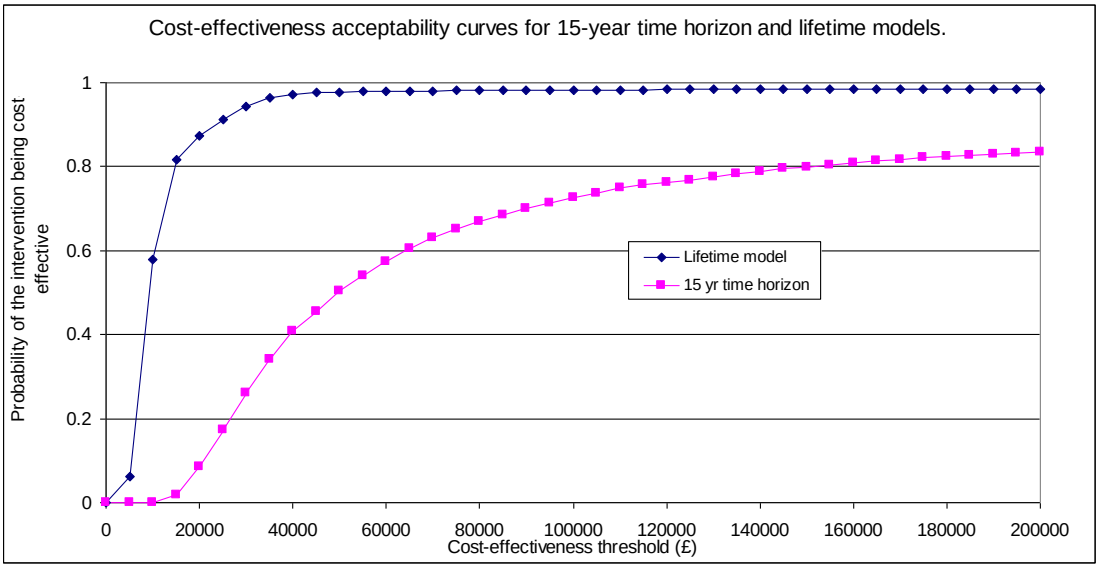


Figure 4 shows that for some cases the QALYs gained by the control group are bigger that the QALYs gained by the intervention group. In these cases the intervention is dominated by usual postnatal care. This means that usual postnatal care accrues more benefits (in the long run) that the dietary and exercise interventions. This can be due to the BMI category the mother is after six months of childbirth.

Figure 5 shows incremental cost-effectiveness curves (CEACs) for the 15-year and lifetime horizons evaluated in the economic model. The net benefit of the dietary and exercise interventions are compared incrementally and the CEACs show the probability that the intervention will results in the greatest net benefit at a specific cost-effectiveness threshold (λ). The net benefit is calculated as:

Net benefit = ($\lambda \times$ *Incremental QALYs*) – *Cost of dietary and exercise intervention*

Figure 5: Cost-effectiveness acceptability curve for 15-year and lifetime horizons



The CEACs (Figure 5) show that when using a 15-year horizon and a threshold of £30,000 per QALY the probability of dietary and exercise interventions being cost-effective is around 26%. Additionally, at a lifetime horizon this probability is around 94%. Thus, the women's BMI category and the time it takes them to move from one category to another (e.g. form overweight to obese) have a direct impact in the quality of life and the resources used by the NHS.

7. Discussion and conclusion

The review of effectiveness concluded that interventions to manage weight gain after childbirth were shown to be effective in the short term. In contrast the economic results were highly dependent on the long term impact of these short term effects. These long term effects are dependent on key assumptions within the modelling. For example the 15 year impact on weight change and the lifelong impact on survival are estimated from observational studies that demonstrate associations rather than causative effects. The long term economic estimates are thus prone to high levels of structural uncertainty not represented in the probabilistic sensitivity analysis.

Strengths – A mathematical model was constructed that allowed the analysis of the impact of dietary and exercise interventions effectiveness over costs and benefits for women after childbirth. It was shown that if the women managed to lose the gestational weight gained they will maintain their pre-pregnancy BMI category.

Limitations – This model is limited by the quality of the evidence used to inform it. The majority of the effectiveness evidence is based in the US; therefore, it is unclear whether it is possible to generalise evidence from this population to women within the UK.

The model uses a single study from the set of trials reviewed in the effectiveness review. This study appears to give weight loss results broadly in line with the whole evidence base on effectiveness and was quality assessed as (+). This being said it should be noted that this was a small study (22 women) and the control group had already lost more weight (equivalent to half of the total weight loss in the study period) between childbirth and the start of the intervention than the intervention group.

