



EUROPE

Antimicrobial stewardship

The effectiveness of educational interventions to change risk-related behaviours in the general population

A systematic review

Sarah King, Josephine Exley, Jirka Taylor, Kristy Kruithof,
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Preface

The National Institute for Health and Care Excellence (NICE) has been asked by the Department of Health to develop a public health guideline aimed at delaying antimicrobial resistance, which will focus on educating the public about:

- The importance of the appropriate use of antimicrobials;
- The dangers associated with the overuse and misuse of antimicrobials; and
- Changes in behaviour that can be taken to avert threats associated with the misuse of these drugs, such as infection prevention measures.

To inform this guidance, RAND Europe was commissioned to undertake a systematic review of the evidence of effectiveness and cost-effectiveness of changing the public's risk related behaviours pertaining to antimicrobial use to inform the development of the guidelines. In particular the review sought to answer two research questions:

1. Which educational interventions are effective and cost-effective in changing people's behaviour to ensure they only ask for antimicrobials when appropriate and use them correctly?
2. Which educational interventions are effective and cost-effective in changing the public's behaviour to prevent infection and reduce the spread of antimicrobial resistance?

In addressing these questions this technical report of our systematic review provides a detailed summary and quality assessment of the available evidence published since 2001, intended to inform the Public Health Advisory Committee (PHAC) tasked with formulating the guideline. The evidence from this review is presented in a series of concise Evidence Statements in adherence with NICE guidance. Each statement provides a high level overview of the key features of the evidence including the number of studies, the quality of evidence and the direction of the estimated effect followed by a brief summary of each of the supporting studies.

RAND Europe is an independent not-for-profit policy research organisation that aims to improve policy- and decision-making in the public interest, through research and analysis. This report has been peer-reviewed in accordance with RAND's quality assurance standards. For more information about this document or RAND Europe, please contact:

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Summary

Antimicrobial drugs include antibiotics, antivirals and antifungals which are used to kill microorganisms such as bacteria and viruses. The availability of effective antimicrobial drugs are estimated to add 20 years to life expectancy. The emergence of antimicrobial resistance (AMR) therefore poses a serious threat to public health. AMR is the ability of microorganisms to continue to multiply uninhibitedly in the presence of antimicrobial drugs, making conventional treatment ineffective. AMR poses a growing threat to public health, as infections from resistant strains of microbials become increasingly difficult and expensive to treat, resulting in prolonged illness and greater risk of death. The over use and inappropriate use of antimicrobials contribute to the acceleration, emergence and spread of AMR. Strategies that encourage antimicrobials to be used more responsibly and less often are therefore needed to safeguard human health. This includes awareness campaigns targeting the public to raise the profile of the issue and induce societal and cultural change.

RAND Europe was commissioned by NICE Centre for Public Health to conduct a systematic review of the effectiveness and cost-effectiveness of educational interventions aimed at changing risk-related behaviours relating to the use of antimicrobials. This evidence will be used to help inform the development of a guideline aimed at delaying antimicrobial resistance.

This review considered educational interventions targeting individuals, communities or the general public delivered via any number of modes (e.g. classroom education, leaflets, campaigns). Specifically, this review aimed to answer the following research questions:

1. Which educational interventions are effective and cost-effective in changing the public's behaviour to ensure they only ask for antimicrobials when appropriate and use them correctly?
2. Which educational interventions are effective and cost-effective in changing the public's behaviour to prevent infection and reduce the spread of antimicrobial resistance?

This review did not include interventions targeting physicians or other prescribers, as this is the focus of another NICE review conducted in parallel to this one (Antimicrobial stewardship: systems and processes for effective antimicrobial medicine use: <http://www.nice.org.uk/guidance/indevelopment/gid-antimicrobialstewardship>).

The review was conducted following guidance presented in 'Developing NICE guidelines: the manual'. A range of relevant databases were searched for data from 2001 onwards. Given that interventions, settings, and population groups differed in the included studies, meta-analyses were not conducted, and the results were summarised narratively in texts and tables.

Overall, 60 studies met the inclusion criteria; 29 of these related to research question 1, and 36 related to research question 2 (5 studies were applicable to both research questions). The results for research question 2 were subdivided into studies related to infection and/or hand hygiene (22 studies) and food safety and hygiene (16 studies). Some studies reported on multiple relevant outcomes and are reported in each relevant section. Twelve studies were rated as moderate quality (+), and the remaining 48 studies were rated as poor quality (-), based on a methodology checklist published by NICE for public health guidance.

The key findings from these studies are briefly summarised below in 'Evidence Statements', which are statements that provide a high level overview of the key features of the evidence, including the number of studies, the quality of evidence, and the direction of the estimated effect followed by a brief summary of each of the supporting studies. Studies have been grouped into Evidence Statements by setting and intervention. For a more detailed overview of the individual studies the reader should refer to the written narrative within the body of the report.

Research question 1: Antibiotic knowledge and behaviour

Pharmacist – led interventions targeting patients or carers of patients

Evidence Statement 1.1 Pharmacist-led verbal education, supplemented with an information leaflet

There is weak evidence from one non-randomised controlled trial (non-RCT) (-)¹, one randomised controlled trial (RCT) (-)² and one pre–post study (-)³ indicating that verbal education on antibiotic adherence from a pharmacist, or the combination of written and verbal education on antimicrobial (AM) use and antimicrobial resistance (AMR) delivered by pharmacists, can improve patients' adherence to treatment and knowledge of AM use, but that written and verbal education did not increase awareness of AMR. However, baseline awareness was high, potentially leaving less room for knowledge gain.

One non-RCT¹ (-) (Spain; n=138) found that individualised verbal education about treatment characteristics, duration, dosage regime and how to use the antibiotic delivered by a pharmacist to patients and/or carers before collecting an antibiotic prescription, lead to increased adherence (aOR 2.23 [95%CI: 1.01 to 4.93] p=0.047).

One RCT² (-) (Australia; n=34) found that the provision of a patient education leaflet plus verbal education from a pharmacist led to improved knowledge of antibiotics (the mean difference in 'antibiotic knowledge' score increased by 33.3% (± 40.8), from 60.0% (± 43.9) to 86.6% (± 17.2) (p=0.008). Conversely, in the control group (who received a 'Consumer Medicines Information' leaflet only), there was a non-significant decrease in knowledge of antibiotics; the mean difference in 'antibiotic knowledge' score decreased from 83.3% (± 23.6) to 80.0% (± 35.8) (p=non-significant (ns)). No statistical comparisons were made between the control and intervention groups.

One pre–post study³ (-) (USA; n=130) reported that pharmacist-led verbal education and a patient educational leaflet and handout significantly improved patients' overall understanding of AMR, from 56.5% at baseline to 78.3% at follow up (p=0.026). However, the change-from-baseline for all three individual component questions/statements was non-significant, potentially because baseline knowledge of the participants was already high. The results also indicated some improvements in patients' understanding of the appropriate use of antibiotics. There was a significant increase in the number of patients who correctly reported that antibiotics should not be used to treat viral infections for two out of the four conditions surveyed: cold, from 58.7% to 80.4% (p=0.02), and flu with body aches, from 34.8% to 60.9% (p=0.02).

Applicability:

While none of the studies were conducted in the UK, the evidence is directly applicable to people in the UK as there are no obvious differences in the population, context or setting of the studies compared with the UK context.

1. Muñoz et al. 2013 (-)
2. Northey et al. 2010 (-)
3. Rodis et al. 2004 (-)

Interventions based in general practice and/or led by a GP targeting patients or parents of paediatric patients

Evidence Statement 1.2 Video- and information leaflet-based interventions in general practice and/or led by a GP targeting parents of paediatric patients

There is weak evidence from two RCTs (+)¹ (-)² and one non-RCT (-)³ that the combination of an educational video on antimicrobial use and antimicrobial resistance, supplemented by an information leaflet delivered within a primary care setting, can improve parents' knowledge of appropriate antimicrobial use and expectations of antimicrobials for their child, but that it was not effective in improving awareness of AMR.

One RCT¹ (+) (USA; n=206) found that a 20-minute video programme, supplemented by an information leaflet, both of which aimed to educate parents on the problem of bacterial resistance to antibiotics and their appropriate use to prevent the development of resistance, did not have an impact on knowledge scores or any of the five statements related to beliefs, but did have a significant impact on one of the five behaviour statements: there was a reduction in saving antibiotics for later use when compared with the control group, 3.82 vs 3.62 (p=0.02).

One RCT² (-) (USA; n=499) conducted in a paediatrician's office reported that an information leaflet ('Your Child and Antibiotics') and a video presented by a GP on judicious use of antibiotics was effective in increasing parents' knowledge of when to use antibiotics for all five statements related to appropriate use of antibiotics for specific conditions in children compared with control, but for only one out of the five more general statements related to increasing awareness of AMR.

One non-RCT³ (-) (USA; n=771) conducted in a GP's office found that provision of an information leaflet ('Your Child and Antibiotics') and a video in waiting rooms significantly improved knowledge of when to take antibiotics in those who reported seeing the video vs those who reported not seeing the video at 36 weeks post-intervention: 7.1% vs 29.2% thought that antibiotics should be used to treat a child with fever or a cold (p≤0.001), and 13.8% vs 44.3% wanted/expected the doctor to prescribe antibiotics for their child (p<0.001).

Applicability:

While none of the studies were conducted in the UK, the evidence is directly applicable to people in the UK, despite differences in the broader healthcare context in the USA, as there are no obvious differences in the population, context or setting of the study compared with the UK context.

1. Bauchner et al. 2001 (+)
2. Taylor et al. 2003 (-)
3. Wheeler et al. 2001 (-)

Evidence Statement 1.3 Communication and/or information leaflet-based interventions in general practice targeting parents of paediatric patients

There is inconsistent evidence from one RCT(-)¹ and one cluster-RCT (+)² on the effectiveness of educational interventions that aim to improve patient doctor dialogue during a GP consultation, supplemented by an information leaflet, on parents expectation of antibiotic treatment or 'intention to consult', but there was significant reduction in antibiotic consumption.

One RCT (-)¹ (USA; n=80) found that an intervention to enhance communication between parents and their child's physician (involving role play) and/or an information leaflet ('Your Child and Antibiotics'), plus a fact sheet about antibiotics and AMR, did not significantly change parents' expectations of antibiotic treatment for their child compared with the control group, who were given information on child nutrition. We note that the results were not clearly presented and that therefore no clear data can be presented here.

One cluster-RCT² (+) (England and Wales; n=558 children) found that online training for GPs in combination with a booklet, designed to be used as a consultation aid (to increase doctor/patient communication) and a take home resource for parents, led to significant reductions in antibiotic consumption (22.4% in intervention vs. 43% in control; aOR [95% CI 0.18 to 0.66]) and parents' intention 'to consult if their child had a similar illness' (55.3% in intervention vs. 76.4% in control; aOR 0.34 [95%CI 0.20 to 0.57]).

Applicability:

While one of the studies was not conducted in the UK, the evidence is directly applicable to people in the UK, despite differences in the broader healthcare context in the USA, as there are no obvious differences in the population, context or setting of the study compared with the UK context.

1. Alder et al. 2005 (-)
2. Francis et al. 2009 (+)

Evidence Statement 1.4 Cold pack and information leaflet-based intervention in general practice led by a GP targeting adult patients

There is weak evidence from one non-RCT (-)¹ (USA; n=299 analysed) that an information leaflet ('Antibiotics – Did You Know?') distributed in a primary care setting to all participating adult patients, significantly decreased the patients' perceived need for antibiotics at post-test follow up ($p < 0.001$ [pre vs. post for all participants]) and increased their knowledge of appropriate antibiotic use (i.e. for what illnesses one should take antibiotics) ($p < 0.034$ [pre-vs. post for all participants]). A sub-sample of patients were allocated a cold pack which contained products designed to provide symptomatic relief, and subgroup analysis revealed that an increase in appropriate antibiotic use knowledge was significantly larger for the education group ($p < 0.002$), but not for those who received both education and a 'cold pack' kit.

Applicability:

While the study was not conducted in the UK, the evidence is directly applicable to people in the UK as there are no obvious differences in the population, context or setting of the study compared with the UK

context.

1. Alden et al. 2010 (-)

Evidence Statement 1.5 Information leaflet (with or without delayed prescription) targeting patients

There is inconsistent evidence from one RCT (-)¹ and one nested-RCT (+)² on the effectiveness of information leaflets within a primary care setting to reduce antibiotic use in patients with lower respiratory tract infections.

One RCT (-)¹ (UK; n=807) conducted in a primary care setting found that providing patients (with acute lower respiratory tract infection) with an information leaflet about the natural history of the condition, had no significant effect on antibiotic use (p=0.58), satisfaction with treatment (p=0.24) or belief in antibiotics (p=0.73) when compared to no leaflet. Patients in this study were also randomised to receive no prescription, delayed prescription or immediate prescription, but leaflet vs. no leaflet results were not presented within each of these prescribing practices.

One nested-RCT² (+) (UK; n=212) found that an information leaflet about the natural course of lower respiratory tract symptoms and the advantages/disadvantages of antibiotic use provided to patients with acute bronchitis who were judged by their GP not to need antibiotics but given a prescription with the advice that they did not need it, significantly reduced inappropriate antibiotic use. Patients in the intervention were significantly less likely to take the antibiotics prescribed compared with patients in the control, who received standard care (RR 0.76 [95%CI: 0.59 to 0.97], p=0.04).

Applicability:

While one of the studies was not conducted in the UK, the evidence is directly applicable to people in the UK as there are no obvious differences in the population, context or setting of the study compared with the UK context.

1. Little et al. 2005 (-)
2. Macfarlane et al. 2002 (+)

Interventions based in the accident and emergency (A&E) department of a hospital targeting patients or parents of paediatric patients

Evidence Statement 1.6 Interactive computerised education module based in A&E targeting patients

There is weak evidence from one pre–post study (-)¹ (USA; n=686) that an educational interactive computerised kiosk situated in an A&E department reduced the desire for antibiotics in patients presenting with acute respiratory infection (ARI). This study found that the proportion of patients with a low desire for antibiotics increased after completing the module, from 22% to 49% (p<0 .001), and that the proportion who strongly wanted antibiotics decreased from 34% to 27% (p<0.001). Change in desire was positively associated with self-report of having learnt something new at the end of the module (aOR 1.67 [95%CI: 1.14 to 2.45]).

Applicability:

The evidence is partially applicable to people in the UK. This is because the population attending A&E for acute respiratory infections in the USA may be more likely to be uninsured and to have lower socio-economic status; in those respects it may differ from the population in the UK.

1. Price et al. 2011 (-)

Evidence Statement 1.7 Video or information leaflet based in A&E targeting parents of paediatric patients

There is weak evidence from one RCT (-)¹ (USA; n=337) that an animated video or information pamphlet delivered in an emergency department of a hospital significantly increased parents' mean rank self-reported knowledge score of appropriate antibiotic use immediately post intervention and at four-weeks follow up, compared to controls. There was no difference in mean score between the video and pamphlet group post intervention (p=0.19) but the video group performed significantly better at four-weeks follow up (p=0.04). The video group was also significantly less likely to report that they would ask paediatrician for antibiotic if their child had an illnesses (such as cold and fever) that had been discussed during the intervention than the pamphlet group: 35.4% vs. 14.5%, respectively (p=0.003).

Applicability:

The evidence is partially applicable to people in the UK. This is because the population attending A&E for acute respiratory infections in the USA may be more likely to be uninsured and to have lower socio-economic status; in those respects it may differ from the population in the UK.

1. Schnellinger et al. 2010 (-)

Intervention based in the home led by researchers targeting the Latino community

Evidence Statement 1.8 Culturally appropriate, home-based educational intervention targeting Latino population

There is weak evidence from one pre–post study¹ (+) (USA; n=422 analysed) that a culturally sensitive home-based educational intervention can increase participants' knowledge of whether it is appropriate to take antibiotics for a cold, sore throat, asthma and influenza (p<0.01 for each).

Applicability

The evidence is partially applicable to the wider UK population, as the study population may differ from the population in the UK. The intervention could be conducted in the UK context and is likely to be relevant to other ethnic minority groups as well.

1. Larson et al. 2009 (+)

Interventions based within primary or secondary schools and/or targeting school aged children

Evidence Statement 1.9 School-based interventions led by a teacher targeting school children or interventions targeting school aged children

There is inconsistent evidence from four pre–post studies – three (-)^{1,2,4} and one (+)⁵ – and one RCT (-)³ concerning whether school-based interventions can positively impact on students’ knowledge and understanding of the concepts of bacteria, antimicrobials and appropriate antimicrobial use.

One pre–post study¹ (-) (UK; n=1736 [school n=62, online n=1674]) found that an e-Bug-developed ‘junior student’–level computer game for 9- to 12-year-old children did not significantly change students’ knowledge of appropriate antibiotic use (e-Bug is a Europe-wide antibiotic and hygiene teaching resource).

Two pre–post studies (-)² (+)³ (UK; n=48 and n=251, respectively) found that a two-day workshop titled Antibiotics and Your Good Bugs, for children 9 to 10 years of age, or a ‘Bug Investigators’ pack, for children 10 to 11 years of age, effectively improved knowledge of microbes/infection and antibiotics and appropriate antibiotic use but did not have any effect on awareness of AMR.

One pre–post study⁴ (-) (Portugal; n=42) found that a one-week hands-on programme, whose title translates as Microbiology Recipes: Antibiotics à la carte, for high school students aged 15 to 16 years old significantly improved students’ knowledge of bacteria and antibiotics, appropriate antibiotic use and awareness of AMR (p<0.05 improvement on all questions).

One RCT⁵ (-) (Italy; n=249) found that an educational food safety campaign, whose title translates as Mission on the Invisible World (which included information on bacteria), did not significantly progress the students’ knowledge of ‘insight into flu and antimicrobial resistance’ (p-values were not reported).

Applicability

While two of the studies were not conducted in the UK, the evidence is directly applicable to people in the UK, as there are no obvious differences in the population, context or setting of the study compared with the UK context.

1. Farrell et al. 2011 (-)
2. McNulty et al. 2001 (-)
3. McNulty et al. 2007 (+)
4. Fonseca et al. 2012 (-)
5. Losasso et al. 2014 (-)

Intervention based in day care centre led by health educator/child care provider targeting parents

Evidence Statement 1.10 Day care-based intervention led by health educators/child care providers targeting parents

There is weak evidence from one RCT¹ (-) (USA; n=659) that the provision of educational materials (brochures, leaflets, colouring sheets and handouts on appropriate antibiotic use) disseminated by care workers may lead to improvements in knowledge of appropriate antibiotic use among parents with a college education (9-point knowledge median score pre vs. post intervention: 7 vs 6.5, $p<0.01$), but not for parents without a college education (median score 6 vs 6, $p=0.20$).

Applicability:

While the study is not set in the UK, the evidence is directly applicable to people in the UK, as there are no obvious differences in the population, context or setting of the study compared with the UK context.

1. Croft et al. 2007 (-)

Interventions implemented within the community

Evidence Statement 1.11 Mass media campaign (advertisements in magazines and newspapers, posters and leaflets) at the community level

There is weak evidence from two US studies (one cluster RCT (+)¹ and one non-RCT (-)²) indicating that media campaigns delivered within a community setting have no effect on a community's knowledge of antibiotics, demand for antibiotics, or use of antibiotics without a prescription.

One cluster RCT¹ (+) (USA; 2000 n=nr; 2003 n=5580) involved a multicomponent educational intervention consisting of six mailed newsletters highlighting misconceptions about antibiotic use for conditions such as colds sent to low-risk patients, as well as other educational materials (stickers, posters, information leaflets and fact sheets) made available in waiting rooms of local paediatric providers, pharmacies and child care centres, versus nothing in the control communities. There was no significant improvement in knowledge scores or demand for antibiotics in intervention communities compared with control communities (aOR 1.2 [95%CI: 0.8 to 1.7]). In subanalysis, however, a significant impact was observed by insurance provider: the proportion of parents with high antibiotic knowledge significantly increased among parents of Medicaid-insured children (aOR 2.2 [95%CI: 1.1 to 4.5]), but not among parents of non-Medicaid-insured children (aOR 1.0 [95%CI: 0.6 to 1.4]).

One non-RCT² (-) (USA; pre-intervention n=273, post-intervention n=293, control post-intervention n=306) showed that a mass media campaign specifically targeting a Latino population was not effective in decreasing the number of antibiotics bought without a prescription in the past 12 months (OR 0.85 [95%CI: 0.27 to 2.63]) and was ineffective at changing participants' beliefs that antibiotics should not be available without a prescription; 30.6% in the intervention community believed they should be available without a prescription before the intervention, compared with 48.0% after and 35.8% in the control post-intervention (p<0.05).

Applicability

The evidence is only partially applicable to people in the UK. This is because the study populations in these studies or the services available to them may differ from those in the UK. It should be noted that antibiotics cannot be legally obtained in the UK without a prescription.

1. Huang et al. 2007 (+)
2. Mainous et al. 2009 (-)

Evidence Statement 1.12 Mass media campaign (information leaflet, posters, nurse educators, newspaper articles) and GP intervention targeting parents at the community level

There is weak evidence from one RCT¹ (-) (USA; n=430) that a community-based intervention involving an information leaflet ('Your Child and Antibiotics'), posters, nurse educators, newspapers articles, and a GP intervention to promote appropriate antibiotic use was effective at increasing parents' knowledge of AMR.

The difference in change in knowledge from baseline to post-intervention was significantly greater for the intervention group than the control, namely, 10% ([95%CI 1.9 to 18.1] p=0.015). In terms of decreasing parents' desire for antibiotics for their child, the change in desire from baseline to post-intervention was significantly greater for the intervention, namely, -8.4% (-13.9 to -2.8) (p=0.003). The evidence related to parents' understanding of when to use antibiotics was less clear; at post-intervention the mean score was significantly lower (better) in the intervention area than control (2.7 vs 3.5, p<0.001); however, the change from baseline for the intervention and control groups was not significantly different (-1.1 vs -0.8, p=0.07).

Applicability

While the study was not conducted in the UK, the evidence is directly applicable to people in the UK as there are no obvious differences in the population, context or setting of the study compared with the UK context.

1. Trepka et al. 2001 (-)

Interventions targeting the general public

Evidence Statement 1.13 Interactive science show based in a holiday resort targeting families with children

There is weak evidence from one pre–post study¹ (+) (UK; n=406) that a science show and interactive stalls based on the e-Bug educational packs can significantly improve knowledge of antibiotics, knowledge of appropriate antibiotic use (e.g. not keeping antibiotics for later use), and AMR in children aged 5 to 11 years old. Children’s knowledge significantly improved for all questions; overall, the percentage of children correctly answering questions increased by 25% (p<0.001). For parents the impact was less marked; knowledge increased for all three questions related to antibiotics and for one of the two questions related to AMR, but not for questions related to antibiotic use. However, baseline knowledge was 95% for both questions.

Applicability

The evidence is directly applicable to parents and children in the UK.

1. Lecky et al. 2014 (+)

Evidence Statement 1.14 Web based educational intervention targeting the general public

There is weak evidence from one pre–post study¹ (-) (UK; n=277) that a health information website significantly improved peoples’ attitudes towards prescribing (i.e. expectation of being prescribed antibiotics for acute otitis media decreased), but that, overall, it did not significantly improve peoples’ awareness of AMR (significant for only three out of seven statements tested) or improve knowledge of appropriate antibiotic use (e.g. taking a full course) (significant for only three out of the six statements tested).

Applicability

While the study was conducted in the UK, it may not be directly applicable to the wider population given that it was conducted in a museum setting and almost a quarter of respondents were doctors.

1. Madle et al. 2004 (-)

Evidence Statement 1.15 Mass media (advertisements in magazines and newspapers, posters and leaflets) and GP interventions at the population level

There is weak evidence from three pre–post studies (-)^{1,2,3} and one repeated cross-sectional survey (-)⁴ that mass media campaigns targeting the general public do not have an effect or have only a small effect on knowledge of and attitudes towards appropriate antibiotic use.

A pre–post study¹ (-) (New Zealand; 1998 n=282, 2003 n=387) that collected information on public views and use of antibiotics for colds in adolescents and adults in 1998 and subsequently from 2002 found that the national campaign did not change the public’s understanding of antibiotic efficacy against viral infections (41% vs. 38% p=0.9). When specific symptoms were evaluated, however, there was

significantly improved knowledge of appropriate antibiotic use for six out of the 13 symptoms. Despite limited impact on knowledge, however, the number of respondents reporting that they consulted a doctor about a cold or flu significantly decreased from 62% to 45% ($p < 0.001$).

One pre–post study (with control post-intervention)² (-) (UK; 2008 $n = 1888$ [England = 1706, Scotland = 182; 2009 $n = 1830$ [England = 1707, Scotland = 123]) reported that the 2008 English public antibiotic poster campaign had no impact on the proportion of incorrect answers among English respondents to the statement ‘Antibiotics work on most coughs and colds’. The incorrect response decreased from 40% in 2008 to 37% in 2009, $p = 0.30$. Compared with Scotland, there was no significant difference for nine out of ten questions related to attitudes towards antibiotic use. Self-reported changes in use of antibiotics did not significantly change for two out of the three measures; the number of English respondents reporting that they kept left-over antibiotics significantly increased, from 2.2% to 7.0%, $p < 0.001$. Compared with Scotland, self-reported changes in use did not significantly differ for two out of the three measures.

One pre–post study³ (+) (UK; 1999 $n = 982$, 2000 $n = 1941$) found that a nationwide public education campaign known as CATNAP (Campaign on Antibiotic Treatment and the National Advice to the Public) that promoted the need to cherish and preserve your normal bacterial flora, locally enhanced to include more channels of promotion, did not significantly change the public’s knowledge of appropriate antibiotic use. There was no change for all seven of the general questions posed, while for questions related to appropriate antibiotic use among children, a significant change was only observed for one out of the five questions – the proportion of adults who agreed that children should be prescribed antibiotics for fever significantly decreased, from 56% to 49% (follow-up difference -7% [one-sided 95%CI: -13.5]).

A repeated cross-sectional survey⁴ (-) (Australia; 1999 $n = 1614$; 2000 $n = 1603$; 2001 $n = 1800$; 2003 $n = 1200$; 2004 $n = 1200$) reported on a community campaign to reduce inappropriate use of antibiotics for the common cold in adolescents and adults. There was a significant decline in those who believed taking antibiotics for cold and flu is appropriate, from 28.7% pre-programme in 2002 to 21.7% in 2004 (percentage-point change 7.0 [95%CI: 3.5 to 10.5]). A comparison of successive yearly consumer surveys revealed a significant decrease in self-reported use of antibiotics to treat a cough, a cold or the flu, from 10.8% in 1999 down to 7.4% in 2004 (percentage-point change 3.4 [95%CI: 1.3 to 5.5]).

Applicability

Two of the studies were conducted in the UK. The other two studies are directly applicable to people in the UK as there are no obvious differences in the population, context or setting in these studies compared with the UK context.

1. Curry et al. 2006 (-)
2. McNulty et al. 2010 (-)
3. Parsons et al. 2004 (+)
4. Wutzke et al. 2007 (-)

Research question 2: Infection and/or hand hygiene

Interventions based in healthcare setting

Evidence Statement 2.1 Healthcare centre-based intervention led by nurses targeting veterans with spinal cord injuries and disorders

There is weak evidence from one pilot RCT study¹ (-) (USA; n=69) that a nurse-administered patient educational intervention about methicillin-resistant *Staphylococcus aureus* (MRSA) in veterans with spinal cord injuries and disorders does not alter participants' knowledge of MRSA (p=0.81) or their self-reported hand hygiene behaviours following such activities as using the toilet (p=0.83); it may, however, improve participants' perception that the intervention altered their hand hygiene behaviour (p=0.02).

Applicability

The evidence is partially applicable to people in the UK population, as the population in this study is likely to differ from the wider UK population.

1. Evans et al. 2014 (-)

Evidence Statement 2.2 Waiting room of A&E based intervention targeting paediatric patients and their parents

There is weak evidence from one pilot RCT¹ (-) (USA; paediatric patients n=60, parents n=57) that hand hygiene education, with or without the use of Glo Gel (to show unclean hands under black light) in a hospital emergency department setting, significantly improved hand cleanliness in paediatric patients pre to post intervention 16.3 (±3.66) to 17.9 (±3.91), with a mean improvement score of 1.60 (±4.7) (p=0.02); there was no significant difference between the groups (p=0.82). For adults there was no significant difference between pre and post intervention (mean improvement score 0.46 (±5.03), p=0.55). There was also a significant improvement among paediatric patients from pre to post intervention for self-reported washing hands of with warm water (70% vs. 85%, p=0.01) but no difference in other behaviours (i.e. wash hands before dinner; wash hands after bathroom). There was no difference between intervention and control for any self-reported behaviour outcomes (p>0.6 for all three questions). There was no difference from pre to post intervention or between the intervention and control in parents' self-reported hand hygiene behaviour (p>0.9 for all), but baseline compliance with hand hygiene behaviour was high.

Applicability

The evidence is partially applicable to people in the UK population, as the population attending A&E for acute respiratory infections in the USA may be more likely to be uninsured and to have lower socio-economic status; in those respects it may differ from the population in the UK

1. Fishbein et al. 2011 (-)

Intervention based in the home led by researchers targeting the Latino community

Evidence Statement 2.3 Culturally appropriate, home-based educational intervention targeting Latino population

There is weak evidence from two pre–post (+)¹ (-)² that a culturally appropriate, home-based educational intervention significantly improved knowledge of respiratory infection prevention and improved hand hygiene behaviour (i.e. use of sanitizer) and uptake of influenza vaccination in urban Latinos.

One pre–post study¹ (+) (USA; n=422 analysed at end) found that a culturally sensitive, home-based educational intervention led to improved mean composite knowledge scores (out of 10) from 5.19 (±1.60) pre-intervention to 5.91 (±1.71) post-intervention (p<0.001). While the proportion of participants reporting that they use alcohol-based hand sanitizer some of the time increased from 1.4% to 66.8% (p<0.001), the proportion washing with antibacterial soap decreased from 45.3% to 24.9% (p<0.001). Finally, there was a reported increase in the number of households with one or more members receiving an influenza vaccination, from 63.7% to 73.9% (p<0.001).

One pre–post study² (-) (USA; n=509) reported significant improvements in households' knowledge of prevention and treatment strategies for all three interventions, namely, (1) education only; (2) education and hand sanitizer; and (3) education, hand sanitizer and face masks. The change in knowledge score was significantly greater for the education and hand sanitizer group compared with the other groups, from 5.48 to 7.24 (out of a score of 10) (p<0.001). Likewise, while rates of vaccination increased in all three groups, it was greatest in the education and hand sanitizer group compared with the other groups, increasing from 19.0% to 57.1% (p<0.001).

Applicability

The evidence is partially applicable to the wider UK population, as the studies' populations may differ from the population in the UK, although the intervention could be conducted in the UK context and is likely to be relevant to other ethnic minority groups.

1. Larson et al. 2009 (+)
2. Larson et al. 2010 (-)

Interventions based within pre-school or primary led by a teacher targeting young children

Evidence Statement 2.4 Preschool- or primary school-based interventions involving appropriate hand hygiene instruction and other educational activities

There is weak evidence from two pre–post studies (-)² (-)³ and one cluster RCT (-)¹ that hand hygiene instruction, with additional educational activities, may improve hand hygiene behaviour in preschool and primary school children.

One cluster RCT¹(-) (Switzerland; n=61) found that hand and nail hygiene instruction in kindergarten classes, for children aged 4 to 6 years old, had a limited effect in improving hand cleanliness (0% both hands clean to 100% both hands dirty) among children who received the intervention, from 34% to 22% (p=0.30) four weeks after the intervention, but that it did have a significant impact on nail hygiene (0% both sides of all 10 fingers clean to 100% both sides of all 10 fingers dirty), which improved from 68% to 53% (p=0.007) among children. The authors reported that the observed improvements for both hand and nail hygiene were significantly greater among children in the intervention than control (p-values were not reported). We note that the way in which the results are presented by the authors is not clear.

One pre-post study²(-) (USA; n=406) reported that parents and teachers observed a positive improvement in the hand hygiene of children attending the second grade of primary school over the course of a four-week, multicomponent education programme, broadly involving appropriate hand washing education, a UV fluorescent glow which allowed the children to observe how well they had washed hands, teacher–student discussions and a range of materials (e.g. stickers, colouring sheets): 64% of parents and 94% of teachers reported that the frequency of hand washing increased (p-values were not reported).

One pre–post study³ (-) (USA; n=35) found that a day care–based intervention for children aged 3.5 to 5 years old, involving hand washing instruction, the Glo Germ UV light, singing, a story, and a video, improved hand washing behaviour in preschool children: the use of soap was observed to increase from 54% to 87%, and rubbing hands together for more than ten seconds increased from 20% to 53% (p-values were not reported). Parents of the children perceived that children’s understanding of the relationship between germs and hand washing increased.

Applicability:

While none of the studies were conducted in the UK, the evidence is directly applicable to people in the UK as there are no obvious differences in the population, context or setting of the study compared with the UK context.

1. Ramseier et al. 2007 (-)
2. Tousman et al. (2007) (-)
3. Witt and Spencer 2004 (-)

Evidence Statement 2.5 Primary school–based interventions involving appropriate hand hygiene and respiratory etiquette, and placement of hand sanitizers for teachers and students

There is weak evidence from one cluster RCT (-)¹ (USA; n=167) that a multicomponent educational intervention may improve hand hygiene behaviour, hygiene etiquette and knowledge of germs in primary school students.

The intervention involved educating teachers and students about appropriate hand hygiene, hand etiquette, and ‘cover your cough’ behaviours; providing information about ‘germs’ and influenza; and placing hand sanitizer in all classrooms and common areas.

The average number of times students washed/sanitized their hands per day was 3.95 in the intervention school vs 3.08 in the control school (p=0.014). Appropriate behaviour related to covering coughs and sneezes was higher in intervention than control schools: 3.76 vs 3.29, p=0.002. Students in the intervention schools also had improved knowledge of how to stop the spread of germs (p<0.001).

Applicability:

While this study was conducted in the USA, there are no obvious differences in the population, context or setting of the study compared with the UK.

1. Stebbins et al. 2010 (-)

Interventions based in schools and/or targeting children nine years of age or older

Evidence Statement 2.6 E-bugs educational interventions targeting children 9 years of age or older

There is inconsistent evidence from five studies (four pre–post studies (-)^{1,2,4} (+)⁵ and one non-RCT (-)³) concerning whether or not e-Bug-based interventions improve knowledge of microbes, awareness of infection, infection prevention and/or hand hygiene among children aged 9 to 15 years old.

One pre–post study¹ (-) (UK; n=1736 [school n=62, online=1674]) found that an e-Bug computer game for 9- to 12-year-old children did not lead to a significant improvement in children’s knowledge of microbes/infection/hand hygiene. Knowledge significantly changed for only 3 out of 21 questions: 2 related to knowledge of microbes (p=0.001 and p=0.02) and 1 related to the benefits of using soap (p=0.02).

One pre–post study² (-) (UK; n=225) found that, following a modified e-Bug lesson plan, 9- to 11-year-old children showed a significant improvement in overall knowledge of microbes, hand hygiene and farm hygiene (p<0.001). However, improvements were not shown for all questions within each topic.

One non-RCT study³ (-) conducted in the Czech Republic, England and France, found that the e-Bug educational pack focussing on knowledge of prudent antibiotic use and hygiene significantly improved children’s ‘knowledge of infection’ in some countries/regions, but not in others. In England (n=2136), knowledge of microbes, of how infections are spread, and how to treat and prevent infection did not significantly differ in junior school children (9- to 11-year-olds) exposed to the intervention compared with children in the control schools. But the authors reported that there were significant improvements among senior school children (12- to 15-year-olds) for all outcomes immediately following the intervention and at six months follow up (p-values were not reported).

One pre–post study⁴ (-) (UK; n=48) found that a two-day workshop titled Antibiotics and Your Good Bugs, for children aged 9 to 10 years old, did not significantly increase the number of children who correctly identified the need to wash their hands after various activities. However, baseline values were high: the overall score increased from 94% to 96% (p=0.5).

One pre–post study⁵ (+) (UK; n=251) found that use of a ‘Bug Investigators’ pack for children aged 10 to 11 years old resulted in a significant increase in the proportion of children who correctly identified that they needed to wash their hands after all 10 activities presented, from 90% to 94% (p<0.001).

Applicability

While one of the studies included study sites outside of the UK, the evidence is directly applicable to people in the UK, as there are no obvious differences in the population, context or setting of the study compared with the UK context.

1. Farrell et al. 2011 (-)
2. Hawking et al. 2013 (-)
3. Lecky et al. 2010 (-)
4. McNulty et al. 2001 (-)

5. McNulty et al. 2007 (+)

Evidence Statement 2.7 School-based educational interventions targeting children 9 years of age or older

There is weak evidence from one pre–post study (-)¹ and one RCT (-)² that school-based interventions can improve hand washing behaviour.

One pre–post study¹ (-) (USA; n=73) found that a five-week hygiene intervention programme called High Five for Healthy Living was effective in improving hand washing behaviour in 11- to 14-year-olds (predominantly African American) attending an afterschool club; 67% of students improved their test scores by 10% (p-values were not reported).

One RCT (-)² (Italy; n=249) found that an educational programme involving multimedia and movies taught in either a practical or a theoretical class, targeting fifth grade students (aged 9 to 11 years old), significantly improved appropriate hand hygiene behaviour in both classes (Incidence Risk Ratio (IRR) 3.4 [95%CI: 2.2 to 5.2] and 3.2 [95%CI: 1.9 to 5.5]), but did not improve knowledge of hand hygiene in either class (IRR 1.1 [95%CI: 1.0 to 1.2] and 1.0 [95%CI: 0.9 to 1.2]).

Applicability

While neither study was based in the UK, the evidence is directly applicable to people in the UK, as there are no obvious differences in the population, context or setting of the study compared with the UK context.

1. Baker et al. 2012 (-)
2. Losasso et al. 2014 (-)

Interventions based in a university setting

Evidence Statement 2.8 Poster campaigns displayed in university restrooms

There is inconsistent evidence from one RCT (-)², one pre-post study (-)² and one non-RCT (-)³ concerning whether or not posters placed in public toilets in university buildings improve the frequency of hand washing or the use of soap, but there does appear to be a significant increase in the use of hand sanitizer.

One RCT¹ (-) (USA; n=252 observations, n=95 surveys) conducted in public toilets on a university campus found that posters with different descriptive norm messages (a high-prevalence message: 'Four out of five college students wash their hands EVERY time they use the bathroom.' or a low-prevalence message: 'One out of five college students wash their hands EVERY time they use the bathroom.') led to a significant increase in the frequency (low prevalence vs. no poster aOR 19.39 p=0.006; high prevalence vs. no poster aOR 6.53 p=0.033) and length of time that participants washed their hands in seconds (high prevalence 9.94 (±7.78), low prevalence 9.57 (±7.78), no poster 6.04 (±7.58), p=0.04) compared to no poster, but not for use of soap (p=0.54). Positive attitudes towards hand washing were significantly greater for the high and low prevalence message compared to no message (p=0.01).

One pre-post study¹ (-) (USA; n=1,005 observations, n=188 surveys) found that a hand hygiene poster campaign targeting university students did not increase observed rates of hand washing but did significantly increase the use of soap during hand washing, from 58.0% to 78.1% (p<0.001). Women were observed to wash their hands and use soap significantly more frequently than men (90% vs 80%, p<0.001).

One non-RCT³ (-) (USA, n=not measured) conducted in public buildings on a university campus found that signs promoting hand hygiene placed next to a hand sanitizer significantly increased hand sanitizer use. Depending on the framing of the message on the sign, the usage increase ranged from 40.6% to 66.4% compared to dispensers with no sign (p<0.01). The greatest usage was observed when the message 'Stay healthy this season. Sanitize your hands' was placed next to dispensers and the smallest increase was for the message ('Germs are out to get you. Get them first!'. The signs had a consistent influence on usage over time and were not significantly moderated by temporal trends (p>0.10).

Applicability

While the studies were not conducted in the UK, the evidence is directly applicable to people in the UK, as there are no obvious differences in the population, context or setting of the study compared with the UK context.

1. Lapinski et al. 2013 (-)
2. Mackert et al. 2013 (-)
3. Updegraff et al. 2014 (-)

Evidence Statement 2.9 Message campaign and hand sanitizer targeting university students

There is weak evidence from one non-RCT (-)² and one non-RCT (-)³ indicating that university-based poster campaigns, with the provision of hand sanitizer and/or a researcher interacting with students, can lead to an increase in the rates of hand washing with had sanitizer and an increase in frequency of hand washing per day.

One non-RCT³ (-) (USA; n=6454) evaluated the impact of an information poster ('Sanitize your hands to prevent cold and flu') placed next to cashier counter en route to a food and drink service in a cafeteria, access to hand sanitizer, and a researcher promoting hand hygiene, compared with the poster and sanitizer alone. On days when all three interventions were implemented, the percentage of students using hand sanitizer was high (60%) compared with those days when only two components were implemented (15–18%) (p-values were not reported).

One cluster non-RCT² (-) (USA; n=430) found that a poster campaign detailing the 'Top 10 gross things students have on their hands', coupled with free hand sanitizer, posted in student halls of residence, effectively improved students' knowledge of the role of hand hygiene in infection control. While students' perceived frequency of engaging in hand hygiene did not differ between the intervention and control, the reported rates of weekly hand washing (students provided weekly reports documenting hand washing activity) were significantly higher among intervention students than controls; 0.48 vs 0.43 times per hour, $p < 0.02$.

Applicability

While none of the studies are set in the UK, the evidence is directly applicable to people in the UK, as there are no obvious differences in the population, context or setting of the study compared with the UK context.

1. Fournier and Berry 2012 (-)
2. White et al. 2003, 2005 (-)

Interventions targeting the general public

Evidence Statement 2.10 Web-based interactive module targeting the general population

There is weak evidence from one RCT¹ (+) (UK; n=517) that a web-based interactive module conducted over four weeks significantly improved self-reported rates of hand washing in adults and that the improvements were sustained eight weeks after the intervention (on a scale of 1 [zero to two times per day] to 5 [more than ten times per day]): 4.45 in intervention vs 4.12 in the control (p<0.001). The intervention also increased positive attitudes, and intentions of hand washing, when compared with controls who received no intervention.

Applicability

The evidence is directly applicable to the UK population.

1. Yardley et al. 2011 (+)

Evidence Statement 2.11 Mass media campaign targeting the general population

There is weak evidence from one pre–post study¹ (+) (Germany; 2008 n=2006, 2009 n=2006), which investigated perceptions of hand hygiene before and after a public campaign titled Wir gegen Viren [Us Against Viruses], that the perceived efficacy of hand hygiene and coughing into the sleeve as an infection control method increased over time among the general public: aOR 1.54 [95%CI: 1.31 to 1.80] and aOR 13.07 [95%CI: 10.00 to 17.08], respectively.

Applicability

While the study was not conducted in the UK, the evidence is directly applicable to people in the UK, as there are no obvious differences in the population, context or setting of the study compared with the UK context.