The cost effectiveness results suggest that dietary and exercise interventions for weight management after childbirth have the potential to be cost effective depending on the ability to maintain the short term impacts of the interventions into the longer term. These interventions have the potential to influence long term health outcomes such as overweight and obesity rates which will have a direct impact in other diseases such as diabetes, cancer, vascular, renal and hepatic diseases.

Studies examining interventions in weight management after childbirth are required in a UK population. Future research in interventions to managing weight gain after childbirth should ensure that follow up is sufficient to demonstrate health and economic advantages. Where trials are designed to collect short term surrogate outcomes the relationship between these and long term final health outcomes should be explicit and quantifiable. Observation studies in a UK population are required to assist in determining long term effects of interventions in this area.

Separate economic models were constructed for weight management during pregnancy (WMIP) and weight management after childbirth (WMAC), this was because of differences in the structure of the underlying decision problems and differences in the interventions being considered. The models have been designed to be as consistent as possible given the constraints of the guidance development process. The model for WMIP was essentially a short-term model whilst the model for WMAC, presented in this report, gives a fuller consideration to long-term effects. The WMIP model included only long-term effects and cost savings associated with

type II diabetes subsequent to gestational diabetes, whilst the WMAC model included costs and effects (including both morbidity and mortality effects) of BMI changes over 15 years following pregnancy. Longer effects beyond 15 years after birth have not been included in the model. Whilst the cumulative impact of weight gain through subsequent pregnancies will have been captured in the model through the use of the 15 year cohort study the impact on costs and in pregnancy outcomes will not be included. These omissions would lead the economic estimates in this report to underestimate cost effectiveness.

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9. Appendices

Appendix 1: Search Strategies

Searches for evidence for the cost effectiveness review and economic model

List of terms

1 (post natal or postnatal).ti.
2 (post pregnancy or postpregnancy).ti.
3 ((Post or after or following) adj birth).ti.
4 (postpartum or post partum).ti.
5 obes*.ti.
6 weight gain*.ti.
7 weight change.ti.
8 weight loss.ti.
9 body mass index.ti.
10 bmi.ti.
11 10 or 6 or 1 or 9 or 4 or 3 or 7 or 2 or 5 or 8
12 (child* or adolescen*).ti.
13 11 not 12

List of databases

Econlit via OVID SP
NHS EED via Cochrane Library via Wiley

Appendix 2: Included studies

Paper	Characteristics of Trial Required to Extrapolate Post-Pregnancy Weight Gain.
Dewey *et al*	<u>Exercise Group Participants.</u> Marital Status: Not reported. Weight gained during pregnancy: 15.2 ± 5.3 kg (pre-pregnancy weight 61.3 ± 6.5 kg, height 163.2 ± 6.9 cm). Weight lost by six months: Not reported (weight 65.7 ± 10.7 kg at end of study, 18 to 20 weeks postpartum). Breast Feeding: All participants planned to breast feed their infant for at least 20 weeks. Exercise: Yes (structured as part of the intervention). Maternal Weight Following Birth: Pre-pregnancy weight: 61.3 ± 6.5 kg, weight gain during pregnancy: 15.2 ± 5.3 kg, infant birth weight: 3.66 ± 0.36 kg. Maternal weight following birth is calculated as pre-pregnancy weight plus weight gain during pregnancy less infant birth weight. <u>Control Group Participants.</u> Marital Status: Not reported. Weight gained during pregnancy: 17.5 ± 5.4 kg (pre-pregnancy weight 61.6 ± 6.5 kg, height 167.6 ± 6.5 cm). Weight lost by six months: Not reported (weight 65.4 ± 8.3 kg at end of study, 18 to 20 weeks postpartum). Breast Feeding: All participants planned to breast feed their infant for at least 20 weeks. Exercise: No (did not engage in aerobic exercise more than once per week during the period of the intervention). Maternal Weight Following Birth: Pre-pregnancy weight: 61.6 ± 6.5 kg, weight gain during pregnancy: 17.5 ± 5.4 kg, infant birth weight: 3.89 ± 0.54 kg. Maternal weight following birth is calculated as pre-pregnancy weight plus weight gain during pregnancy less infant birth weight.