1. Meilicke et al. 2013 (+)

Research question 2: Hygiene and/or food safety

Intervention based in the home led by a community facilitator targeting adults living in a 'deprived' community

Evidence Statement 3.1 Home-based interventions targeting adults from a 'deprived' community

There is weak evidence from one pre–post study² (+) (UK; n=904) that a home-based food storage education intervention targeting adults living in a deprived community, provided by a community-based facilitator, effectively improved peoples' knowledge of and behaviour around appropriate refrigeration. The proportion of respondents who identified, and had their fridge set at, the correct operating temperature increased from 31.7% to 78.4% ($p<0.01$) and 69.3% to 84.2% ($p=0.03$), respectively; the proportion of refrigerators containing food past its 'use by date' significantly decreased, from 10.1% to 5.2% ($p=0.03$), and the proportion of refrigerators in which raw meat and cooked food were stored incorrectly decreased from 16.2% to 7.1% ($p=0.04$) and 14.7% to 7.2% ($p<0.05$), respectively.

Applicability

The evidence is partially applicable to the wider UK population, as the study population was a deprived community, and therefore may differ from the wider UK population.

1. Ghebrehewet and Stevenson 2003 (+)

Interventions based in schools and/or targeting school aged children

Evidence Statement 3.2 Primary school-based interventions targeting school children or interventions targeting school-aged children

There is inconsistent evidence from two pre–post studies (-)¹ (-)² and one RCT (-)³ that school-based educational interventions have an impact on children’s knowledge of appropriate food handling.

One pre–post study¹ (-) (UK; n=1736 [school n=62, online=1674]) found that an e-Bug computer game for 9- to 12-year-old children did not improve children’s knowledge of appropriate food handling, as assessed by means of three questions.

One pre-post study² (-) (USA; n=300) found that a web-based food safety programme targeting middle school students (approx.10 to 13 years of age) had a significant impact on mean knowledge food safety score for students in grade seven (52.2% (±15.19) vs. 65.2% (±16.44), p<0.001) and eight (49.8% (±16.83) vs. 60.1% (±20.35), p<0.001) but not among students in grade six 56.0% (±15.62) vs. 56.0% (±20.12) p=ns). How far the student progressed through the programme’s required lesson and the total usage of the programme were both significantly correlated with learning achievement: $r^2=0.065$, $p<0.00$, and $r^2=0.0353$, $p=0.005$ respectively.

One RCT² (-) (Italy; n=249) found that an educational programme involving multimedia and movies taught in either a practical or a theoretical class, targeting students aged 9 to 11 years old, significantly improved knowledge of appropriate ‘food handling’ among children attending a practical class (IRR 1.1 [95%CI: 1.0 to 1.3], p<0.001) but not among children attending a theory-based learning class (IRR 1.0 [95%CI: 0.9 to 1.1]).

Applicability:

One study was conducted in the UK, and the other was conducted in Italy. In the latter study, there are no obvious differences in the population, context or setting of the study compared with the UK.

1. Farrell et al. 2011 (-)
2. Lynch et al. 2008 (-)
3. Losasso et al. 2014 (-)

Evidence Statement 3.3 Summer enrichment programme targeting school children

There is weak evidence from one pilot pre–post study¹ (-) (USA; n=22) that an education programme provided to youth aged 6 to 16 years old from low-income families may have effectively improved knowledge of food-borne illness and food safety across all survey questions asked. For example, knowledge of the importance of washing hands before handling food increased by 76% among 13- to 16-year-olds and by 91% among 6- to 12-year-olds (p-values were not reported), and knowledge that harmful bacteria are found in raw poultry and unpasteurised milk increased by 77% among 13- to 16-year-olds, but by only 9% among 6- to 12-year-olds.

Applicability

While the study was not conducted in the UK, the evidence is likely to be partially applicable to the UK population as the study population may differ from the wider UK population.

1. Comer (2002) (-)

Interventions based in a university targeting students

Evidence Statement 3.4 University-based interventions targeting students

There is weak evidence from one non-RCT (+)¹ and two pre–post studies (-)^{2,3} that food safety campaigns targeting students at university significantly improved food safety knowledge, attitudes and practice.

One non-RCT study¹ (+) (USA; n=710) found that a multicomponent university campaign involving food safety lectures and/or a Facebook fan page for online food safety education significantly increased knowledge scores from pre- to post-intervention for students in the intervention ($p<0.05$) but not the control ($p=0.06$). The change in knowledge was significantly greater among students who took the lecture compared with students who only looked at Facebook (p -values were not reported). The change in attitude was significantly greater in all intervention groups compared with the control (p -values were not reported). Change in food safety practices was significant from pre- to post-intervention for all groups, including the control ($p<0.05$); the group who just received the lecture had significantly lower scores than the groups who accessed the Facebook fan page (p -values were not reported).

One pre–post study² (-) (USA; n=1,159) found that a food safety campaign effectively improved most food safety knowledge measures of students (with the exception of hand washing procedure): overall mean scores (on a scale of 1 to 8) significantly increased, from 3.29 (1.61) to 4.17 (1.84) ($p<0.001$) and the campaign significantly improved students' use of soap before cooking ($p<0.001$) and after using the toilet ($p<0.001$).

One pre–post study³ (-) (USA; n=71) found that an interactive computer module had a significantly positive impact on students' food safety attitude scores, which increased from 114.5 to 122.2 out of a possible 147 points ($p\leq 0.001$). Beliefs scores increased from 85.8 to 97.6 out of a possible 119 points ($p\leq 0.001$) and self-reported food safety practices increased from 19.0 to 21.0 out of a possible 27 points ($p=0.001$). In subgroup analysis, health majors outperformed non-health majors across all three measures ($p<0.05$).

Applicability

While none of the studies were conducted in the UK, the evidence is directly applicable to people in the UK. There are no obvious differences in the population, context or setting of the study compared to the UK context.

1. Bramlett Mayer and Harrison 2012 (+)
2. Maurer Abbot et al. 2012 (-)
3. Yarrow et al. 2009 (-)

Interventions based within the community

Evidence Statement 3.5 Community-based interventions targeting parents

There is weak evidence from two RCTs (-)^{1,3} and one cluster non-RCT (-)² that workshops or a multimedia intervention targeting parents result in modest improvements in food safety behaviour.

One RCT¹ (-) (USA; n=168) found that a workshop including topics on food safety (in addition to other topics) improved self-reported food safety behaviour among low-income parents. It is not clear how effective this intervention was compared with the control group, who received the intervention at a later time point to those in the intervention group, because results are presented pre–post intervention within each group: for those who received immediate education the mean score (on a scale of 1 to 50) increased from 34.9 to 42.8 (p-values were not reported), while for those who received the education later it increased from 35.4 to 42.8 (p-values were not reported).

One cluster non-RCT² (-) (USA; n=600 analysed at end) found that a mass media campaign involving traditional mass media (such as posters and radio advertisements) and newer social media methods, including YouTube videos and an iPhone/iPad application, had a significant impact on food safety behaviour (e.g. appropriately throwing away leftovers) among those in the intervention communities compared with those in the control; 50% vs 38% (p=0.009).

One RCT³ (-) (USA n=394) found that a multimedia intervention (computer kiosk) or information leaflets given to pregnant women and mothers improved the overall food safety score for women in both groups (on a scale of 1 to 5). The interactive multimedia group increased from 3.8 to 4.1; the leaflet group increased from 3.8 to 3.9. The difference in change between groups was only significant when controlling for age, though the size of the effect was small (p=0.03).

Applicability:

While none of the studies were conducted in the UK, the evidence is directly applicable to people in the UK. There are no obvious differences in the population, context or setting of the study compared with the UK context.

1. Dollahite et al. 2014 (-)
2. James et al. 2013 (-)
3. Trepka et al. 2008 (-)

Evidence Statement 3.6 Classes for youths and adults

There is weak evidence from one pre–post study¹ (-) (USA; n= 602 [youths=229 youths, adults=373]) that food preparation classes provided to youths and adults are effective in improving all of the safe food handling behaviours tested. The proportion reporting that they washed their hands before preparing food increased by 38% for youths and 11% for adults ($p<0.001$ for both); likewise, the proportion reporting that they washed fresh fruits and vegetables before preparation increased by 29% for youths and 8% for adults ($p<0.001$ for both) and the proportion using a clean knife and cutting board to prepare fruits or vegetables to avoid cross-contamination increased by 36% for youths ($p<0.001$) and 7% of adults ($p=0.013$).

Applicability

While the study was not conducted in the UK, the evidence is directly applicable to people in the UK. There are no obvious differences in the population, context or setting of the study.

1. Brown and Herman 2005 (-)

Evidence Statement 3.7 Mass media campaigns targeting adults

There is weak evidence from one pre–post study (+)¹ and one non-RCT (-)² that mass media campaigns may lead to minor short-term improvements in food safety knowledge and some short-term changes in food safety behaviour.

One pre–post study¹ (+) (USA; n=250) found that the mass media Fight BAC! Campaign, targeting the Latino community, was effective at improving food safety knowledge among participants who had seen the campaign compared with those who had not seen the campaign (aOR 3.54 [95%CI: 1.74 to 7.18]). However, the campaign only had a significant effect on two of nine food safety behaviour practices: proper hand washing increased from 94% to 99% ($p=0.04$) and proper meat defrosting technique increased from 7% to 14% ($p=0.01$).

One non-RCT² (-) (UK; n=38) found that a UK-based mass media intervention designed to improve safety behaviour during food preparation had some immediate effectiveness on observed food safety behaviour that was not sustained 4 to 6 weeks later. Overall the mean score for food safety malpractice score among controls ranged from 9,501 to 9,845 (scoring scale not reported) over the course of the study. For the intervention group, the mean score decreased from 12,373 to 7,322 immediately after intervention, but increased to 9,835 after a period of 4 to 6 weeks (p -values were not reported). In the intervention group, the immediate intervention effect upon all targeted behaviours was either ‘low’ or ‘moderate’ (effect sizes ranging from 0.18–0.47) (p -values were not reported).

Applicability

The evidence is only partially applicable to the wider UK population, as the studies populations may differ from the wider population of the UK, although for the US study the interventions could be conducted in the UK context and the results are likely to be relevant to other ethnic minority groups.

1. Dharod et al. 2004 (+)
2. Redmond et al. 2006 (-)

Evidence Statement 3.8 Computer-based interventions targeting adults

There is weak evidence from one RCT (+)¹ and one pre–post study (-)², that education delivered via a computer, with or without printed materials, may improve food safety knowledge but not food safety behaviours.

One RCT¹ (+) (USA; n=446) found that neither web-based nor printed materials significantly improved adherence to any of the 10 food safety practices tested ($p>0.05$ for all) or intention to consume any of the 12 risky food groups ($p>0.05$ for all) among older adults (aged 70 to 75 years old). However, many appropriate practices, such as storing leftovers for no more than five days and refrigerating leftovers within two hours, were already high at baseline (89.8% and 94.0%, respectively).

One pre–post study² (-) (Sweden; n=92) found that a computer-based education programme significantly increased knowledge of food safety in adults immediately following the intervention related to cross-contamination (52% vs 87% ($p\leq 0.001$)) and knowledge of the correct storage temperature for smoked salmon and raw mincemeat (22% vs 67% ($p\leq 0.001$) and 23% vs 67% ($p\leq 0.001$), respectively). However, there was no significant improvement in food safety behaviours; the proportion of participants refraining from tasting raw mincemeat non-significantly increased, from 80% before to 88% ($p=ns$) three weeks after, while the proportion checking the fridge temperature non-significantly decreased, from 51% to 41% (p -values were not reported).

Applicability

The evidence is directly applicable to people in the UK. There are no obvious differences in the population, context or setting of the study compared with the UK context.

1. Kosa et al. 2011 (+)
2. Nydahl et al. 2012 (-)

Table of Contents

Preface.....	i
Summary.....	iii
Research question 1: Antibiotic knowledge and behaviour	v
Research question 2: Infection and/or hand hygiene.....	xvii
Research question 2: Hygiene and/or food safety.....	xxvi
Table of Contents.....	xxxiii
Figures.....	xxxv
Tables.....	xxxvii
Acknowledgements.....	xxxix
Abbreviations	xli
1. Introduction	1
1.1. Objectives.....	2
1.2. Structure of this report	2
2. Methods	3
2.1. Inclusion/exclusion criteria	3
2.2. Search Strategy	5
2.3. Study selection, data extraction and quality assessment	7
2.4. Evidence synthesis	8
3. Included studies.....	9
3.2. Structure of results.....	11
4. Antibiotic knowledge and behaviour.....	13
4.1. Pharmacist-led interventions targeting patients or carers of patients.....	30
4.2. Interventions based general practice and/or led by a GP targeting patients or parents of paediatric patients.....	34
4.3. Interventions based in the accident and emergency department of a hospital targeting patients or parents of paediatric patients	44
4.4. Intervention based in the home led by researchers targeting the Latino community	47

4.5. Interventions based within primary or secondary schools and/or targeting school aged children	48
4.6. Intervention based in day care centre led by health educator/child care provider targeting parents.....	53
4.7. Interventions implemented within the community	54
4.8. Interventions targeting the general public	59
5. Infection and/or hand hygiene	67
5.1. Interventions based in healthcare setting.....	79
5.2. Intervention based in the home led by researchers targeting the Latino community.....	82
5.3. Interventions based within pre-school or primary led by a teacher targeting young children	84
5.4. Interventions based in schools and or targeting students 9 years of age or older.....	89
5.5. Interventions based in a university	96
5.6. Interventions targeting the general public	102
6. Hygiene and/or food safety	107
6.1. Intervention based in the home led by a community facilitator targeting adults living in a ‘deprived’ community.....	115
6.2. Interventions based in schools and/or targeting school aged children	116
6.3. Interventions based in a university targeting students.....	120
6.4. Interventions based within the community	124
7. Discussion	135
7.1. Limitations of the studies/evidence base.....	137
7.2. Gaps in the evidence.....	139
7.3. Conclusion	139

Figures

Figure 1 PRISMA diagram of literature search.....9

Tables

Table 1 Summary of inclusion/exclusion criteria.....	3
Table 2 Databases, registries and URLs searched	6
Table 3. Summary of studies relevant to research question 1. For the direction of effect to be classified as effective/improved, p-values had to be less than 0.05.	14
Table 4 Summary of studies relating to infection and/or hygiene that addressed research question 2. For the direction of effect to be classified as effective/improved, p-values had to be less than 0.05.	68
Table 5 Summary of studies relating to hygiene and/or food safety that addressed research question 2. For the direction of effect to be classified as effective/improved, p-values had to be less than 0.05.	108
Table 6 Quality Assessment of Included Studies	154
Table 7. List of excluded studies	159

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Abbreviations

AM	antimicrobial
AMR	antimicrobial resistance
AOM	acute otitis media
aOR	adjusted odds ratio
ARI	acute respiratory infection
CI	confidence interval
CPH	Centre for Public Health
GP	general practitioner
HHI	hand hygiene index
IRR	incidence risk ratio
ITT	Intention-to-Treat
LR	Likelihood Ratio
MRSA	methicillin-resistant <i>Staphylococcus aureus</i>
NeLI	National electronic Library of Infection
NICE	National Institute for Health and Care Excellence
NHI	nail hygiene index
NS	not significant
OR	odds Ratio
PICOS	Population, Intervention, Comparison, Outcomes and Study design
RCT	randomised controlled trial
RR	relative risk
SCT	social cognitive theory
SD	standard deviation
TB	tuberculosis

RAND Europe

URI/URTI upper respiratory infection/upper respiratory tract infection

URL uniform resource locator

1. Introduction

The National Institute for Health and Care Excellence (NICE) has been asked by the Department of Health to develop a guideline aimed at delaying antimicrobial resistance. The scope for this guideline was published on the NICE website in October 2014 [1]. Overall, the guideline will focus on public education about:

- The importance of using antimicrobials correctly;
- The dangers associated with their overuse and misuse; and
- Changes in behaviour that can avert the problems associated with the misuse of antimicrobials, such as infection prevention and control measures.

In order to inform this guideline ('Antimicrobial Stewardship: changing risk-related behaviours in the general population'), RAND Europe was commissioned by NICE to conduct a systematic review of the effectiveness and cost-effectiveness of educational interventions to change people's behaviour in order to: (1) ensure appropriate demand for, and correct use of, antimicrobials; and (2) prevent infection and reduce the spread of antimicrobial resistance.

The review questions are based on the NICE public health guideline scope, and the review methodology is based on the NICE guidelines manual [2]. Specifically, this review aimed to answer the following research questions:

1. Which educational interventions are effective and cost-effective in changing the public's behaviour to ensure they only ask for antimicrobials when appropriate and use them correctly?
2. Which educational interventions are effective and cost-effective in changing the public's behaviour to prevent infection and reduce the spread of antimicrobial resistance?

This review did not include interventions targeting physicians or other prescribers, as this is the focus of another NICE review conducted in parallel to this one. (Antimicrobial stewardship: systems and processes for effective antimicrobial medicine use [3]).

1.1. Objectives

The objectives of this systematic review were to:

- Estimate the effectiveness of education interventions that elicit changes in knowledge, awareness and/or behaviour in people about how and when to take antimicrobials;
- Estimate the effectiveness of educational interventions that elicit behavioural change in people to prevent such infections as flu and tuberculosis (TB) and, more specifically, to reduce the spread of antimicrobial resistance;
- Estimate the cost-effectiveness of these educational interventions;
- Identify strengths and weaknesses in the literature, and identify whether there are any gaps in the literature that may need to be addressed in future studies.

1.2. Structure of this report

Following this introductory chapter, the next chapter, Chapter 2, describes the methods used to conduct this systematic review. An overview of included studies is presented in Chapter 3. Chapters 4 to 6 present the core findings of the work, structured according to the research question. For research question 2, we differentiate between those studies which present results related to infection control and hand hygiene and those that consider food safety. Finally, Chapter 7 presents a discussion of the results.

2. Methods

2.1. Inclusion/exclusion criteria

In order to identify relevant studies, we defined the population(s), intervention(s), comparison(s), outcome(s) and study types of interest (abbreviated as PICOS), some of which were common to both research question and others of which were applicable to only one of the research questions. The PICOS are summarised in Table 1, and a more detailed overview is presented in Appendix A.1.

Table 1 Summary of inclusion/exclusion criteria

PICOS	Inclusion	Exclusion
Population	<p>Both questions: People of all ages, including children and young people, living at home, in the community or in hospital. The following population groups were included:</p> <ul style="list-style-type: none"> • People who regularly take a lot of antibiotics, including, but not limited to, young children and older people • People who misuse antibiotics, including, but not limited to, those who: <ul style="list-style-type: none"> - do not take the correct dose for the correct amount of time and via the correct route - keep antimicrobials to use another time - self-medicate (i.e. take antimicrobials without prescription or advice from a healthcare professional) - share antimicrobials with others - use counterfeit medications • People whose social and economic circumstances or health puts them at greater risk of acquiring or transmitting infectious disease and antimicrobial strains, including, but not limited to, those who: <ul style="list-style-type: none"> - are immunosuppressed - have a chronic disease - live in crowded conditions - are homeless - have been in prison - are migrants from countries with a high prevalence of infectious diseases, such as TB 	<ul style="list-style-type: none"> • Studies conducted in low-income countries • Studies* conducted in locations other than the following: <ul style="list-style-type: none"> - the 15 member countries in the European Union prior to the accession of ten candidate countries on 1 May 2004 (known as EU-15); - Australia; - New Zealand; - USA; - Canada.

PICOS	Inclusion	Exclusion
Intervention(s)	<p>Research question 1: Educational interventions that reduce the misuse of antimicrobials, particularly antibiotics. This includes educating the general public about:</p> <ul style="list-style-type: none"> • When, why and how to use antimicrobials; • The dangers of overuse and misuse (including self-medication, sharing medicines, not completing or missing doses, buying antimicrobials on the Internet, or using counterfeit antimicrobials); and • Suitable alternatives to antimicrobials (e.g. using over-the-counter medicines for the symptoms of a cold). <p>Research question 2: Interventions that educate the general public about how to reduce the spread of antimicrobial resistance at home and in the community. This includes interventions to prevent and reduce transmission of infection by targeting:</p> <ul style="list-style-type: none"> • Hand washing behaviour; • Respiratory etiquette, e.g. using a tissue to cover the mouth when coughing and sneezing; and • Food hygiene practices. <p>These studies may not necessarily be specifically aimed at preventing antimicrobial resistance.</p> <p>Both research questions: Interventions that educate the general public about the type of healthcare they should ask for to prevent or treat infectious diseases. For example, so they are clear that:</p> <ul style="list-style-type: none"> • Antibiotics should not be used for a cold or flu (e.g. for research question 1); and • Vaccines or other protection, such as anti-malarial medication, should be used when travelling abroad (e.g. for research question 2). <p>Interventions that are delivered at the population, community, organisational or individual level in any setting and by any mode of delivery (e.g. via the Internet, apps, face-to-face) Examples include:</p> <ul style="list-style-type: none"> • Individual level: prescribers and dispensers telling patients how important it is to use antimicrobials properly and discussing the dangers of over- and misuse (e.g. for research question 1) • Population and community level: media campaigns on appropriate antibiotic use (e.g. for research question 1) or media campaigns on infection prevention (hand washing, food hygiene) (e.g. for research question 2) 	<p>Studies focussing on:</p> <ul style="list-style-type: none"> • National and international policy on AMR • Surveillance to track antimicrobial use and resistance in bacteria • Developing new drugs, treatments and diagnostics • Education of prescribers about the diagnosis of infectious diseases and clinical decisions concerning whether to prescribe an antimicrobial • Education of healthcare professionals about hygiene practices to prevent the spread of infectious diseases • Environmental cleanliness and cleaning products • Promoting safe sex • Antimicrobial use in animals • Antibiotic stewardship • The use of herbal alternatives for antibiotics • Multicomponent interventions where education was not the main component of the intervention (e.g. in cases where there were several interventions, if the majority were not 'educational' than the study was excluded)
Comparison(s)	<p>Studies had to include a comparison group (e.g. baseline comparison, different educational strategies, or different modes of delivery).</p>	

PICOS	Inclusion	Exclusion
Outcome(s)	<p>Research question 1:</p> <ul style="list-style-type: none"> • Knowledge and awareness of when, why and/or how antimicrobials should be used • Knowledge and awareness of antimicrobial resistance • Knowledge of the type of support people can expect from health professionals in relation to the use of antimicrobials • The ability and confidence of prescribers and dispensers to talk to people about the use and misuse of antimicrobials • Demand for antimicrobials (particularly antibiotics) • Adherence to prescribed antimicrobials • Inappropriate antimicrobial use • Inappropriate antimicrobial prescribing** <p>Research question 2</p> <ul style="list-style-type: none"> • People’s knowledge and awareness of how they can prevent infection and reduce the spread of antimicrobial-resistant microbes • Hand washing behaviour • Behaviour to reduce the spread of such airborne diseases as TB and flu (for example, use and appropriate disposal of tissues when coughing and sneezing) • Food hygiene practices <p>Both research questions:</p> <ul style="list-style-type: none"> • Any studies which report cost data 	<ul style="list-style-type: none"> • Studies* that only reported prescribing rates, as prescribing rates may not always represent a useful proxy of demand
Study design	<p>Randomised controlled trials, non-randomised controlled trials, and pre–post/before and after studies were eligible for inclusion. For the economic review, published economic evaluations, such as cost-effectiveness analyses, cost–utility analyses, cost–benefit analyses, cost-minimisation analyses, and cost-consequence analyses were eligible for inclusion.</p>	<ul style="list-style-type: none"> • Letters, editorials and commentaries • Studies not published in English • Other*: <ul style="list-style-type: none"> - unpublished dissertations - studies only published as conference abstracts/posters - one-group studies that only reported post-intervention data - qualitative studies

NOTES: *Given the large number of potentially relevant studies that were identified in the searches, we made further refinements to the original protocol.

**We sought to include studies that evaluated ‘inappropriate antimicrobial prescribing by healthcare professionals’, but we subsequently found that what was considered to constitute prescribing that was inappropriate’ was not apparent or explicitly identified in the literature and therefore could not be assessed.

2.2. Search Strategy

One search was conducted to address all research questions. The literature was searched in a range of relevant databases, registries and URLs, as listed in Table 2. The searches were limited to English language publications and studies reported from 2001 onwards. This date was chosen because it is the date of the publication of the WHO Global Strategy for Containment of Antimicrobial Resistance [4]. All of the results of the searches were loaded together into EndNote bibliographic software.

Table 2 Databases, registries and URLs searched

Databases
Medline and Medline in process (Ovid)
Embase (Elsevier) (includes conference proceedings)
Cumulative Index to Nursing and Allied Health Literature (CINAHL) (EBSCO)
Web of Science Core Collection ^a (Thomson Reuters)
Cochrane Library ^b (Wiley)
Trials (CENTRAL), Database of Abstracts and Reviews (DARE), Health Technology Assessment Database (HTA), NHS Economic Evaluation Database (NHS EED)
PsycInfo (EBSCO)
Education Resources Information Center (ERIC) (EBSCO)
Sociological Abstracts (Proquest)
Social Sciences Abstracts (EBSCO)
Health Management Information Consortium (HMIC) (Ovid)
NIHR Health Technology Assessment (NIHR HTA and other NIHR journals)
NICE Technology appraisals
Registries
CEA Registry (https://research.tufts-nemc.org/cear4/)
ClinicalTrials.gov (https://clinicaltrials.gov/)
International Clinical Trials Registry Platform (ICTRP) (http://www.who.int/ictcp/en/)
URLs
Oaister (www.oaister.org)
OpenGrey (www.opengrey.eu)
NYAM Grey Literature Report (www.greylit.org)
Economic databases
NHS Economic Evaluation Database (NHS EED)
EconLit (EBCSO)
CEA Registry

NOTES: ^a Includes: Science Citation Index, Social Sciences Citation Index, Arts & Humanities Citation Index, Conference Proceedings Citation Index – Science, Conference Proceedings Citation Index – Social Sciences & Humanities. ^b Includes: Cochrane Database of Systematic Reviews (CDSR), Cochrane Central Register of Controlled Trials

2.2.1. Search terms

Working in conjunction with NICE, an Ovid Medline search was developed to ensure that the terms were broad enough to capture a range of studies but also narrow enough to capture all relevant studies (i.e. to balance specificity and sensitivity). This strategy was used as the base from which all search strategies for the other databases were created. As appropriate, terms were mapped to available subject indexing in the other databases and/or searched as text words in the titles and abstracts of their records. The Ovid Medline search is presented in Appendix A.

2.2.2. Additional searches

Additional techniques typically used to identify evidence for systematic reviews were applied:

- Searching for specific trial/campaign names (e.g. of well-known public health campaigns identified by expert knowledge and Google searches)

- Carrying out citation searches of key publications to identify subsequent publications (e.g. checking references of all included studies to make sure that potentially relevant studies were not missed)

Unpublished studies were sought by searching the URLs, clinical trial registries and conference proceedings noted in Table 2. NICE also provided additional related papers and reports to be used as background information and/or to be screened for inclusion (following a ‘call for evidence’ from stakeholders).

2.3. Study selection, data extraction and quality assessment

A first pass of the study references (downloaded into Endnote) was conducted by the information specialist to exclude studies conducted in low-income countries. One reviewer then screened the titles and abstracts of papers (using the inclusion/exclusion criteria specified in Table 1) in the Endnote file for obvious excludes (second pass). At this stage, a random sample of 10% of titles and abstracts were double screened by two reviewers independently (for two of the reviewers, we found that agreement between them occurred in 88.1% of references [Cohen’s Kappa of 0.59]). We also incorporated a third pass for those references that the first reviewer found not to be obvious includes or excludes. The titles and abstracts of these references were thus screened by two additional reviewers independently.

Full papers of potentially relevant studies identified in the third pass were obtained and screened by two independent reviewers. Any discrepancies were resolved through consultation with a third reviewer.

Study information was extracted into an Excel spreadsheet by one reviewer and a sample of 10% was checked by a second reviewer. At this stage, the data were found to be abstracted accurately and only minor editorial changes were recommended.

To assess the quality of the included studies, it was agreed between NICE and RAND Europe that a methodology checklist previously published by NICE for public health guidance was most appropriate [3]. This checklist incorporates 25 questions, some of which are only applicable to controlled trials (see Appendix B, which reports all criteria that were evaluated).

In order to make an overall study quality grading (i.e. ‘++’ or ‘+’ or ‘-’), we used the following summary assessment:

Internal validity

To provide an overall quality assessment of a randomised controlled trial (RCT), we chose five key criteria. In order for a RCT to receive a ‘++’ overall rating, the trial must have reported adequate (i.e. a rating of ‘++’) 1) randomisation and 2) allocation concealment, used 3) intention-to-treat (ITT) analysis, have 4) controlled for confounding factors in the analysis, and 5) have an adequate sample size. If most of these criteria were given a ‘+’ rating (i.e. the criteria were partially addressed), the study was given an overall rating of ‘+’; if one or more of these criteria were not met (i.e. given a ‘-’ rating), the study was given an overall rating of ‘-’.

In order for non-randomised controlled studies or before-and-after studies to get a ‘++’ rating, all criteria had to be adequately addressed (i.e. all of the individual criteria had to have been scored as ‘++’); for a ‘+’

rating, the majority criteria ratings had to be '+' or '++' (with no '-' for criteria in sections 3 or 4); a study was given a '-' if one or more criteria in sections 3 and 4 were rated as '-', or if too many criteria were 'NR'. We felt that all the criteria in sections 3 and 4 were key criteria.

External validity

To evaluate external validity, we made a judgement regarding whether or not the findings of the study were generalisable beyond the confines of the study itself to other similar population groups (e.g. would a study conducted in one day care centre be applicable to day care centres in general?).

Quality assessments were conducted by one reviewer and all were checked by a second reviewer, with any discrepancies resolved through discussion or by consulting a third reviewer. The quality assessments for each included study are provided in Appendix B.

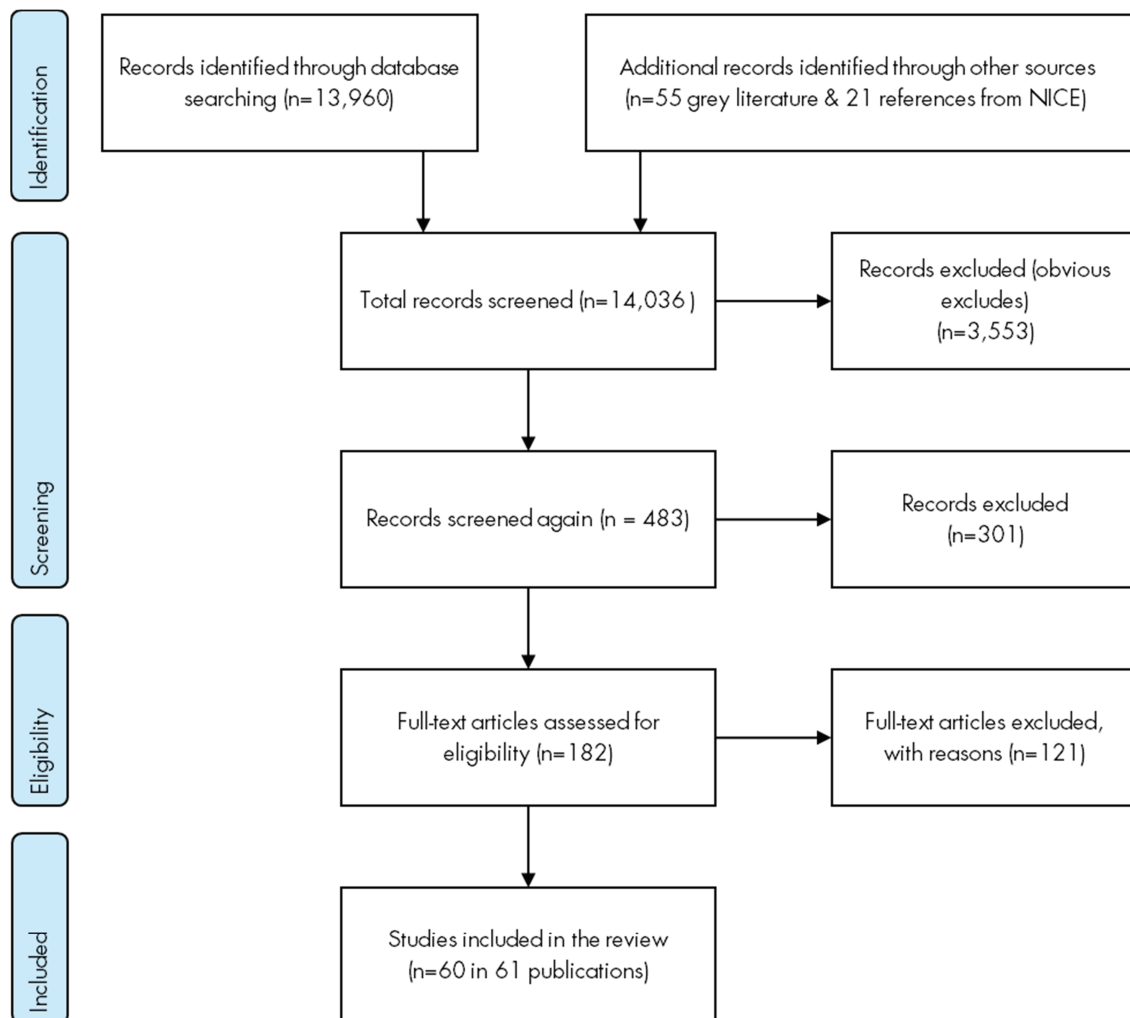
2.4. Evidence synthesis

In our protocol, we stated that meta-analyses would be undertaken where possible, provided that there was no clinical or statistical heterogeneity between the studies. Given that the interventions, settings and population groups differed in the included studies, meta-analyses were not conducted, and the results were summarised narratively in text and tables.

3. Included studies

Overall, 14,036 titles and abstracts were screened for inclusion, and 60 studies in 61 publications met the inclusion/exclusion criteria. A list of excluded studies, with reasons for exclusion, is presented in Appendix C. An overview of the quality assessment results for all of the included studies is presented in Appendix B, and detailed evidence tables are presented in a separate document.

Figure 1 PRISMA diagram of literature search



Research question 1

Textbox 1 Research question 1

'Which educational interventions are effective and cost-effective in changing the public's behaviour to ensure they only ask for antimicrobials when appropriate, and use them correctly?'

In total, 29 studies evaluated educational interventions that aim to change people's knowledge, awareness and/or behaviour regarding when, why and/or how to use antimicrobials, and/or to increase people's knowledge of antimicrobial resistance. Of these, 6 studies specifically evaluated the effectiveness of interventions on inappropriate antibiotic use as a behavioural outcome. No relevant cost-effectiveness studies were identified that addressed this question.

The majority of studies were conducted in the USA (13 studies) and the UK (10 studies), with 2 studies conducted in Australia, 1 in Italy, 1 in New Zealand, 1 in Portugal and 1 in Spain. There were 13 RCTs, 3 non-RCTs, and 13 pre–post/before and after studies. Overall, 8 studies were rated as moderate quality (+) and 21 as weak quality (-).

Research question 2

Textbox 2 Research question 2

'Which educational interventions are effective and cost-effective in changing the public's behaviour to prevent infection and reduce the spread of antimicrobial resistance?'

In total, 36 studies, in 37 publications, evaluated educational interventions that aimed to change people's knowledge about and awareness of infection and/or how they can reduce the spread of antimicrobial-resistant microbes (5 of which were also presented in the section above [5-9]). We found that studies that addressed this question could be subdivided into two sections – one that focuses on infection and hand hygiene and one that focuses on infection and food hygiene.

3.1.1. Infection and/or hand hygiene

In total, 22 studies, in 23 publications, reported on infection and/or hand hygiene (5 of which also reported outcome data on knowledge of antimicrobials and/or AMR and are presented in the findings for research question 1 as well [5-9]). No relevant cost-effectiveness studies were identified that addressed hand hygiene.

The majority of studies were conducted in the USA (12 studies) and the UK (6 studies); 1 in Germany, 1 in Italy, 1 study was conducted in Switzerland, and 1 study was conducted in three countries (Czech Republic, France and England). There were 7 RCTs, 4 non-RCTs, and 11 pre–post (that is, before and after) studies. Overall, 4 studies were rated as moderate quality (+) and 18 studies as weak quality (-).

3.1.2. *Hygiene and/or food safety*

A total of 16 studies focused on hygiene and/or food safety (2 of which also presented data related to infection and/or hand hygiene and are thus included in both sections of the report [5 7]). No relevant cost-effectiveness studies were identified that addressed hand hygiene.

The majority were conducted in the USA (11 studies); 3 studies were conducted in the UK, 1 in Italy and 1 in Sweden. There were 4 RCTs, 3 non-RCTs and 9 pre–post/before and after studies. Overall, 3 studies were rated as moderate quality (+) and 13 studies as weak quality (-).

3.2. Structure of results

In the following three chapters, we present the findings relevant to research question 1 and question 2 (results relevant to the latter question are separated into two chapters).

4. Antibiotic knowledge and behaviour

A total of 29 studies evaluated educational interventions that aim to change people's knowledge, awareness and/or behaviour regarding when, why and/or how to use antimicrobials, and/or to increase people's knowledge of antimicrobial resistance:

- 13 interventions were based in a healthcare setting targeting patients:
 - 3 interventions were led by pharmacists [10-12]
 - 8 interventions were based in a general practice and/or led by a GP targeting patients or parents of paediatric patients [13-20]
 - 2 intervention were based in the accident and emergency department of a hospital [21-22]
- 1 intervention was home-based, was led by researchers, targeting Latino families [6]
- 5 interventions were based in a school, were led by a teacher, targeting primary and/or secondary school children [5 7-9 23]
- 1 intervention was based in a day care centre, was led by health educators/child care providers, targeting parents [24];
- 3 interventions were implemented within a specific community [25-27]
- 6 interventions were mass media or mixed interventions targeting the general public [28-33]

A brief overview of the studies and their results are presented in Table 3. The studies are presented within the table by setting, as outlined above. Some sections are further subdivided by who led the intervention, the target population and/or the type of intervention; within each subsection studies are presented alphabetically. The studies within a subsection inform each Evidence Statement. Where reported, we have presented some additional outcomes evaluated in the eligible studies that are not specified in our inclusion/exclusion criteria, but may be of interest to the reader (i.e. re-consultation rates, prescription rates). These outcomes have not been summarised in the evidence statements as they are incidental findings to our review - which aimed to evaluate educational interventions on knowledge and awareness of antibiotics, and antibiotic resistance, demand (e.g. expectation to receive antibiotics), adherence to antimicrobials, inappropriate antimicrobial use, and inappropriate prescribing (which differs from 'prescription rates'). Any summary of these additional outcomes would therefore not follow systematic review methodology. A more detailed overview of the interventions, findings and limitations/consideration for each study is presented in text below the summary table.

Table 3. Summary of studies relevant to research question 1. For the direction of effect to be classified as effective/improved, p-values had to be less than 0.05.

Reference/ study type/ country/ (quality assessment)	Population and setting	Comparisons		Key outcomes evaluated that are relevant to this review*	Direction of effect for intervention
		Intervention/ (sample size)	Comparator/ (sample size)		
Pharmacist-led interventions targeting patients					
Muñoz et al 2014 RCT Spain (-)	Adult patients or carers presenting at an urban pharmacy with a prescription for antibiotics.	Pharmacist-delivered individualised verbal education about treatment characteristics, duration, dosage regime and how to use the antibiotic, lasting about 20 minutes. (n=70)	Standard care (n=68)	Adherence to treatment, evaluated by a combination of the Morisky–Green test (details not provided) and a self-reported pill count.	Adherence to antibiotic treatment was significantly higher in the intervention group than in the control group.
Northey et al. 2014 RCT (pilot study) Australia (-)	Adult patients presenting at a community pharmacy for dispensing of a valid antibiotic prescription	Extensive verbal education from pharmacist, supplemented by an information leaflet titled ‘Why Do Some People Need Antibiotics?’ (n= 13)	Patients who did not receive verbal education but who did receive a consumer medicines information (CMI) leaflet (which differed in content from the leaflet received by intervention group) (n= 13)	Antibiotic knowledge score; calculated as the percentage of correct responses to all 4 questions posed	<ul style="list-style-type: none"> • Significant increase in antibiotic knowledge (from pre to post) in the intervention • No significant difference in antibiotic knowledge (from pre to post) among the controls (although baseline knowledge was already high)

Reference/ study type/ country/ (quality assessment)	Population and setting	Comparisons		Key outcomes evaluated that are relevant to this review*	Direction of effect for intervention
		Intervention/ (sample size)	Comparator/ (sample size)		
Rodis et al. 2004 Pre-post USA (-)	Adult patients with acute upper respiratory tract infection (URTI) symptoms attending a multidisciplinary urgent care clinic	Verbal education from pharmacist, supplemented by an information leaflet titled 'A New Threat to Your Health: Antibiotic Resistance' and a hand-out on frequently asked questions about AMR (n=130)	NA	<p>Knowledge of antibiotic resistance; patients were asked their level of agreement with three AMR-related statements</p> <ul style="list-style-type: none"> There was no significant change in the level of agreement with any of the 3 individual statements related to AMR (although baseline knowledge was already high) The number agreeing with all 3 statements (measured as an overall score) significantly improved <p>Knowledge of appropriate antibiotic use; evaluated by assessing patients' perception of the need for antibiotic therapy to treat 4 conditions</p> <ul style="list-style-type: none"> Improvements in knowledge for 2 out of the 4 conditions 	
Interventions based in a general practice and/or led by a GP targeting patients and/or parents of patients					
Video and information leaflet					
Bauchner et al. 2001 RCT USA (+)	Parents registered in two paediatric primary care clinics located in urban and suburban settings, and an affiliated day care centre	A 20-minute video programme to educate parents on the problem of bacterial resistance to antibiotics and on their appropriate use to prevent the development of resistance, supplemented by an information leaflet titled 'What Every Parent Should Know About Antibiotics' (n=103)	No intervention (n=103)	<p>Knowledge of appropriate antibiotic use and AMR; calculated as the proportion of correct responses to all 11 questions on indications for antibiotics and practices that may lead to resistance</p> <p>Parental beliefs regarding appropriate antibiotic use; assessed by the level of agreement with 5 statements about antibiotic use</p> <p>Parental behaviour; participants indicated the frequency with which they adhered to a prescribed regimen or followed appropriate or inappropriate antibiotic practices</p>	<p>No significant effect</p> <p>No significant effect; there was no change in the level of agreement for all 5 statements</p> <p>No significant effect; there was no change in parental behaviour for 4 out of the 5 regimens</p>