Leermakers *et al*	<u>Correspondence Behavioural Weight Loss Programme Participants.</u> Marital Status: 93.5% married, 2.2% single, 4.3% separated or divorced. Percentage of subjects who exceeded IOM weight gain recommendations: 64%. (pregnancy weight gain: 17.5 ± 5.7 kg). Weight lost by six months: No (7.8 ± 4.5 kg lost at end of six month study period, note at start of study women were between three and twelve months postpartum (mean: 8.3 ± 2.2 months). Retained weight at start of study 11.0 ± 4.2 kg). Breast Feeding: Lactating participants were excluded from the study. Exercise: Yes (encouraged as part of the intervention). Maternal Weight Following Birth: Not reported. <u>Non Treatment Control Condition Participants.</u> Marital Status: 79.1% married, 20.9% single, 0% separated or divorced. Percentage of subjects who exceeded IOM weight gain recommendations: 77%. (pregnancy weight gain: 19.8 ± 6.7 kg). Weight lost by six months: No (4.9 ± 5.4 kg lost at end of six month study period, note at start of study women were between three and twelve months postpartum (mean: 8.5 ± 2.1 months). Retained weight at start of study 11.3 ± 3.7 kg). Breast Feeding: Lactating participants were excluded from the study. Exercise: Not reported. Maternal Weight Following Birth: Not reported.
Lovelady *et al*	<u>Experimental Group Participants,</u> Marital Status: Not reported. Weight gained during pregnancy: 15.5 ± 1.0 kg (pre-pregnancy weight 68.6 ± 2.3 kg, height 166.5 ± 1.9 cm). Weight lost by six months: Not reported (4.4 ± 0.4 kg lost at end of study, 14 weeks postpartum). Breast Feeding: Yes (duration not reported). Exercise:

	Yes (structured as part of the intervention). Maternal Weight Following Birth: Pre-pregnancy weight: 68.6 ± 2.3 kg, weight gain during pregnancy: 15.5 ± 1.0 kg, infant birth weight: 3.61 ± 0.21 kg. Maternal weight following birth is calculated as pre-pregnancy weight plus weight gain during pregnancy less infant birth weight. <u>Control Group Participants,</u> Marital Status: Not reported. Weight gained during pregnancy: 14.8 ± 1.3 kg (pre-pregnancy weight 70.5 ± 2.9 kg, height 164.8 ± 1.3 cm). Weight lost by six months: Not reported (0.9 ± 0.5 kg lost at end of study, 14 weeks postpartum). Breast Feeding: Yes (duration not reported). Exercise: Did not engage in aerobic exercise more than once per week during the period of the intervention. Maternal Weight Following Birth: Pre-pregnancy weight: 70.5 ± 2.9 kg, weight gain during pregnancy: 14.8 ± 1.3 kg, infant birth weight: 3.51 ± 0.10 kg. Maternal weight following birth is calculated as pre-pregnancy weight plus weight gain during pregnancy less infant birth weight.
Lovelady *et al*	<u>Diet and Exercise Group Participants,</u> Marital Status: Not reported. Weight gained during pregnancy: Not reported. Weight lost by six months: Not reported. Breast Feeding: Yes (till completion of study at 14 weeks postpartum). Exercise: Yes (structured as part of the intervention). Maternal Weight Following Birth: Not reported. <u>Control Group Participants,</u> Marital Status: Not reported. Weight gained during pregnancy:

	Not reported. Weight lost by six months: Not reported. Breast Feeding: Yes (till completion of study at 14 weeks postpartum). Exercise: No (sedentary women recruited women were instructed not to change their physical activity during the study). Maternal Weight Following Birth: Not reported.
McCrory et al	<u>Diet Group Participants,</u> Marital Status: Not reported. Weight gained during pregnancy: 15.2 ± 5.0 kg (pre-pregnancy weight 67.3 ± 14.0 kg, height 165.0 ± 10.0 cm). Weight lost by six months: Yes (weight 66.4 ± 9.8 kg at end of 11 day study period, note at start of study women were between 8 and 16 weeks postpartum (mean: 12.2 ± 3.5 weeks). However, weight at start of study period 68.3 ± 10.2 kg so most of weight gained during pregnancy lost pre-study). Breast Feeding: Yes. Exercise: Yes (three days per week, maintenance of planned baseline exercise). Maternal Weight Following Birth: Pre-pregnancy weight: 67.3 ± 14.0 kg, weight gain during pregnancy: 15.2 ± 5.0 kg, infant birth weight: 3.58 ± 0.53 kg. Maternal weight following birth is calculated as pre-pregnancy weight plus weight gain during pregnancy less infant birth weight. <u>Diet and Exercise Group Participants,</u> Marital Status: Not reported. Weight gained during pregnancy: 16.1 ± 4.8 kg (pre-pregnancy weight 64.9 ± 14.2 kg, height 164.6 ± 7.7 cm). Weight lost by six months: Not reported (weight 67.8 ± 12.7 kg at end of 11 day study period, note at start of study women were between 8 and 16 weeks postpartum (mean: 12.0 ± 3.7 weeks). However, weight at start of study period 69.0 ± 12.8 kg). Breast Feeding: Yes.