Reference/ study type/ country/ (quality assessment)	Population and setting	Comparisons		Key outcomes evaluated that are relevant to this review*	Direction of effect for intervention
		Intervention/ (sample size)	Comparator/ (sample size)		
Taylor et al. 2003 RCT USA (-)	Parents of children who were less than 24 months, attending paediatric offices/clinics	Information leaflet titled 'Your Child and Antibiotics', accompanied by a short videotaped message reinforcing the key points in the leaflet (n=252)	Parents who were given an information leaflet about injury prevention (n=247)	Knowledge of appropriate antibiotic use; evaluated by means of parents' level of agreement with 9 statements related to antibiotic use (5 related to specific conditions in children, 4 more general statements about antibiotic use)	<ul style="list-style-type: none"> Parents' level of agreement significantly improved for all 5 conditions related to specific conditions in children Parents' level of agreement did not change for 3 out of the 4 more general statements related to antibiotic use
Wheeler et al. 2001 Non-RCT USA (-)	Parents with a child attending a paediatric clinic	Eight-minute videotape on a loop on monitors in physicians' waiting rooms; an information leaflet titled 'Your Child and Antibiotics' was also available in the waiting room (n=297)	Parents who self-reported not having seen the video or read the information leaflet (n=474)	Knowledge of appropriate antibiotic use; based on one questions which assessed perception of need for antibiotics to treat a child with fever or cold Appropriate expectation on antibiotic prescribing; based on one question which assessed expectation for antibiotics for a child with cold or fever Change in physician prescribing	<p>Significant effect</p> <p>Significant effect</p> <p>No significant changes in physician prescribing practice (data not reported)</p>

Reference/ study type/ country/ (quality assessment)	Population and setting	Comparisons		Key outcomes evaluated that are relevant to this review*	Direction of effect for intervention
		Intervention/ (sample size)	Comparator/ (sample size)		
Communication intervention and/or information leaflet					
Alder et al. 2005 RCT USA (+)	Parents of children (1 to 10 years of age) presenting with complaints of ear pain, sore throat, cough, congestion and/or fever attending a suburban primary care clinic	Role-play to promote parental ability to communicate with the medical provider (communication assertion) (n=20) or information leaflet titled 'Antibiotics and Your Child' and a factsheet about antibiotics use and AMR (n=20) or combined intervention (n=20)	Parents who were provided with information on child nutrition (n=20)	Change in parental expectation of antibiotic treatment for their child; based on 1 question	<ul style="list-style-type: none"> No effect for either of the first two interventions alone vs control Significant interaction effect; communication intervention led to reduction in expectation for treatment when it was implemented without the antibiotic information intervention. Significantly fewer prescriptions for parents who received the communication assertion. No significant difference between parents who did or did not receive the information leaflet
Francis et al. 2009 Cluster-RCT UK (+)	Parents of children (aged 6 months to 14 years) presenting at primary care practice with an acute respiratory tract infection	Clinicians were trained online in the use of an interactive booklet on respiratory tract infections, and used the booklet during consultations with participants to facilitate discussion of parent's main concerns, asking about their expectations, prognosis, treatment options and reasons they should re-consult. (n=30 practices; 256 parents)	Standard care (n=31 practices; 272 parents)	Self-reported rates of face-to-face consultation with a primary care clinician in their general practice, or with an out-of-hours provider, in the two weeks after initial consultation Parents' intention to consult if their child had a similar illness Antibiotics taken within first two weeks following consultation (including antibiotics prescribed after initial consultation) Parents reporting being satisfied, and reassured after consultation	<ul style="list-style-type: none"> No difference between intervention and control Significantly lower among parents in intervention Significantly lower among parents in intervention No difference between intervention and control

Reference/ study type/ country/ (quality assessment)	Population and setting	Comparisons		Key outcomes evaluated that are relevant to this review*	Direction of effect for intervention
		Intervention/ (sample size)	Comparator/ (sample size)		
Cold pack resource and information leaflet					
Alden et al. 2010 Non-RCT USA (-)	Adult patients attending primary care centres	Information leaflet titled 'Antibiotics – Did You Know?' plus a take-home 'cold pack' containing products designed to provide symptomatic relief (n= 147)	Patients who received the leaflet only ('Antibiotics – Did You Know?') (n= 152)	Perceived need for antibiotics (authors do not state how this was measured) Knowledge of appropriate antibiotic use; evaluated based on level of agreement with all 4 statements related to conditions for which one might use antibiotics Number of patients self-reporting that obtained a prescription	Effective, before vs after, all participants (i.e. measuring impact of information leaflet only) • Effective, before vs after, all participants (i.e. measuring impact of educational leaflet only) • Education only was more effective than education plus 'cold pack' No significant difference between patients who reported receipt of the cold pack and education only group

Reference/ study type/ country/ (quality assessment)	Population and setting	Comparisons		Key outcomes evaluated that are relevant to this review*	Direction of effect for intervention
		Intervention/ (sample size)	Comparator/ (sample size)		
Information leaflet (and different prescribing strategies) Little et al. 2005 RCT UK (-)	Patients (aged three years and older) presenting at primary care with acute uncomplicated lower respiratory tract infection	Two factors: 1) Provision of a one-page information leaflet on the natural history of the condition, addressed parents' major worries and provided advice about when to seek further help 2) No antibiotics, delayed prescription or immediate antibiotics (Immediate antibiotics =262 [133 no leaflet, 129 leaflet], Delayed prescription=272 [136 no leaflet, 136 leaflet], no offer of antibiotics=272 [133 no leaflet, 140 leaflet])	NA	Belief in antibiotics (not clear whether in general or in patients' specific contexts): Likert scale (extremely effective, very effective, moderately effective, slightly effective, not very effective, and not at all effective) Self-reported antibiotic use Reconsulting with a cough in the one month following initial consultation	Leaflet vs. no leaflet: No significant difference. Antibiotic prescription: Significantly fewer who received either no antibiotics or a delayed prescription believed in the effectiveness of antibiotics compared to those who received immediate antibiotics. Leaflet vs. no leaflet: No significant difference Antibiotic prescription: Significantly lower consumption in among those who received no antibiotics or a delayed prescription compared to immediate antibiotics Leaflet vs. no leaflet: Significantly more frequent for patients who received a leaflet Antibiotic prescribing: Significantly less frequent for those who received an immediate antibiotic

Reference/ study type/ country/ (quality assessment)	Population and setting	Comparisons		Key outcomes evaluated that are relevant to this review*	Direction of effect for intervention
		Intervention/ (sample size)	Comparator/ (sample size)		
Macfarlane et al. 2002 RCT UK (+)	Previously well adults presenting with acute bronchitis in three suburban general practices; patients randomised were those for whom the GP deemed antibiotics were not definitely indicated that day, but who were provided with a prescription for antibiotics to take at the patient's discretion	Information leaflet about the natural course of lower respiratory tract symptoms and the advantages and disadvantages of antibiotic use; advice from their GP that they did not need to take antibiotics (n=106)	Patients who were not given a patient information leaflet but who were advised by their GP that they did not need to take antibiotics (n=106)	Reduction in inappropriate antibiotic use; proportion of patients who did not take antibiotics that were prescribed Reconsultation for the same symptoms within the one month	Significant effect No difference between groups
Interventions based in the accident and emergency department of a hospital targeting patients or parents of paediatric patients					
Computer kiosk					
Price et al. 2011 Pre-post USA (-)	English- and Spanish-speaking adult patients with acute respiratory infection (ARI) symptoms presenting at a hospital emergency department	A bilingual, interactive, educational computer kiosk (n=686)	NA	Perceived desire for antibiotics; patients rated how much they wanted antibiotics	Significant effect

Reference/ study type/ country/ (quality assessment)	Population and setting	Comparisons		Key outcomes evaluated that are relevant to this review*	Direction of effect for intervention
		Intervention/ (sample size)	Comparator/ (sample size)		
Video or information leaflet Schnellinger et al. 2010 RCT USA (-)	Parents/guardians of children (aged 0 to 18 years) who presented to the Emergency Department during the height of influenza season.	3-minute animated video about appropriate use of antibiotics. Participants watched the video once (n=83); or American Academy of Pediatrics pamphlet about antibiotic use and resistance. Given 15 minutes to read material before returning to research assistant (n=79)	No intervention (n=84)	Improvement in knowledge score; assessed based on the number of correct answers out of 10 questions (details of questions not provided)	Pre vs. post: Controls: No difference between any time points Pamphlet: Significant increase immediately following intervention, and from post-intervention to 4-weeks follow up Video: Significant increase immediately following baseline, but no difference from post-intervention to 4-weeks follow up Control vs. Pamphlet: Significantly greater scores in pamphlet group post intervention and 4-weeks follow up Control vs. Video: Significantly greater scores in video group post intervention and 4-weeks follow up Pamphlet vs. Video: No difference in scores post intervention, but significantly greater scores at 4-weeks follow up (baseline knowledge for all groups was high)
				Appropriate use of antibiotics; based on 1 question 'Would you ask paediatrician for antibiotics if your child had one of the illnesses discussed?'	Significantly fewer parents in the video group would ask for antibiotics than the pamphlet group

Reference/ study type/ country/ (quality assessment)	Population and setting	Comparisons		Key outcomes evaluated that are relevant to this review*	Direction of effect for intervention
		Intervention/ (sample size)	Comparator/ (sample size)		
Intervention based in the home led by researchers targeting the Latino community					
Larson et al. 2009 Pre-post USA (+)	Predominantly Latino neighbourhood in upper Manhattan, New York	Bi-monthly home visits; Spanish- language educational materials; and a Centers for Disease Control and Prevention (CDC) information leaflet regarding appropriate use of antibiotics (n=422)	NA	Knowledge of what conditions antibiotics may be appropriate for (cold, viral sore throat, asthma, influenza) Concern about AMR	There was an improvement in peoples' knowledge of when it may be appropriate to take antibiotics There was less concern about AMR after the intervention
Interventions based within primary and secondary schools and/or targeting school aged children					
Farrell et al. 2011 Pre-post UK (-)	Children aged 9 to 12 years old from three schools and recruited online through school based contacts	e-Bug-developed computer games (n=1736 [in-school n=62, online n=1674])	NA	Knowledge of appropriate antibiotic use; assessed by asking children 6 questions	There were no significant differences in answers to the questions after the intervention
Fonseca et al. 2012 Pre-post Portugal (-)	High school students aged 15 or 16 years old	A week-long, inquiry-based, hands-on practical course for high school students titled 'Microbiology Recipes: Antibiotics à la Carte' (n=42)	NA	Knowledge of the concepts bacteria and antibiotics; evaluated based on 7 questions Knowledge of AMR; evaluated using three questions Knowledge of appropriate antibiotic use; evaluated using one question	Significant effect for all 7 questions Significant effect for all 3 questions Significant effect
Losasso et al. 2014 RCT Italy (-)	Fifth grade students aged 9 to 11 years old, in 12 public schools	Health campaign titled Mission on the Invisible World, consisting of ad hoc multimedia and movies and using a practical approach (no detail on practical approach reported by authors) (n=162)	Health campaign titled Mission on the Invisible World, consisting of ad hoc multimedia and movies using a theoretical approach (no detail on theoretical approach reported by authors) (n=87)	Knowledge of flu and AMR (authors do not make clear how this outcome was assessed)	No change in knowledge scores pre- post intervention for either group; no results were presented for between- group differences

Reference/ study type/ country/ (quality assessment)	Population and setting	Comparisons		Key outcomes evaluated that are relevant to this review*	Direction of effect for intervention
		Intervention/ (sample size)	Comparator/ (sample size)		
McNulty et al. 2001 Pre-post (pilot study) UK (-)	Children aged 9 to 10 years old at a Gloucester state school	Two 90-minute workshops covering micro-organisms, bacteria, antibiotics and hand washing (n=48)	NA	Knowledge of microbes/infection, and antibiotics; evaluated in 4 sections of the questionnaire, children had to answer all questions in the section correctly Knowledge of AMR; measured in 1 section of the questionnaire; children had to answer all questions correctly	Children's knowledge of microbes/infections and antibiotics improved for 3 out of the 4 sections (baseline knowledge was high) No significant effect (baseline knowledge was high)
McNulty et al. 2007 Pre-post UK (+)	Children aged 10 to 11 years old in primary schools	'Bug Investigators' school resource pack (n=251)	NA	Knowledge of microbes and antibiotics; evaluated in 3 sections of the questionnaire; children had to answer all questions correctly Knowledge of AMR; measured in one section of the questionnaire; children had to answer all questions correctly Knowledge of appropriate antibiotic use; measured in two sections of the questionnaire with specific questions on symptoms and complying with doctors' advice; children had to answer all questions correctly	Children's knowledge of microbes and antibiotics improved in all 3 sections No significant effect Children's knowledge of appropriate antibiotic use improved for both sections of questionnaire

Reference/ study type/ country/ (quality assessment)	Population and setting	Comparisons		Key outcomes evaluated that are relevant to this review*	Direction of effect for intervention
		Intervention/ (sample size)	Comparator/ (sample size)		
Intervention based in day care led by health educators/child care providers targeting parents					
Croft et al. 2007 RCT USA (-)	Parents with pre-kindergarten children (specific ages not presented by authors)	Presentation by health educators to child care providers on infections, infection controls and basic principles regarding AMR and appropriate antibiotic use; educational materials given to parents (n=298)	No intervention (n=361)	Parental knowledge scores of appropriate antibiotic use; combined score was created of antibiotic indications for 5 different respiratory diagnoses or symptoms Awareness of AMR; evaluated using question related to infections being harder to treat if a child takes an antibiotic when it is not needed Parental attitudes and beliefs related to appropriate antibiotic use; evaluated using 2 questions related to whether ask doctor for antibiotics	<ul style="list-style-type: none"> • Effective among parents who were college graduates • No effect among parents who were non-college graduates • Effective among parents who were college graduates • No effect among parents who were non-college graduates • For college graduates attitudes improved for 1 out of the 2 statements • For non-college graduates attitudes improved for 1 out of the 2 statements
Interventions implemented within the community					
Mass media campaign					
Huang et al. 2007 Cluster RCT USA (+)	Parents in 16 communities in Massachusetts	Mailed newsletter; approach of initial observation without antibiotics ('watchful waiting') for mild ear infections in low-risk patients; educational materials in waiting rooms of local paediatric providers, pharmacies, and child care centres (n=534 in 2000, n=1034 in 2003)	No intervention (n=537 in 2000, n=1037 in 2003)	Antibiotic knowledge scores; the proportion of participants with a high level of antibiotic knowledge classified as correctly answering 7 or more questions out of 10 Demand for antibiotics; proportion of parents considered to have a tendency to demand antibiotics, classified as agreeing with 1 or more questions out of 3	<ul style="list-style-type: none"> • No significant effect • In stratified analysis by insurance provider there was an effect among Medicaid-insured participants but not among non-Medicaid-insured participants No significant effect

Reference/ study type/ country/ (quality assessment)	Population and setting	Comparisons		Key outcomes evaluated that are relevant to this review*	Direction of effect for intervention
		Intervention/ (sample size)	Comparator/ (sample size)		
Mainous et al. 2009 Non-RCT USA (-)	Adults from the Latino community in South Carolina	Patient information leaflet; public service advertisements in Spanish-language newspapers (pre-intervention n=273)	No intervention (geographical control) (n=243)	Current antibiotic use; two questions related to having bought antibiotics without a prescription Attitude towards prescribing; one question related to belief that antibiotics should be available without a prescription	No significant effect for both questions Ineffective; significantly more participants believed that antibiotics should be available without a prescription post-intervention
Mass media and GP intervention					
Trepka et al. 2001 RCT USA (-)	Household caregivers (usually parents) of children <4 years of age	Information leaflet titled 'Your Child and Antibiotics'; posters; presentations made by nurse- educators, who distributed the information leaflet; newspaper article about antibiotic resistance; physician-oriented interventions ('grand rounds' presentations, small-group academic detailing) (n=215)	No intervention (n=215)	Awareness of AMR; assessed by determining level of agreement with 3 statements Knowledge of appropriate antibiotic use; proportion of parents who thought that antibiotics were always or sometimes, versus never, indicated for each of 5 respiratory diagnoses; a mean score was created by the summation of the responses for the 5 diagnoses	Significant effect • For participants in the intervention knowledge of appropriate antibiotic use was improved for 4 out of 5 diagnoses • In control knowledge of appropriate antibiotic use was improved for 3 out of 5 diagnoses • There was no difference in change in scores between baseline and post-intervention between the intervention and control

Reference/ study type/ country/ (quality assessment)	Population and setting	Comparisons		Key outcomes evaluated that are relevant to this review*	Direction of effect for intervention
		Intervention/ (sample size)	Comparator/ (sample size)		
Interventions targeting the general public					
Interactive science show based in a holiday resort targeting families with children					
Lecky et al. 2014 Pre-post UK (+)	Families (parents and children aged 5 to 11 years old)	e-Bug-developed computer- based interactive science show which covered microbes, hand hygiene ¹ , respiratory hygiene, food hygiene, antimicrobial resistance and prudent antibiotic use (n=406)	NA	Knowledge of antibiotics; evaluated using 3 questions Knowledge of appropriate antibiotic use; measured using 2 questions related to keeping antibiotics for later Knowledge of AMR; measured using 2 questions	For both children and parents knowledge of antibiotics improved for all 3 questions • For children knowledge of appropriate antibiotic use improved for both questions • For adults there was no change in knowledge for either question • Children's knowledge of AMR improved for both questions • Adults' knowledge of AMR improved for 1 out of the 2 questions
Web-based intervention conducted in a museum					
Madle et al. 2004 Pre-post UK (-)	General public attending a science museum	Health education website: the National electronic library of Infection (Nell) Antibiotic Resistance website (n=227)	NA	Awareness of AMR; measured using 7 statements Knowledge of appropriate antibiotic use; measured using 6 statements related to attitudes to antibiotic use in acute otitis media (AOM) Attitudes to prescribing; measured using 2 questions related to expectation of prescribing for AOM	Increased awareness of AMR for 3 out of the 7 statements Improvement in knowledge on appropriate antibiotic use in 3 out of the 6 statements Improvement in attitudes for both questions

¹ While the intervention included information on hand hygiene, knowledge of or behaviour around hand hygiene was not assessed as an outcome by the study authors.

Reference/ study type/ country/ (quality assessment)	Population and setting	Comparisons		Key outcomes evaluated that are relevant to this review*	Direction of effect for intervention
		Intervention/ (sample size)	Comparator/ (sample size)		
Mass media and GP intervention Curry et al. 2006 Pre-post New Zealand (-)	Adolescents and adults aged over 16 years old	Education campaign titled 'Wise Use of Antibiotics', involving placing educational posters and leaflets in family practice waiting rooms and pharmacies, and GP education (n=200 in 1998, n=200 in 2003)	NA	Awareness that antibiotics are not effective in the treatment of viral infections Understanding of when it is appropriate (or inappropriate) to take antibiotics for specific symptoms (13 different symptoms were assessed) Consulted the doctor about a URTI Consulted the doctor with the expectation of receiving an antibiotic Reported receiving an antibiotic prescription from doctor when attending for URTI	No effect; there was no change in awareness after the campaign There was a significant improvement for 6 out of the 13 symptoms assessed There was a significant decrease No significant effect There was a significant decrease in patients receiving antibiotics.

Reference/ study type/ country/ (quality assessment)	Population and setting	Comparisons		Key outcomes evaluated that are relevant to this review*	Direction of effect for intervention
		Intervention/ (sample size)	Comparator/ (sample size)		
McNulty et al. 2010 Pre-post UK (-)	General populations of England (intervention) and Scotland (comparison)	2008 English public antibiotic campaign, involving three posters displayed in magazines and newspapers; key message: 'The best way to treat most colds, coughs or sore throats is plenty of fluids and rest. For advice talk to your pharmacist or doctor' (n=1706 in 2008, n=1707 in 2009)	Scottish population, who were assumed to have had minimal exposure to the English campaign (n=182 in 2008, n=123 in 2009)	Knowledge and attitudes to antibiotics and appropriate antibiotic use; measured using 10 statements related to how antibiotics work and when to take antibiotics	England pre (2008) vs post (2009): <ul style="list-style-type: none"> No effect; no change in knowledge and attitude for 9 out of 10 statements England vs Scotland (2009): <ul style="list-style-type: none"> No effect; no difference in knowledge between intervention and control for 9 out of 10 statements
				Self-reported behaviour of appropriate antibiotic use; measured using 3 questions related to respondents' practices (being prescribed an antibiotic, asked for an antibiotic and saving antibiotics for later use)	England pre vs post: <ul style="list-style-type: none"> No change in behaviour for 2 out of the 3 questions Significant increase in respondents saving antibiotics England vs Scotland: <ul style="list-style-type: none"> No difference between intervention and control for 2 out of 3 questions English respondents significantly more likely to take an antibiotic without being told to do so by a doctor/nurse

Reference/ study type/ country/ (quality assessment)	Population and setting	Comparisons		Key outcomes evaluated that are relevant to this review*	Direction of effect for intervention
		Intervention/ (sample size)	Comparator/ (sample size)		
Parsons et al. 2004 Pre-post UK (+)	Adult population registered with general practitioners	Locally enhanced national educational campaign (n=982 pre-intervention, n=1941 post-intervention)	NA	<p>Knowledge of appropriate antibiotic use; measured using seven questions related to general understanding of when to take antibiotics and 5 questions related to when children should be prescribed antibiotics</p> <p>Attitude; agreement with the statement 'that a child's parents are best people to decide whether or not they need antibiotics'</p> <p>Prescription rates</p>	<ul style="list-style-type: none"> No change in knowledge for any of the 7 general statements about when to take antibiotics No change in knowledge for when children should be prescribed antibiotics for 4 out of 5 questions <p>No significant change in attitude</p>
Wutzke et al. 2007 Pre-post (repeated cross- sectional surveys) Australia (-)	Adolescents and adults aged over 15 years old	Radio and television broadcasts, newspapers articles, information leaflets, posters, stickers, badges, prescription pads for GPs; patient information leaflets on sore throat and cough (distributed to GPs); (n=1614 in 1999, n=1603 in 2000, n=1800 in 2001, n=1200 in 2003 and n=1200 in 2004)	NA	<p>The belief that taking antibiotics for cold and flu is appropriate</p> <p>Self-reported use of antibiotics to treat cough, cold or flu</p>	<p>Dispensing rates in study area were not significantly different from that expected based on the previous four years of data</p> <p>The proportion of participants having this belief was decreased after the campaign</p> <p>There was a decrease in self-reported inappropriate antibiotic use</p>

NOTE. NA – Not Applicable

4.1. Pharmacist-led interventions targeting patients or carers of patients

Verbal Education

1. A controlled trial (**non-RCT**) by **Muñoz et al. 2014 (-) in Spain** assessed the effectiveness of an educational intervention on antibiotic adherence and patient-reported resolution of symptoms. Adult patients (aged 18 years and over) or carers attending a city pharmacy to collect oral antibiotics either for themselves or someone they were looking after. In total 138 participants were recruited into the study (70 to intervention, 68 to control). The first participant was randomised into an intervention or control group, with the remaining sample systematically allocated to the two groups. The intervention focused on providing individualised verbal information to the patient, or carer, about their treatment characteristics, duration, dosage regime, and how to use the prescribed antibiotic. The discussion took place in an area set apart from the counter, lasted about 20 min and followed an antibiotic dispensing protocol drawn up by the head pharmacist. Written information was not provided to the participants. The control group participants received standard care. Telephone interviews were conducted seven days after the dispensation. Patients' adherence to treatment was evaluated by a combination of the Morisky-Green test (details not provided) and a self-reported pill count. Patients were considered compliant if they were categorised as such in both measures and non-compliant if they were found to be non-compliant in either of the two measures. Non-treatment-compliant patients were categorised as mild if a single dose was missed, and moderate, if more than one dose was missed. In total 126 (91.3%) of participants completed the telephone interview and were included in the analysis (62 intervention, 64 control).

Findings: Adherence to antibiotic treatment was significantly higher among the intervention (67.2% [95%CI: 55.0 to 77.4]) than control (48.4% [95%CI: 36.4 to 60.6]); difference of 18.8% [95%CI: 15.8 to 34.6] ($p=0.033$). Moderate non-compliance (more than one dose intake missed) was significantly greater in the control (81.2%) than intervention (38.1%); difference 43.1% [95%CI: 16.4 to 63.1] ($p = 0.001$). There was no significant difference in participants' health perceptions, although perceptions were higher among the intervention group, who were more likely to report being 'totally cured' than the control; (54.7% [95%CI: 42.6 to 66.3] vs. 46.8% [95%CI: 34.9 to 59.0], respectively ($p=0.297$)).

Considerations/limitations: There are inherent limitations in the measurements used. The study used indirect tests, which tend to overestimate adherence, although the use of two different methods could reduce the bias. In this study, patient knowledge was not an outcome measure in itself, but was tested as a predictor for user adherence. Participant allocation, with the exception of the first participant, was not randomized.

Verbal education and information leaflet

2. A **pilot RCT** by **Northey et al. 2010 (-) in Australia** investigated the effect of pharmacist-led verbal education and a patient information leaflet on the use and knowledge of antibiotics among patients presenting at one of three community pharmacies in New South Wales for dispensing of a valid antibiotic prescription. Thirty-four adult patients were randomly assigned to receive the intervention,

which consisted of extensive verbal education provided by the pharmacist, supported by a leaflet produced by the National Prescribing Services (NPS) titled 'Why Do Some People Need Antibiotics?' or to a control group who received a consumer medicines information (CMI) leaflet. The intervention leaflet included information on how misuse of antibiotics increases the number of antibiotic-resistant infections; why this is an increasing problem and how the patient can use antibiotics correctly to help reduce antibiotic resistance; and details on how patients could manage symptoms of a respiratory infection without antibiotics. A baseline survey was taken prior to randomisation, and this survey was repeated approximately one month later; 26 (76.5%) participants completed the follow-up survey and were included in the analysis (13 in the intervention group, 13 in the control group).

Findings: The authors reported a significant increase in antibiotic knowledge for those patients receiving the intervention; the mean difference in antibiotic knowledge score (%) increased by 33.3 (± 40.8), from 60.0 (± 43.9) to 86.6 (± 17.2) ($p=0.008$). The authors reported a non-significant decrease in mean score among those in the control -5.1 (± 23.0), from 83.3 (± 23.6) to 80.0 (± 35.8) ($p=ns$). The effect size was reported to be large ($r=0.5$).

Limitations/considerations: Potentially no effect was seen in the CMI group, as the mean baseline knowledge score was high (83.3%), whereas there was potentially more room for knowledge gain in the intervention group, as the mean baseline knowledge was lower (60.0%). Due to the small sample size and differences in knowledge between the groups at baseline, the results of this study are unlikely to be reliable.

3. A **pre-post study by Rodis et al. 2004 (-) in the USA** assessed the effect of pharmacist-initiated verbal education and an information leaflet on knowledge about antibiotic resistance and appropriate antibiotic use among 130 adult patients presenting at an urgent care clinic with acute upper respiratory tract infection (URTI) symptoms. Before they were seen by a physician, a trained pharmacist engaged the patient in a five-minute dialogue during which the pharmacist: (1) defined antibiotic resistance; (2) explained the risks associated with antibiotic resistance; (3) described the correlation between inappropriate use of antibiotics and the emergence of antibiotic resistance; (4) reviewed conditions requiring antibiotic treatment; and (5) educated the patient on what he or she can do to reduce the spread of antibiotic resistance. During the intervention, the patient was given two handouts, both developed by the Centers for Disease Control and Prevention, one titled 'A New Threat to Your Health: Antibiotic Resistance' and another addressing frequently asked questions about antibiotic resistance. A baseline survey was taken prior to the patient's receiving the intervention and repeated two weeks after; 46 (35.4%) completed the follow-up survey and were included in the analysis.

Findings: At the two-week follow up, the authors found a non-significant increase in patients' understanding of antibiotic resistance as evaluated by the following three statements: 'Some germs are becoming harder to treat with antibiotics' ($p=0.21$); 'If antibiotics are overused they will not work as well for treating infections' ($p=0.35$); 'If antibiotics are used frequently, you may be infected with bacteria that are hard to treat' ($p=0.09$). When the responses were combined into a measure of agreement with all three statements, however, the authors found a significant improvement in

patients' knowledge of antibiotic resistance, from 56.5% to 80.4% ($p=0.026$). Knowledge of appropriate antibiotic use was measured by assessing patients' perception of the need for antibiotic therapy for four viral infections. Patients' knowledge significantly improved for two conditions: cold ($p=0.023$) and flu with cough and body aches ($p=0.016$), but not for the other two conditions: dry cough with no fever ($p=0.158$) and non-streptococcal sore throat ($p=0.363$).

Limitations/considerations: The difference in results for knowledge of antimicrobial resistance between the individual and combined statements potentially reflect differences in baseline knowledge of the participants; at baseline, 89.1% of patients surveyed agreed with the statement 'Some germs are becoming harder to treat with antibiotics', and 91.3% agreed with the statement 'If antibiotics are overused, they will not work as well for treating infections', while only 61.0% agreed with all three statements. Likewise, the improvement in knowledge of when to use antibiotics appears patchy. The response rate to the post-intervention survey was poor, and consequently the comparison study size was small. The authors speculate that those who felt they had learnt something may have been more likely to respond.

Evidence Statement 1.1 Pharmacist-led verbal education, supplemented with an information leaflet

There is weak evidence from one non-randomised controlled trial (non-RCT) (-)¹, one randomised controlled trial (RCT) (-)² and one pre–post study (-)³ indicating that verbal education on antibiotic adherence from a pharmacist, or the combination of written and verbal education on antimicrobial (AM) use and antimicrobial resistance (AMR) delivered by pharmacists, can improve patients' adherence to treatment and knowledge of AM use, but that written and verbal education did not increase awareness of AMR. However, baseline awareness was high, potentially leaving less room for knowledge gain.

One non-RCT¹ (-) (Spain; n=138) found that individualised verbal education about treatment characteristics, duration, dosage regime and how to use the antibiotic delivered by a pharmacist to patients and/or carers before collecting an antibiotic prescription, lead to increased adherence (aOR 2.23 [95%CI: 1.01 to 4.93] p=0.047).

One RCT² (-) (Australia; n=34) found that the provision of a patient education leaflet plus verbal education from a pharmacist led to improved knowledge of antibiotics (the mean difference in 'antibiotic knowledge' score increased by 33.3% (± 40.8), from 60.0% (± 43.9) to 86.6% (± 17.2) (p=0.008). Conversely, in the control group (who received a 'Consumer Medicines Information' leaflet only), there was a non-significant decrease in knowledge of antibiotics; the mean difference in 'antibiotic knowledge' score decreased from 83.3% (± 23.6) to 80.0% (± 35.8) (p=non-significant (ns)). No statistical comparisons were made between the control and intervention groups.

One pre–post study³ (-) (USA; n=130) reported that pharmacist-led verbal education and a patient educational leaflet and handout significantly improved patients' overall understanding of AMR, from 56.5% at baseline to 78.3% at follow up (p=0.026). However, the change-from-baseline for all three individual component questions/statements was non-significant, potentially because baseline knowledge of the participants was already high. The results also indicated some improvements in patients' understanding of the appropriate use of antibiotics. There was a significant increase in the number of patients who correctly reported that antibiotics should not be used to treat viral infections for two out of the four conditions surveyed: cold, from 58.7% to 80.4% (p=0.02), and flu with body aches, from 34.8% to 60.9% (p=0.02).

Applicability:

While none of the studies were conducted in the UK, the evidence is directly applicable to people in the UK as there are no obvious differences in the population, context or setting of the studies compared with the UK context.

1. Muñoz et al. 2013 (-)
2. Northey et al. 2010 (-)
3. Rodis et al. 2004 (-)

4.2. Interventions based general practice and/or led by a GP targeting patients or parents of paediatric patients

4.2.1. *Video and information leaflet*

1. A RCT by **Bauchner et al. 2001 (+) in the USA** evaluated the effectiveness of an educational video on the knowledge, beliefs, and behaviours surrounding the appropriate use of oral antibiotics of caregivers attending two paediatric offices in Boston and an affiliated day care centre. A total of 206 primary caregivers (usually parents) with a child between the ages of 6 months and 3 years were randomised to receive the intervention, which consisted of a 20-minute video containing information on common viral and bacterial childhood infections, the differences between bacteria and viruses that account for their susceptibility or lack of susceptibility to antibiotics, the importance of adhering to a prescribed antibiotic regimen, and ways in which inappropriate antibiotic use can lead to bacterial resistance. The video presented encounters of real parents with their child's paediatrician, visual graphics and didactic information. Parents were asked to view it as often as they liked over a two-month period. Additionally, parents received a brochure titled 'What Every Parent Should Know About Antibiotics', specifically designed for the project. The brochure contained information about common viral infections, how to use antibiotics, and a statement that antibiotics are effective only against bacterial infections. The control group received no intervention. A baseline interview included 11 questions related to knowledge that antibiotics and practices may lead to resistance, 5 related to parents' beliefs about antibiotics and 5 related to parents' behaviour in adhering to prescribed regimen and appropriate antibiotic use. The interview was repeated two months later. In total, 193 (93.7%) participants completed the post-test interview and were included in the analysis: 102 (99.0%) in the intervention; 91 (88.3%) in the control.

Findings: The authors found no significant differences in post-test mean knowledge scores (from 0–11), beliefs, and self-reported behaviours between the intervention and control in univariate analysis. Controlling for covariates had no impact on participants' knowledge scores (8.04 vs 7.82, $p=0.31$), or any of the five statements related to belief, but there was a significantly greater mean score (indicating more appropriate behaviour) in the intervention group for one out of the five behaviour items, namely, 'I throw out leftover antibiotic medicine' (3.82 vs 3.62, $p=0.02$).

The authors also reported that there was no evidence of a dose response with self-reported exposure to the video for any outcome. However, there was a significant interaction by study site for the mean knowledge scores, which were significantly higher for the intervention than the control in the urban clinic location (6.92 vs 6.03, $p=0.003$), but not the suburban clinic site (9.19 vs 9.14, p -values were not reported).

In addition, in unadjusted analyses, a significantly higher percentage of participants in the video group compared with the control group believed there were any problems with receiving too many antibiotics over time (81% vs 68%, $p=0.007$). The results were unchanged after adjusting for baseline values and other potentially confounding variables. The positive effect was limited to participants from the urban clinic site, where nearly twice as many participants in the video group compared with the control group (67% vs 34%, $p=0.007$) believed there were problems. There was essentially no

difference between conditions among participants from the suburban clinic site (94% in the video group vs 94% in the control group).

Limitations/considerations: Although there is the possibility that additional parents who received the video did not watch it, 81% of parents self-reported having viewed the video at least once.

2. A RCT by Taylor et al. 2003 (-) in the USA evaluated the effectiveness of an educational leaflet and video message on attitudes towards judicious antibiotic use among parents attending one of eight paediatricians in the Seattle, Washington, area. Five hundred parents with children who were younger than 24 months were randomly assigned to receive the intervention or the control. The intervention consisted of an information leaflet titled 'Your Child and Antibiotics', which describes the differences between viral and bacterial illnesses; lists common illnesses, such as URIs, for which antibiotics are usually not needed; explains the relationship between overuse of antibiotics and bacterial resistance; and encourages parents to discuss these issues with their child's doctor. The leaflet was accompanied by a short, videotaped message which featured one of the physicians from their child's paediatric practice discussing the key points in the information leaflet. The control group received an information leaflet on injury prevention. A baseline questionnaire, which included nine statements about appropriate antibiotic usage and seven statements about injury prevention in young children was undertaken at enrolment and six weeks after the intervention; 358 (72%) participants completed the post-intervention questionnaire and were included in the analysis, 174 (69.0%) intervention, 184 (74.5%) control.

Findings: The authors reported that the intervention significantly modified parental beliefs about the need for antibiotics for all five of the statements related to the use of antibiotic for specific conditions in children (a lower score indicates attitudes supportive of judicious use of antibiotics): 'Giving an antibiotic to a child with cold symptoms can prevent an infection from occurring', 1.86 vs 2.16 ($p=0.005$); 'It is worth trying an antibiotic when my child has cold symptoms for 5 days' 1.93 vs 2.34 ($p=0.001$); 'Treatment with antibiotics is necessary when a child's nasal discharge turns from yellow to green in colour' 2.61 vs 3.47 ($p=0.001$); 'Antibiotics help a child's cold symptoms clear up more quickly' 1.64 vs 2.01 ($p=0.001$); and 'Antibiotics are helpful in treating colds' 1.52 vs 1.87 ($p<0.001$). In contrast, the results for more general or theoretical statements about antibiotic use were mixed (a higher score indicates attitudes supportive of judicious use of antibiotics). Only one out of the four statements was significantly higher in the intervention than the control: 'Overuse of antibiotics can make bacteria more resistant to antibiotics', 5.78 vs 5.52 ($p=0.021$), while three out of the four statements were non-significantly higher: 'Too many children are treated with antibiotics when not necessary', 5.18 vs 4.86 ($p=0.07$); 'Parents should not try to persuade a doctor to prescribe antibiotics', 5.26 vs 4.99 ($p=0.078$); 'Physicians should never prescribe antibiotics when they are unnecessary', 5.64 vs 5.47 ($p=0.10$).

Limitations/considerations: The authors state that familiarity with the design and statements on the initial questionnaire may have had an effect on the follow-up questionnaire. Furthermore, parents who completed the follow-up survey had some attitudes more supportive of judicious use of antibiotics at baseline than did parents who did not complete the survey, thus potentially introducing bias.

3. A **non-RCT** by **Wheeler et al. 2001 (-) in the USA** investigated the impact of an educational strategy that focused on parents of paediatric patients and their physicians with the aim of reducing injudicious antibiotic use. The intervention primarily consisted of an eight-minute videotaped message, using a standardised script based on the American Academy of Paediatrics, and an information leaflet titled 'Your Child and Antibiotics', which was available in the waiting room at the time that patients arrived for registration (it was not specifically given to the parent). In addition, staff received a training session on judicious antibiotic use at the end of week one, before the showing of the antibiotic videotape. Parent attitudes and physicians' prescribing practices were monitored before the showing of the videotape, during week two when the videotape was shown and approximately 36 weeks later. In total, 771 patients were surveyed; 474 (61%) reported that they had not seen the video or read the information leaflet, and these were treated as the control.

Findings: Parents who did see the video were significantly less likely than controls to think that antibiotics should be used always or mostly to treat a child with fever or cold compared with those who did not see the videotape at week two: 14.7% vs 29.1% ($p \leq 0.001$) and at week 36: 7.1% vs 29.2% ($p \leq 0.001$). Parents who saw the video were also significantly less likely to want/expect the doctor to prescribe antibiotics for their child than those who did not see the video at week two: 27.6% vs 36.9% ($p < 0.001$) and week 36: 13.8% vs 44.3% ($p < 0.001$). There was no change in physician prescribing practice (data not reported). Of the nine participating physicians, eight reported that they had discussed antibiotic resistance with patients more during the study than before; seven said that they had discussed the videotape or the leaflet messages with their patients on a regular or occasional basis. All nine GPs considered that educational videos could be an effective tool as a regular part of health maintenance visits.

Limitations/considerations: The study relied on patient reporting to determine exposure, rather than an external control, and it did not account for how much of the video the participant had seen (no specific viewing time minimum was required to be included in the intervention).

Evidence Statement 1.2 Video- and information leaflet-based interventions in general practice and/or led by a GP targeting parents of paediatric patients

There is weak evidence from two RCTs (+)¹ (-)² and one non-RCT (-)³ that the combination of an educational video on antimicrobial use and antimicrobial resistance, supplemented by an information leaflet delivered within a primary care setting, can improve parents' knowledge of appropriate antimicrobial use and expectations of antimicrobials for their child, but that it was not effective in improving awareness of AMR.

One RCT¹ (+) (USA; n=206) found that a 20-minute video programme, supplemented by an information leaflet, both of which aimed to educate parents on the problem of bacterial resistance to antibiotics and their appropriate use to prevent the development of resistance, did not have an impact on knowledge scores or any of the five statements related to beliefs, but did have a significant impact on one of the five behaviour statements: there was a reduction in saving antibiotics for later use when compared with the control group, 3.82 vs 3.62 (p=0.02).

One RCT² (-) (USA; n=499) conducted in a paediatrician's office reported that an information leaflet ('Your Child and Antibiotics') and a video presented by a GP on judicious use of antibiotics was effective in increasing parents' knowledge of when to use antibiotics for all five statements related to appropriate use of antibiotics for specific conditions in children compared with control, but for only one out of the five more general statements related to increasing awareness of AMR.

One non-RCT³ (-) (USA; n=771) conducted in a GP's office found that provision of an information leaflet ('Your Child and Antibiotics') and a video in waiting rooms significantly improved knowledge of when to take antibiotics in those who reported seeing the video vs those who reported not seeing the video at 36 weeks post-intervention: 7.1% vs 29.2% thought that antibiotics should be used to treat a child with fever or a cold (p≤0.001), and 13.8% vs 44.3% wanted/expected the doctor to prescribe antibiotics for their child (p<0.001).

Applicability:

While none of the studies were conducted in the UK, the evidence is directly applicable to people in the UK, despite differences in the broader healthcare context in the USA, as there are no obvious differences in the population, context or setting of the study compared with the UK context.

1. Bauchner et al. 2001 (+)
2. Taylor et al. 2003 (-)
3. Wheeler et al. 2001 (-)

4.2.3. *Communication and/or information leaflet*

1. A RCT by Alder et al. 2005 (-) in the USA tested an intervention based on Social Cognitive Theory (SCT) to reduce parents' expectations of their child being prescribed antibiotics, in favour of improved communication with a physician. The study was set at two suburban primary care clinics with multiple providers in the Salt Lake City, Utah, metropolitan area, and recruited 80 parents whose children were aged between 1 and 10 years old who had ear pain, sore throat, cough, congestion and/or fever and who had not received antibiotic therapy during the previous two weeks. The parents were randomised into three intervention groups and one control group (n=20 each group). Parents assigned to a 'communication intervention' were asked to review four questions to be answered during the clinic visit, designed to enable parents to obtain information about their child's illness during the clinic visit, and asked to write any additional questions they had for their child's healthcare provider. The next step in the intervention was to promote parents' efficacy to be assertive in asking and receiving answers to the recommended questions through a short series of role-playing exercises. Parents assigned to an 'information only' intervention group received educational information about antibiotics, antibiotic resistance, and the link between misusing antibiotics and the emergence of antibiotic resistance through a Center for Disease Control and Prevention (CDC) information leaflet titled 'Antibiotics and Your Child' and a fact sheet about antibiotic use and antibiotic resistance. A third intervention group combined both the communication and information component. A control intervention group unrelated to antibiotic use or parent-physician communication was included, focusing on child nutrition. A questionnaire was administered at baseline and post-intervention; parents were asked to rate their level of expectation for a specific therapy from 1 (almost always) to 7 (rarely). Differences between baseline and post-intervention responses were calculated and used as an indicator of change in treatment expectations. Differences in antibiotic use and receipt of an antibiotic prescription were also measured.

Findings: The authors reported that there was no significant change in mean scores of parents' general expectation of receiving antibiotic treatment for their child, for either the communication (communication vs. no communication -0.28 (\pm 0.75) vs. 0.11 (\pm 1.39), $p=0.121$) or antibiotic information intervention (antibiotic education vs. no education: -0.08 (\pm 0.98) vs. -0.11 (\pm 1.24), $p=0.604$). However, there was a significant interaction effect ($p=0.049$), with the communication intervention, leading to a reduction in expectation for treatment by parents when it was implemented without the antibiotic information intervention (-0.45 vs. 0.31) compared to implementation with the antibiotic intervention (-0.10 vs. -0.05). The communication intervention resulted in a reduction in the number of prescriptions (OR 0.171 [95%CI: 0.031 to 0.934] $p=0.042$), while the information leaflet resulted in a non-significant decrease in the number of prescriptions (OR 0.398 [95%CI: 0.082 to 1.924] $p=0.252$).