	Exercise: Yes (structured as part of the intervention). Maternal Weight Following Birth: Pre-pregnancy weight: 64.9 ± 14.2 kg, weight gain during pregnancy: 16.1 ± 4.8 kg, infant birth weight: 3.54 ± 0.49 kg. Maternal weight following birth is calculated as pre-pregnancy weight plus weight gain during pregnancy less infant birth weight. <u>Control Group Participants,</u> Marital Status: Not reported. Weight gained during pregnancy: 16.1 ± 6.0 kg (pre-pregnancy weight 66.4 ± 8.7 kg, height 166.5 ± 7.1 cm). Weight lost by six months: Not reported (weight 68.3 ± 8.6 kg at end of 11 day study period, note at start of study women were between 8 and 16 weeks postpartum (mean: 12.6 ± 3.7 weeks). However, weight at start of study period 68.5 ± 8.5 kg). Breast Feeding: Yes. Exercise: Yes (three days per week, maintenance of planned baseline exercise). Maternal Weight Following Birth: Pre-pregnancy weight: 66.4 ± 8.7 kg, weight gain during pregnancy: 16.4 ± 6.0 kg, infant birth weight: 3.52 ± 0.41 kg. Maternal weight following birth is calculated as pre-pregnancy weight plus weight gain during pregnancy less infant birth weight.
O'Toole *et al*	<u>Structured Diet and Physical Activity Programme Participants,</u> Marital Status: Not reported. Weight gained during pregnancy: All study participants gained more than 15 kg during pregnancy otherwise not reported). Weight lost by six months: No (reported that at start of intervention all study participants were more than 5 kg heavier than pre-pregnancy weight at baseline 85.4 ± 3.5 kg, weight at 12 weeks 84.8 ± 4.2 kg, weight at one year 84.1 ± 4.3 kg). Breast Feeding: Breastfeeding women were not excluded, otherwise not reported. Exercise: Yes (structured as part of the intervention). Maternal Weight Following Birth:

	Not reported. Self Directed Programme Participants, Marital Status: Not reported. Weight gained during pregnancy: All study participants gained more than 15 kg during pregnancy otherwise not reported). Weight lost by six months: Not explicitly reported (however reported that at start of intervention all study participants were more than 5 kg heavier than pre-pregnancy, weight at baseline 78.6 ± 1.6 kg, weight at 12 weeks 73.0 ± 2.2 kg, weight at one year 71.3 ± 2.2 kg thus a mean participant in the self directed programme would have lost 5.6 kg by 12 weeks and 7.3 kg by 1 year compared to baseline. Note however that women were between 6 weeks and 6 months postpartum at start of study). Breast Feeding: Breastfeeding women were not excluded, otherwise not reported. Exercise: Not reported. Maternal Weight Following Birth: Not reported.
Albright *et al*	Intervention Group Participants, Marital Status: 95% married, 5% other marital status Weight gained during pregnancy: Not reported. Weight lost by six months: Not reported. Breast Feeding: Not reported. Exercise: Yes (structured as part of intervention). Maternal Weight Following Birth: Not reported.
Kinnunen *et al*	Intervention Group Participants, Marital Status: Not reported. Weight gained during pregnancy: Total mean gestational weight gain 16.2 ± 5.0 kg. Nine (19%) of participants in the intervention group gained less than recommended, thirteen (28%) of

	participants in the intervention group gained the recommended amount of weight and twenty-five (53%) of participants in the control group gained more than recommended. Weight lost by six months: Not reported, however it is reported that weight retention at two months postpartum compared to pre-pregnancy weight is 4.3 ± 4.0 kg. Breast Feeding: Not reported. Exercise: Yes (structured as part of intervention). Maternal Weight Following Birth: Not reported. <u>Control Group Participants,</u> Marital Status: Not reported. Weight gained during pregnancy: Total mean gestational weight gain 15.3 ± 5.0 kg. Nine (24%) of participants in the intervention group gained less than recommended, eleven (30%) of participants in the intervention group gained the recommended amount of weight and seventeen (46%) of participants in the control group gained more than recommended. Weight lost by six months: Not reported, however it is reported that weight retention at two months postpartum compared to pre-pregnancy weight is 4.2 ± 3.9 kg. Breast Feeding: Not reported. Exercise: Not reported. Maternal Weight Following Birth: Not reported.
Olsen *et al*	<u>Intervention Group Participants,</u> Marital Status: 79.0% married, separated or divorced, 21.0% single. Weight gained during pregnancy: Overall gestational weight gain in the intervention group 14.1 ± 4.51 kg. Weight lost by six months: Not reported, however it is reported that weight retention at one year postpartum compared to pre-pregnancy weight is 0.59 ± 4.75 kg. Breast Feeding: Not reported.