Limitations/considerations: This study had a small sample size, and it is difficult to interpret the results as presented by the study authors because the data were not clearly reported; the data presented in the tables do not clearly match the intervention and control groups described in the text.

2. A cluster-RCT by Francis et al. 2009 (+) in England and Wales evaluated the effectiveness of an information booklet, designed to be used as a consultation aid in general practice. In total 83

practices were randomised to the intervention or control. Clinicians in intervention practices received online training on how to use the booklet. The training encouraged clinicians to use the booklet during consultations with parents of children (aged 6 months to 14 years) presenting with acute respiratory tract infections to facilitate discussion of the parent's main concerns, asking about their expectations, prognosis, treatment options and reasons that should prompt reconsultation. The content of the booklet was not described in the paper. Clinicians in the control arm conducted consultations following their usual standard practice. Telephone questionnaires were conducted with parents two weeks after initial consultation to determine; self-reported rates of re-attendance for the same illness, antibiotic prescribing, antibiotic consumption, future consulting intentions and parents' satisfaction. In total 61 practices and 558 parents were included in the analysis; 30 practices in intervention with data available from 256 (93%) parents and 31 practices in control with data available from 272 (96%) of parents.

Findings: There were significant reductions in antibiotic consumption (22.4% in intervention vs. 43% in control; aOR [95% CI 0.18 to 0.66]) and parents' intention 'to consult if their child had a similar illness' (55.3% in intervention vs. 76.4% in control; aOR 0.34 [95%CI 0.20 to 0.57]). The intervention also lead to significant reductions in rates of antibiotic prescribing (19.5% in intervention vs. 40.8% in control; aOR 0.29 [95%CI 0.14 to 0.60]). There was no difference in self-reported rates of face-to-face consultation with a primary care clinician in their general practice, or with an out-of-hours provider, in the two weeks after initial consultation between intervention and control or the proportion of parents who reported being satisfied or very satisfied with their consultation between intervention and control, or feeling very reassured after their consultation: reconsultation rates were 12.9% in intervention and 16.2% in control (aOR 0.75 [95%CI 0.41 to 1.38]); and satisfaction levels were 90.2% in intervention and 93.5% in control (aOR 0.64 [95%CI 0.33 to 1.22]) and reassured 72.0% in intervention and 75.3% in control (aOR 0.84 [95%CI 0.57 to 1.25]).

Limitations/considerations: Neither clinicians nor parents were blinded to the study aims. Consequently clinicians in the control group might have altered their behaviour, which the authors speculate might have impacted on parents' satisfaction. The study did not measure treatment fidelity, which if suboptimal could have diluted the treatment effect. It was not possible to determine which element of the intervention contributed to the observed effect. Given that the rates of prescribing decreased while reconsultation rates did not, the intervention may have had a greater effect on clinicians' behaviour than parents' behaviour. It is not possible to know what impact the booklet had on parents' knowledge, attitudes or beliefs.

Evidence Statement 1.3 Communication and/or information leaflet-based interventions in general practice targeting parents of paediatric patients

There is inconsistent evidence from one RCT(-)¹ and one cluster-RCT (+)² on the effectiveness of educational interventions that aim to improve patient doctor dialogue during a GP consultation, supplemented by an information leaflet, on parents expectation of antibiotic treatment or ‘intention to consult’, but there was significant reduction in antibiotic consumption.

One RCT (-)¹ (USA; n=80) found that an intervention to enhance communication between parents and their child’s physician (involving role play) and/or an information leaflet (‘Your Child and Antibiotics’), plus a fact sheet about antibiotics and AMR, did not significantly change parents’ expectations of antibiotic treatment for their child compared with the control group, who were given information on child nutrition. We note that the results were not clearly presented and that therefore no clear data can be presented here.

One cluster-RCT² (+) (England and Wales; n=558 children) found that online training for GPs in combination with a booklet, designed to be used as a consultation aid (to increase doctor/patient communication) and a take home resource for parents, led to significant reductions in antibiotic consumption (22.4% in intervention vs. 43% in control; aOR [95% CI 0.18 to 0.66]) and parents’ intention ‘to consult if their child had a similar illness’ (55.3% in intervention vs. 76.4% in control; aOR 0.34 [95%CI 0.20 to 0.57]).

Applicability:

While one of the studies was not conducted in the UK, the evidence is directly applicable to people in the UK, despite differences in the broader healthcare context in the USA, as there are no obvious differences in the population, context or setting of the study compared with the UK context.

1. Alder et al. 2005 (-)
2. Francis et al. 2009 (+)

4.2.4. *Cold pack resource and information leaflet*

1. A **non-RCT study by Alden et al. 2010 (-) in the USA** evaluated the impact of a ‘cold pack’ take-home kit and an information leaflet on knowledge of, attitude to and receipt of an antibiotic prescription among adult patients attending eight practices in the Honolulu area of Hawaii. The practices were selected based on a higher than average prescription rate, as indicated in the records of the state’s largest private insurance company, and based on a high proportion of Asian American and Hawaiian/Pacific Islanders among the patient population. A total of 299 participants were included in the study, and of these, 159 were selected by the physician to receive a ‘cold pack’ kit in addition to the education. The kit which contained products designed to provide symptomatic relief identified by the targeted ethnic population and approved by the physicians. The products (Tylenol®, lemon throat lozenges, instant chicken soup packets and ginger tea) were placed inside a zip lock bag and lined with coloured paper to provide a professional look while maintaining the low cost nature of the intervention. All participants in the study received an information leaflet titled ‘Antibiotics – Did You

Know?’ The leaflet contains basic information about bacterial vs viral infection, with cartoon schematics and photos regarding URI and antibiotics. Patients with additional questions were urged to talk with their doctor about the risks of antibiotics. A concluding comment notes that ‘Antibiotics are not always the answer’. Participants completed a pre-consultation questionnaire that included measurements of patient knowledge and attitudes and practices with respect to URI infection and treatment. The authors did not report when the post-consultation questionnaire was conducted.

Findings: The authors reported that, when pre–post data were analysed for all participants, the perceived need for antibiotics significantly decreased ($p<0.001$) and patient knowledge of appropriate antibiotic use (i.e. for what illness should one take antibiotics) significantly increased ($p<0.034$) after the intervention. A t-test analysis of the pre- versus post-intervention means between groups revealed that the increase in appropriate antibiotic use knowledge was significantly larger for the education group ($p<0.002$), but not for those who received both education and a ‘cold pack’ kit. A chi-squared analysis demonstrated that there was no statistical difference in the number of participants reporting that they obtained a prescription between patients reporting receipt of the cold pack and the information leaflet only group.

Limitations/considerations: The authors of this study did not report any knowledge scores, so it is not possible to assess the size of the change or whether this change was statistically significant.

Evidence Statement 1.4 Cold pack and information leaflet–based intervention in general practice led by a GP targeting adult patients

There is weak evidence from one non-RCT (-)¹ (USA; n=299 analysed) that an information leaflet (‘Antibiotics – Did You Know?’) distributed in a primary care setting to all participating adult patients, significantly decreased the patients’ perceived need for antibiotics at post-test follow up ($p<0.001$ [pre vs. post for all participants]) and increased their knowledge of appropriate antibiotic use (i.e. for what illnesses one should take antibiotics) ($p<0.034$ [pre-vs. post for all participants]). A sub-sample of patients were allocated a cold pack which contained products designed to provide symptomatic relief, and subgroup analysis revealed that an increase in appropriate antibiotic use knowledge was significantly larger for the education group ($p<0.002$), but not for those who received both education and a ‘cold pack’ kit.

Applicability:

While the study was not conducted in the UK, the evidence is directly applicable to people in the UK as there are no obvious differences in the population, context or setting of the study compared with the UK context.

1. Alden et al. 2010 (-)

4.2.6. *Information leaflet (and different prescription strategies)*

1. An **RCT by Little et al. 2005 (-) in the UK** estimated the effectiveness of three prescribing strategies and an information leaflet vs. no information leaflet (i.e. 6 conditions) for acute lower respiratory tract infection. In total 807 participants, drawn from patients (aged three years or older) presenting to one of 37 English primary care facilities with uncomplicated acute uncomplicated lower respiratory tract infection, who had a cough as the main symptom and at least one symptom or sign localising to the lower tract (sputum, chest pain, dyspnea, wheeze) were randomised for inclusion in the study. Participants were block-randomised into six groups based on two factors: 1) they were either given an information leaflet or not; and 2) they were allocated into one of three antibiotic options: immediate antibiotics, no offer of antibiotics, and delayed antibiotics. The delayed antibiotic option was defined as advice to use a course of antibiotics available on request if symptoms were not resolved after 14 days. The one-page information leaflet included information about the natural history of the condition, addressed parents' major worries and provided advice about when to seek further help. Measured outcomes included symptom duration and severity, reported by participants through symptom diaries, self-reported satisfaction with treatment and belief in antibiotics, and a questionnaire on antibiotic use. In addition, the authors reviewed the patients' notes for reconsultation with cough and for complications within one month randomisation. Complete diaries were returned by 562 (70%) participants (100 no leaflet and no antibiotics, 107 no leaflet and delayed antibiotics, 101 no leaflet and antibiotics, 112 leaflet and no antibiotics, 107 leaflet and delayed antibiotics, 113 leaflet and antibiotics) and 78 (10%) provided information on symptom severity and duration.

Findings: Comparing participants that received the leaflet with those that did not, there was no difference in the proportion of patients that used antibiotics (55% vs. 57% respectively, $p=0.58$), in the proportion who believed in antibiotics (54% vs. 56%, $p=0.73$) or the proportion who were very satisfied with their overall management (78% vs. 76%, $p=0.24$).

Considerations/limitations: The exact question about 'belief in antibiotic's was not indicated so it is not clear whether that refers to the participants' belief in the effectiveness of antibiotics in general, in the context of acute LRTI, or in the context of the individuals' treatment only. It appears that some study participants had access to antibiotics from sources other than their primary care – 16% of the 'no antibiotic' group reported having used antibiotics.

2. A **nested RCT by Macfarlane et al. 2002 (+) in the UK** sought to assess the impact of an information leaflet regarding the use of antibiotics in patients with acute bronchitis on the likelihood of patients taking antibiotics. A total of 212 adults presenting with acute bronchitis at three suburban general practices in Nottingham who were deemed not to require antibiotics, based on GPs clinical judgement, were eligible for randomisation. The intervention group received an information leaflet about the natural course of lower respiratory tract symptoms and the advantages and disadvantages of antibiotic use ($n=106$), while the control received no information leaflet ($n=106$). All patients were given a prescription for antibiotics and provided with verbal advice from the GP that the patient did not need antibiotics, but to use their own judgement whether to get them in due course.

Findings: After one to two weeks, the patients were contacted to see if they had taken the prescribed antibiotics. The authors reported that patients who received the information leaflet were significantly less likely to have taken the antibiotics than those in the control: 49 (47%) vs 63 (62%) (RR 0.76 [95%CI: 0.59 to 0.97], p=0.04). There was no evidence of confounding by age, sex or smoking status; whether patients paid for their prescriptions; description of cough; presence of chest signs; or general practice. Reconsultation rates were similar for patients in both groups (rates and p-values not reported).

Limitations/considerations: Many aspects of this study were well conducted, but it is not clear if the patients may have accurately reported whether or not they took the prescriptions; it is possible that they could have answered what they thought was appropriate (i.e. not taking the antibiotics), rather than what they actually did.

Evidence Statement 1.5 Information leaflet (with or without delayed prescription) targeting patients

There is inconsistent evidence from one RCT (-)¹ and one nested-RCT (+)² on the effectiveness of information leaflets within a primary care setting to reduce antibiotic use in patients with lower respiratory tract infections.

One RCT (-)¹ (UK; n=807) conducted in a primary care setting found that providing patients (with acute lower respiratory tract infection) with an information leaflet about the natural history of the condition, had no significant effect on antibiotic use (p=0.58), satisfaction with treatment (p=0.24) or belief in antibiotics (p=0.73) when compared to no leaflet. Patients in this study were also randomised to receive no prescription, delayed prescription or immediate prescription, but leaflet vs. no leaflet results were not presented within each of these prescribing practices.

One nested-RCT² (+) (UK; n=212) found that an information leaflet about the natural course of lower respiratory tract symptoms and the advantages/disadvantages of antibiotic use provided to patients with acute bronchitis who were judged by their GP not to need antibiotics but given a prescription with the advice that they did not need it, significantly reduced inappropriate antibiotic use. Patients in the intervention were significantly less likely to take the antibiotics prescribed compared with patients in the control, who received standard care (RR 0.76 [95%CI: 0.59 to 0.97], p=0.04).

Applicability:

While one of the studies was not conducted in the UK, the evidence is directly applicable to people in the UK as there are no obvious differences in the population, context or setting of the study compared with the UK context.

1. Little et al. 2005 (-)
2. Macfarlane et al. 2002 (+)

4.3. Interventions based in the accident and emergency department of a hospital targeting patients or parents of paediatric patients

4.3.1. *Computer kiosk*

1. A pre–post study by Price et al. (2011) (-) in the USA analysed the impact of a bilingual, interactive, educational computer kiosk which was introduced into the emergency departments of eight hospitals. Patients with symptoms of acute respiratory infection (ARI) were directed to the kiosk by staff and signs. The kiosk was designed to improve patients' knowledge about antibiotics and ARIs and to reduce patients' desire for antibiotics. In total 2,207 patients initiated the module, of whom 686 (31%) completed the module. Patients' desire for antibiotics was measured before and after completion of the module, and their perceived gain in knowledge regarding appropriate antibiotic use for ARI was measured after.

Findings: The proportion of patients with low desire for antibiotics increased from 22% to 49% ($p<0.001$), and the proportion who strongly wanted antibiotics decreased from 34% to 27% ($p<0.001$). Of the patients who completed the module, 75% reported having learnt something new. Self-report of having learnt something new was a significant predictor of having a decrease in desire for antibiotics (aOR 1.67 [95%CI: 1.14 to 2.45]). A multivariable model also suggested that patients with a moderate pre-visit desire for antibiotics were more likely to have decreased desire for antibiotics after the module than patients with a strong pre-visit desire for antibiotics, although the confidence intervals between these two subgroups overlap: aOR 4.01 [95%CI: 3.05 to 5.27] vs aOR 2.86 [95%CI: 1.76 to 4.66], respectively.

Limitations/considerations: There appeared to be a low completion rate for those patients who started the module (31%). The authors stated that they do not know why this rate was so low, but this low rate needs to be taken into consideration when interpreting the results.

Evidence Statement 1.6 Interactive computerised education module based in A&E targeting patients

There is weak evidence from one pre–post study (-)¹ (USA; n=686) that an educational interactive computerised kiosk situated in an A&E department reduced the desire for antibiotics in patients presenting with acute respiratory infection (ARI). This study found that the proportion of patients with a low desire for antibiotics increased after completing the module, from 22% to 49% ($p < 0.001$), and that the proportion who strongly wanted antibiotics decreased from 34% to 27% ($p < 0.001$). Change in desire was positively associated with self-report of having learnt something new at the end of the module (aOR 1.67 [95%CI: 1.14 to 2.45]).

Applicability:

The evidence is partially applicable to people in the UK. This is because the population attending A&E for acute respiratory infections in the USA may be more likely to be uninsured and to have lower socio-economic status; in those respects it may differ from the population in the UK.

1. Price et al. 2011 (-)

4.3.2. Video or information leaflet

1. An RCT by Schnellinger et al 2010 (-) in the USA compared the effectiveness of an animated video with a pamphlet at increasing parents' knowledge on appropriate antibiotic use. Parents/guardians of children (aged 0 to 18 years) presenting to the emergency department during the height of influenza season were randomly assigned to either a control group who received no intervention or a treatment group that received either an American Academy of Pediatrics pamphlet about antibiotic use, which they were allowed to read for 15 minutes before handing back to the researcher or viewed a three-minute animated video once concerning the proper use of antibiotics. Parents completed a knowledge survey containing 10 questions pertaining to appropriate antibiotic use and resistance at three time points: T1) baseline before being assigned to an intervention; T2) immediately post-intervention; and T3) four-weeks follow up. Additionally parents completed an evaluation survey at T2 which included questions about participants' attitudes towards antibiotic use. In total 337 parents were approached to participate in the study, of which 246 (73.0%) completed two questionnaires (control n=84, pamphlet n=79, video n=83) and 189 (56.1%) completed the questionnaire at four-weeks follow up (control n=61, pamphlet n=63, video n=65).

Findings: Median knowledge scores (from 0 to 10) improved immediately after reading the pamphlet or viewing the video compared to baseline: 8 (1 to 10) vs. 10 (1 to 10) and 9 (2 to 10) vs. 10 (2-10) respectively, $p < 0.001$. At four weeks' follow up the video group's score remained stable compared to post-intervention scores 10 (2-10) to 10 (2 to 10) ($p = 0.32$), whereas the pamphlet groups knowledge continued to improve 10 (1 to 10) to 9 (2 to 10) ($p = 0.002$). There was no change in the control groups' knowledge score at any time point. For participants that did not get a perfect knowledge score at baseline the proportion whose knowledge score improved from T1 to T2 was 34% in controls, 90% in pamphlet group and 84.5% in video group. For those with an improvement in knowledge scores at T2, the percentage with decreased scores at T3 was 47.1% in control group, 46.6% in

pamphlet group and 36.6% in video group. The median and range in decreased scores from T2 to T3 was significantly different between the video and pamphlet group (p-value not reported). For mean rank knowledge score (form 1 to 189) both the video and pamphlet group performed significantly better than the control group at both T2 and T3. The video group performed better than the pamphlet group at T3 only; 94.3 vs. 111.8 p=0.04. In the evaluation survey undertaken at T2 respondents in the video group reported they would be significantly less likely to ask paediatrician for antibiotic if their child had an illnesses (such as cold and fever) that had been discussed during the intervention than the pamphlet group: 35.4% vs. 14.5%, respectively (p=0.003) but not for 'Is there an antibiotic for every infection?' (10.1% vs. 12.0% p=0.92).

Limitations/considerations: Median baseline knowledge was high ranging from 8 to 9 out of 10, which might have left little room for improvement. Participating in the study might have led to increased interest among parents, leading to the potential for contamination between time points T2 and T3 which could have led to an under estimate of effect.

Evidence Statement 1.7 Video or information leaflet based in A&E targeting parents of paediatric patients

There is weak evidence from one RCT (-)¹ (USA; n=337) that an animated video or information pamphlet delivered in an emergency department of a hospital significantly increased parents' mean rank self-reported knowledge score of appropriate antibiotic use immediately post intervention and at four-weeks follow up, compared to controls. There was no difference in mean score between the video and pamphlet group post intervention (p=0.19) but the video group performed significantly better at four-weeks follow up (p=0.04). The video group was also significantly less likely to report that they would ask paediatrician for antibiotic if their child had an illnesses (such as cold and fever) that had been discussed during the intervention than the pamphlet group: 35.4% vs. 14.5%, respectively (p=0.003).

Applicability:

The evidence is partially applicable to people in the UK. This is because the population attending A&E for acute respiratory infections in the USA may be more likely to be uninsured and to have lower socio-economic status; in those respects it may differ from the population in the UK.

1. Schnellinger et al. 2010 (-)

4.5. Intervention based in the home led by researchers targeting the Latino community

Information leaflet, a child's colouring book, influenza vaccination information, hand hygiene and coughing etiquette information

1. A **pre-post study by Larson et al. 2009 (+) in the USA** assessed the impact of a culturally appropriate, home-based educational intervention on the knowledge, attitudes and practices regarding prevention and treatment of upper respiratory infections among 422 urban Latinos. The intervention involved bi-monthly home visits by a research coordinator who provided each household with a packet of Spanish-language educational materials, including a table describing symptoms of common cold and influenza, a child's colouring book about germs, contact information regarding locations for influenza vaccination, prevention strategies such as hand hygiene and coughing etiquette (e.g. cover your cough), and a CDC information leaflet regarding appropriate use of antibiotics. A survey was administered during the first home visit and six months after the third home visit. It included 85 questions to assess knowledge, attitudes and self-reported practices regarding transmission, prevention and treatment of URIs, prevention practices such as hand hygiene and influenza vaccination, and knowledge of antibiotic use. Analysis was conducted at the household level.

Findings: After six months, the authors reported significant improvements for some outcomes, including appropriate knowledge of 'who should get an antibiotic'. The percentage of participants who thought antibiotics were appropriate for a cold was 51.2% before the intervention vs 32.5% after the intervention; those who thought antibiotics were appropriate for a sore throat was 89.4% before the intervention vs 84.6% after the intervention (we note that this rate is still high despite being improved); those who thought antibiotics was appropriate for asthma was 28.1% before the intervention vs 19.4% after the intervention; those who thought antibiotics was appropriate for influenza was 47.5% before the intervention vs 32.9% after the intervention ($p < 0.01$ for all comparisons). In addition, the authors reported that before the intervention 59.7% of the participants worried about antibiotic resistance, but that this actually decreased to 44.5% after the intervention ($p < 0.01$).

Limitations/considerations: The authors of this study only reported results for significant findings, and did not discuss the non-significant results in detail, so that we do not have a full picture in which to assess the overall effectiveness of this intervention. It is also concerning that a significantly lower proportion of people were worried about antibiotic resistance after the intervention.