	Exercise: Yes (structured as part of intervention). Maternal Weight Following Birth: Not reported. <u>Control Group Participants,</u> Marital Status: 79.9% married, 19.0% single. Weight gained during pregnancy: Overall gestational weight gain in the intervention group 14.8 ± 4.68 kg. Weight lost by six months: Not reported, however it is reported that weight retention at one year postpartum compared to pre-pregnancy weight is 1.31 ± 5.60 kg. Breast Feeding: Not reported. Exercise: Not reported. Maternal Weight Following Birth: Not reported.

Appendix 3: Probabilistic sensitivity analysis parameters

Regression model predicting weight gain over 15 years

Characteristic	Experimental Group			Control Group		
	Change in body weight at 15 year follow up			Change in body weight at 15 year follow up		
Y axis intercept	-2.00	1.00	-2.00	-2.00	1.00	-2.00
Marital Status	Coefficient	Selection	Value	Coefficient	Selection	Value
Married	0.00	0.00	0.00	0.00	0.00	0.00
Single	3.36	1.00	3.36	3.36	1.00	3.36
Gestational weight gain categories	Coefficient	Selection	Value	Coefficient	Selection	Value
Less than recommended	0.43	0.06	0.03	0.43	0.10	0.04
Recommended	0.00	0.29	0.00	0.00	0.25	0.00
More than recommended	4.19	0.65	2.71	4.19	0.65	2.73
Weight loss by six months	Coefficient	Selection	Value	Coefficient	Selection	Value
Lost weight gained in pregnancy	0.00	0.67	0.00	0.00	0.26	0.00
Retained weight gained in pregnancy	5.44	0.33	1.79	5.44	0.74	4.01
Duration of breast feeding	Coefficient	Selection	Value	Coefficient	Selection	Value
Did not breast feed	2.02	0.00	0.00	2.02	0.00	0.00
Breast fed for between 2 and 12 weeks	2.44	0.00	0.00	2.44	0.00	0.00
Breast fed beyond 12 weeks	0.00	1.00	0.00	0.00	1.00	0.00
Postpartum participation in aerobic exercise	Coefficient	Selection	Value	Coefficient	Selection	Value
Yes	0.00	1.00	0.00	0.00	0.00	0.00
No	2.59	0.00	0.00	2.59	1.00	2.59
Body mass index at birth	Coefficient	Selection	Value	Coefficient	Selection	Value
Underweight	0.00	0.01	0.00	0.00	0.00	0.00
Normal weight	1.83	0.53	0.97	1.83	0.34	0.62
Overweight	4.76	0.44	2.08	4.76	0.62	2.95
Obese	8.31	0.02	0.20	8.31	0.04	0.34

Characteristic	Mean	95% Confidence Interval		Standard Error	Distribution
		Lower Bound	Upper Bound		
Experimental Group					
Maternal Height	1.665	1.63	1.70	0.06	Normal
Maternal weight pre-pregnancy	68.60	64.09	73.11	7.63	Normal
Maternal body mass index pre-pregnancy	24.75	23.18	26.31	2.65	Normal
Maternal weight gain during pregnancy	15.50	13.54	17.46	3.32	Normal
Maternal weight at start of trial (4-6 weeks postpartum)	76.60	70.92	82.28	9.62	Normal
Change in weight over duration of trial (10 weeks kg)	-4.40	-5.18	-3.62	1.33	Normal
Control Group					
Maternal Height	1.648	1.62	1.67	0.04	Normal
Maternal weight pre-pregnancy	70.50	64.82	76.18	9.62	Normal
Maternal body mass index pre-pregnancy	25.96	24.59	27.33	2.32	Normal
Maternal weight gain during pregnancy	14.80	12.25	17.35	4.31	Normal
Maternal weight at start of trial (4-6 weeks postpartum)	74.60	70.68	78.52	6.63	Normal
Change in weight over duration of trial (10 weeks kg)	-0.90	-1.88	0.08	1.7	Normal