Evidence Statement 1.8 Culturally appropriate, home-based educational intervention targeting Latino population

There is weak evidence from one pre–post study¹ (+) (USA; n=422 analysed) that a culturally sensitive home-based educational intervention can increase participants’ knowledge of whether it is appropriate to take antibiotics for a cold, sore throat, asthma and influenza (p<0.01 for each).

Applicability

The evidence is partially applicable to the wider UK population, as the study population may differ from the population in the UK. The intervention could be conducted in the UK context and is likely to be relevant to other ethnic minority groups as well.

1. Larson et al. 2009 (+)

4.6. Interventions based within primary or secondary schools and/or targeting school aged children

4.6.1. *E-bugs educational interventions*

e-Bug education delivered through a computer game

1. A pre–post study by Farrell et al. 2011 (-) in the UK evaluated an e-Bug-developed ‘junior student’–level computer game for 9- to 12-year-old children. The game consisted of a number of levels, each of which taught a set of learning outcomes. In the game, the players choose an avatar, which travels around the inside the human body meeting useful and harmful cartoon microbes in various contexts and scenarios. The learning outcomes were taught through the game’s mechanics (the rules of the game) rather than through its story or dialogue. For example, instead of telling the player that soap washes harmful microbes off the skin, the player was instructed to throw globules of soap at microbes to make the harmful microbes disappear. On average, the game took 30–40 minutes to play. The study was conducted in three schools in Glasgow, Gloucester and London. In addition, several schools and school-related contacts were emailed to advertise the online game to children. In total the game was distributed to 1,736 students (62 in schools, 1,674 online). In order to test children’s increase in knowledge a game show quiz was incorporated into the game’s structure to test children’s knowledge related to microbes, hygiene and antibiotics. Overall 652 students completed level 1: Introduction to Microbes, 317 completed level 2: Harmful Microbes, 181 completed level 3: Useful Microbes, 81 completed level 4: Hygiene and 54 completed level 5: Antibiotics.

Findings: The authors assessed knowledge of appropriate antibiotic use by asking the children (n=52) to address six statements, but found no significant differences in the students responses before and after playing the game for any statement: ‘Antibiotics kill bacteria’; ‘Antibiotics kill viruses’; ‘Antibiotics will cure any illness’; ‘Antibiotics can harm our good bacteria as well as bad bacteria’; ‘Antibiotics help when you have a cough’; and ‘Most coughs and colds get better without antibiotics’. The results were presented in a complex manner, so cannot be easily reproduced in this brief summary.

Limitations/considerations: Although there was a relatively large sample size of participants, data for only 52 participants were available for the analysis of antibiotic knowledge. The authors also noted that many children had the required knowledge before playing the game, which possibly had an impact on the non-significant results. Approximately 50% of the players who started the game dropped out before completing the first level. The authors hypothesised that levels may have been too easy or too difficult; the levels took too long to complete; or the participants were bored with the game.

Workshops: Antibiotics and Your Good Bugs

2. A **pilot pre–post study by McNulty et al. 2001 (-) in the UK** assessed the impact of two 90-minute workshops entitled Antibiotics and Your Good Bugs on the knowledge of children aged 9 to 10 years old of ‘good’ bacteria and the effect of antibiotics on them. The workshops took place in a Gloucester state school on consecutive days at the end of the half-term in which children had learned about micro-organisms and had visited Severn Trent waterworks. The workshops were given by a microbiologist, and two class teachers were present. They consisted of a theoretical part, covering such points as the existence of good bacteria and the effect of antibiotics, and a practical part. Forty-eight children took part in the workshops; 38 (21%) completed a post-workshop questionnaire assessing children’s knowledge two weeks after attending and were included in the analysis. A questionnaire was completed before the workshop and repeated two weeks afterwards. It comprised six sections: ‘where bugs are found’ (7 questions), ‘our good bugs’ (4 questions), ‘what antibiotics do’ (6 questions), ‘how bugs spread’ (5 questions), ‘hand washing’ (7 questions) and ‘antibiotic resistance’ (3 questions).

Findings: The percentage of children answering all questions correctly significantly increased for three out of the six sections: ‘where bugs are found’ from 80.5% to 93.2% ($p < 0.001$); ‘how do bacteria spread?’ from 87.0% to 93.0% ($p < 0.001$); and ‘what antibiotics do’, which showed the greatest increase, from 45.0% to 73.0% ($p < 0.0001$). There was a non-significant increase for the remaining sections.

Limitations/considerations: Students’ baseline knowledge about ‘where bugs are found’, ‘how bugs spread’, and ‘the importance of hand washing’ was very high (80.5%, 87.0% and 94.0%, respectively), which may partially explain why there was a non-significant increase in knowledge in the latter two themes.

‘Bug Investigators’ pack

3. A **pre–post study by McNulty et al. 2007 (+) in the UK** aimed to measure the effectiveness of the ‘Bug Investigators’ pack in improving primary school children’s knowledge about micro-organisms, hygiene and antibiotics. This study was conducted in primary schools targeting children aged 10 to 11 years old. The resource pack was taught by class teachers, and it encompassed classroom, homework and optional web-based educational elements. It included information about infections and how they are spread, and it aimed to raise awareness about the appropriate use of antibiotics and the drawbacks of overuse. A questionnaire was distributed before the intervention and one to six weeks after the intervention. It comprised six sections: ‘bugs/bacteria are found’ (10 questions);

‘bugs/bacteria spread’ (5 questions); ‘you need to wash your hands’ (10 questions); ‘our own bugs/bacteria all over our body’ (4 questions); ‘antibiotics’ (7 questions); ‘resistant bacteria and superbugs’ (3 questions); and ‘when given an antibiotic by a doctor or nurse’ (2 questions). Of the 251 children who participated, 198 (78.9%) completed both questionnaires and were included in the analysis.

Findings: The percentage of children answering all questions correctly significantly improved for six out of the seven sections after the teaching intervention: ‘bugs/bacteria are found’ (77% vs 87%, $p<0.001$); ‘bugs/bacteria spread’ (88% vs 92%, $p=0.005$); ‘you need to wash your hands’ (90% vs 94%, $p<0.001$); ‘our own bugs/bacteria all over our body’ (53% vs 69%, $p<0.001$); ‘antibiotics’ (40% vs 67%, $p<0.001$); and ‘when given an antibiotic by a doctor or nurse’ (44% vs 74%, $p<0.001$). But for the section ‘knowledge about resistant bacteria and ‘superbugs’, there was no effect (51 to 54%, $p=0.25$). Results from the individual questions under each section show that the children learnt about antibiotics, in particular, that they kill our good bacteria (46% increase) [95%CI: 31.1 to 53.8] and don’t kill viruses (40% increase) [95%CI: 30.9 to 48.9], and about appropriate antibiotic use, including that they don’t help when you have a cold (35% increase [95%CI: 26.6 to 44.1]) or a cough (31% increase [95%CI: 21.9 to 39.7]); that people ‘should not stop taking antibiotics as soon as they start to feel better’ (32% increase [95%CI: 23.5 to 40.2]); and that they should always finish a course of antibiotics (29% increase [95%CI: 21.1 to 37.5]).

Limitations/considerations: The response rate was low despite initial high interest; the authors speculate that this would suggest that teachers found it difficult to add activities to their teaching plans if they are not part of the National Curriculum.

4.6.1. Courses

Course called ‘Microbiology Recipes: antibiotics à la carte’

4. A pre–post study by Fonseca et al. 2012 (-) in Portugal assessed a one-week hands-on interventional programme called ‘Microbiology Recipes: Antibiotics à la Carte’ to promote awareness about antibiotic resistance among high school students aged 15 to 16 years old. The intervention included both wet and dry lab activities to promote participants’ understanding of concepts related to bacteria, antibiotics and antibiotic resistance. In total 42 students participated in the study. A questionnaire was undertaken at baseline, and included 11 questions to assess the students’ understanding and beliefs about bacteria, antibiotics (7 questions), appropriate antibiotic use (1 question) and antibiotic resistance (3 questions). The questionnaire was repeated at the end of the programme.

Findings: At the end of the week programme, the authors found significant pre–post differences for all 11 questions, indicating increased understanding of the concepts of bacteria, antibiotics, appropriate antibiotic use and antibiotic resistance. There was also an increase in the number of students able to achieve top-level responses in the post-test for 7 out of the 11 questions (4 related to understanding of bacteria and antibiotics, 1 related to appropriate antibiotic use and 2 related to AMR), and a decrease in the number of students who did not answer questions for 5 out of the 11 questions (3 related to understanding of bacteria and antibiotics and 2 related to AMR).

Limitations/considerations: Students self-selected to participate in the programme.

Multimedia and movies

5. An RCT by Losasso et al. 2014 (-) in Italy assessed the effect of an educational food safety campaign titled Mission on the invisible world on 249 fifth grade students' (aged 9 to 11 years old) knowledge of bacteria, hand hygiene and food handling, and hand hygiene behaviour. Participating classes were randomised to either a practical (n=162) or a theoretical class (n=87), based on different teaching approaches that covered the same content. These different teaching approaches were not described in detail. Teaching material used for both classes consisted of ad hoc multimedia and movies. A questionnaire was implemented pre- and post-intervention and completed by both participating children and their parents. The questionnaire included one topic area relating to flu and antimicrobial resistance.

Findings: The authors reported that neither of the groups showed statistically significant progress in knowledge of 'insight into flu and antimicrobial resistance'. In the practical class, the difference in the students' knowledge between pre- and post-intervention, as assessed using an Incidence Risk Ratio (IRR), was 1.1 [95%CI: 1.0 to 1.2] (p=ns), In the theoretical class, the IRR was 1.0 [95%CI: 0.9 to 1.2] (p=ns) (p-values were not reported).

Limitations/considerations: The authors of this RCT did not describe the methods of randomisation or allocation concealment in detail, although other methodological aspects were well reported.

Evidence Statement 1.9 School-based interventions led by a teacher targeting school children or interventions targeting school aged children

There is inconsistent evidence from four pre–post studies – three (-)^{1,2,4} and one (+)⁵ – and one RCT (-)³ concerning whether school-based interventions can positively impact on students’ knowledge and understanding of the concepts of bacteria, antimicrobials and appropriate antimicrobial use.

One pre–post study¹ (-) (UK; n=1736 [school n=62, online n=1674]) found that an e-Bug-developed ‘junior student’-level computer game for 9- to 12-year-old children did not significantly change students’ knowledge of appropriate antibiotic use (e-Bug is a Europe-wide antibiotic and hygiene teaching resource).

Two pre–post studies (-)² (+)³ (UK; n=48 and n=251, respectively) found that a two-day workshop titled Antibiotics and Your Good Bugs, for children 9 to 10 years of age, or a ‘Bug Investigators’ pack, for children 10 to 11 years of age, effectively improved knowledge of microbes/infection and antibiotics and appropriate antibiotic use but did not have any effect on awareness of AMR.

One pre–post study⁴ (-) (Portugal; n=42) found that a one-week hands-on programme, whose title translates as Microbiology Recipes: Antibiotics à la carte, for high school students aged 15 to 16 years old significantly improved students’ knowledge of bacteria and antibiotics, appropriate antibiotic use and awareness of AMR (p<0.05 improvement on all questions).

One RCT⁵ (-) (Italy; n=249) found that an educational food safety campaign, whose title translates as Mission on the Invisible World (which included information on bacteria), did not significantly progress the students’ knowledge of ‘insight into flu and antimicrobial resistance’ (p-values were not reported).

Applicability

While two of the studies were not conducted in the UK, the evidence is directly applicable to people in the UK, as there are no obvious differences in the population, context or setting of the study compared with the UK context.

1. Farrell et al. 2011 (-)
2. McNulty et al. 2001 (-)
3. McNulty et al. 2007 (+)
4. Fonseca et al. 2012 (-)
5. Losasso et al. 2014 (-)

4.8. Intervention based in day care centre led by health educator/child care provider targeting parents

Presentation by healthcare providers to child care providers and brochures, leaflets, colouring sheets, posters and hand-outs for parents

1. A **cluster-RCT by Croft et al. 2007 (-) in the USA** assessed the impact of an intervention by child care centre staff on parental knowledge and attitudes regarding appropriate antibiotic use. The intervention took place in 282 child care centres in Wisconsin. The intervention consisted of a presentation by two health educators to child care providers on the differences between bacterial and viral infections, infection control and basic principles regarding AMR and appropriate antibiotic use. Subsequently, the educators provided centre staff with materials for distribution to parents, including brochures, leaflets, colouring sheets, posters and handouts, on appropriate antibiotic use. The control group received no intervention and was recruited from 150 day care facilities also in Wisconsin. A questionnaire was conducted pre-intervention and 30 days after the initial presentation to child care centre staff. It included questions to assess knowledge of bacterial versus viral infections and knowledge of antibiotic indications for different respiratory symptoms, as well as three questions related to attitudes and beliefs regarding respiratory illness and antibiotic use. In total, 151 (51%) parents from the intervention facilities and 140 (46%) from the control facilities were included in the final outcome analysis.

Findings: The results were presented by educational status of the parents. Among college graduates, intervention parents scored higher on the 9-point knowledge score compared with controls (median score 7.0 vs 6.5, $p < 0.01$). For the belief statement related to AMR the intervention was effective; significantly more intervention parents agreed that their child is more likely to develop a hard-to-treat infection if he/she takes antibiotics when not needed compared with the control (88% vs 73%, $p = 0.02$). For one out of the two statements related to a child's need for antibiotics the intervention was effective; significantly fewer parents in the intervention reported that they were likely to believe that they knew when their child needed an antibiotic before meeting a physician compared with those in the control (32% vs 49%, $p = 0.05$), while a non-significant difference was observed for 'I may ask my child's doctor for an antibiotic when my child has cough, cold or flu symptoms' (1% vs 6%, $p = 0.12$).

Among non-college graduates, no significant difference was observed in parents' knowledge scores between the intervention and control (median score 6 vs 6, $p = 0.20$). Differences between the intervention and control was statistically significant for one out of the two attitude/belief questions related to a child's need for antibiotics, 'I may ask my child's doctor for an antibiotic when my child has cough, cold or flu symptoms' (9% vs 20%, $p = 0.05$), and was approaching statistical significance for the question related to AMR, 'my child is more likely to develop a hard-to-treat infection if he/she took unnecessary antibiotics' (72% vs 58%, $p = 0.06$).

Limitations/considerations: Given that parents with different educational levels were not randomised *per se* (it is only the day care centres that were randomised), analyses by educational level should be considered as exploratory. Another consideration is that the proportion of parents who

recalled receiving educational materials in the intervention group was low and that some parents in the control group recalled receiving educational materials, making interpretation of the results somewhat difficult.

Evidence Statement 1.10 Day care-based intervention led by health educators/child care providers targeting parents

There is weak evidence from one RCT¹ (-) (USA; n=659) that the provision of educational materials (brochures, leaflets, colouring sheets and hand outs on appropriate antibiotic use) disseminated by care workers may lead to improvements in knowledge of appropriate antibiotic use among parents with a college education (9-point knowledge median score pre vs. post intervention: 7 vs 6.5, $p<0.01$), but not for parents without a college education (median score 6 vs 6, $p=0.20$).

Applicability:

While the study is not set in the UK, the evidence is directly applicable to people in the UK, as there are no obvious differences in the population, context or setting of the study compared with the UK context.

1. Croft et al. 2007 (-)

4.9. Interventions implemented within the community

4.9.1. *Mass media campaigns (advertisements in magazines and newspapers, posters and leaflets)*

1. A **cluster RCT by Huang et al. 2007 (+) in the USA** aimed to determine the impact of a community-wide educational intervention on parental misconceptions likely contributing to paediatric antibiotic overprescribing. Sixteen communities in Massachusetts were included. They were dichotomised into small and large towns, paired according to a composite of percentage of Medicaid-insured and percentage of racial minority residents (based on US Census 1990 data), and allocated to either the intervention or the control. Parental education in the eight intervention communities included six mailed newsletters highlighting misconceptions regarding upper respiratory illness, appropriate use of analgesics and antibiotics, and an approach of initial observation without antibiotics ('watchful waiting') for mild ear infections in low-risk patients. Parents in the intervention communities were also exposed to educational materials (stickers, posters, information leaflets and fact sheets) in waiting rooms of local paediatric providers, pharmacies, and child care centres. Parents in the control group received no intervention. The intervention was implemented throughout three successive cold and flu seasons, from September 2000 to March 2003. Questionnaires were sent in 2000 prior to the intervention to randomly selected households with children less than 6 years old and in May 2003, at the end of the intervention, to a different selection of households. The survey included ten knowledge questions, eight of which focused on the role of antibiotics for specific childhood upper respiratory illnesses and two of which focused on the difference between viral and bacterial infections. Additionally, three questions assessed parents' desire for antibiotics. In 2000,

1071 (46%) survey responses were received (534 intervention group, 537 control), and in 2003, 2071 (40%) responses were received (1034 intervention group, 1037 control).

Findings: The authors calculated a combined knowledge score (≥ 7 out of 10 questions correct). They found that the antibiotic knowledge among the intervention and control both significantly increased from 2000 to 2003: intervention 52% vs 64% ($p < 0.05$) and control 54% vs 61% ($p < 0.05$). In multivariate analysis, the authors found no overall intervention effect (aOR 1.2 [95%CI: 0.8 to 1.7]). There was also no intervention effect on mean knowledge scores of intervention communities when compared with control communities (mean score improvement 0.1 questions [95%CI: 0.2 to 0.4] in similar multivariate models). In stratified analysis of Medicaid- and non-Medicaid-insured families, the data showed a significant intervention impact among Medicaid-insured families (aOR 2.2 [95%CI: 1.1 to 4.5]) but not among non-Medicaid-insured families (aOR 1.0 [95%CI: 0.6 to 1.4]), although there was no significant intervention effect for the change in mean knowledge scores among the Medicaid population (mean score improvement 0.3 points [95%CI: 0.3 to 0.9 points] $p = 0.3$). There was no intervention effect for items designed to measure proclivity to demand antibiotics. Statistical differences between intervention and control were not reported.

Limitations/considerations: The authors reported that there were secular trends towards improved knowledge among the controls, potentially as a result of the attention paid to antibiotic press by the media. Medicaid insurance is a strong surrogate for other socioeconomic variables that were not controlled for in the analysis, including literacy and income. It was not possible for the research team to identify whether a specific component of the intervention was effective.

2. A **non-RCT by Mainous et al. 2009 (-) in the USA** evaluated the effectiveness of an educational intervention to decrease self-medication with antibiotics in the Latino community living in South Carolina. The intervention involved patient information leaflet and public service advertisements for Spanish-language newspapers. The educational initiative, entitled Solo Con Receta (only with a prescription), focused on the risks involved in self-medication and the benefits of receiving a diagnosis and treatments from the formal health sector. More than 1,000 leaflets were distributed at community sites (physician's offices, churches, English-language classes, Mexican restaurants, and Mexican food stores). There were also radio broadcasts. The intervention lasted nine months, from July 2007 to March 2008. Adults living in another community, more than 200 miles away, where the intervention was not disseminated, acted as the control. A survey undertaken at baseline prior to the intervention was sent to 273 participants in the intervention community. The survey was repeated up to three months after the intervention, with 293 participants in the intervention community and 306 participants in the control community. The survey included four questions related to lifetime use of antibiotics without obtaining a prescription and three questions related to current use of (2 questions) and attitudes towards (1 question) antibiotics without a prescription. Only participants with complete data were used in the analysis, 219 pre-intervention, 229 post-intervention and 243 in the control at post-intervention.

Findings: Exposure to the study leaflets was found not to be a significant predictor of use of antibiotics without a prescription in the past 12 months (OR 0.85 [95%CI: 0.27 to 2.63]). Multivariate analysis indicated that the strongest predictor of attitudes towards antibiotics without a

prescription or use of antibiotics was past purchase of antibiotics without a prescription outside the United States (aOR 5.72 [95%CI: 3.12 to 10.48]). The percentage of adults who believed that antibiotics should be available without a prescription significantly increased within the intervention community, from 30.6% pre-intervention to 48.0% post-intervention ($p < 0.05$), and at post-intervention it was significantly greater than the control community, at 35.8% ($p < 0.05$).

Limitations/considerations: The study population were able to access antibiotics without a prescription. This study focused on a narrow population group. We note that only 69% of the adults surveyed in the intervention group and 60% in the control community reported to have read or heard something on the radio regarding the appropriate use of antibiotics, and only 25.9% in the intervention community and 8.6% in the control community reported seeing the patient information leaflets. It is unclear if a lack of effective dissemination in the intervention group and contamination in the control group may have had an impact on the results.

Evidence Statement 1.11 Mass media campaign (advertisements in magazines and newspapers, posters and leaflets) at the community level

There is weak evidence from two US studies (one cluster RCT (+)¹ and one non-RCT (-)²) indicating that media campaigns delivered within a community setting have no effect on a community's knowledge of antibiotics, demand for antibiotics, or use of antibiotics without a prescription.

One cluster RCT¹ (+) (USA; 2000 n=nr; 2003 n=5580) involved a multicomponent educational intervention consisting of six mailed newsletters highlighting misconceptions about antibiotic use for conditions such as colds sent to low-risk patients, as well as other educational materials (stickers, posters, information leaflets and fact sheets) made available in waiting rooms of local paediatric providers, pharmacies and child care centres, versus nothing in the control communities. There was no significant improvement in knowledge scores or demand for antibiotics in intervention communities compared with control communities (aOR 1.2 [95%CI: 0.8 to 1.7]). In subanalysis, however, a significant impact was observed by insurance provider: the proportion of parents with high antibiotic knowledge significantly increased among parents of Medicaid-insured children (aOR 2.2 [95%CI: 1.1 to 4.5]), but not among parents of non-Medicaid-insured children (aOR 1.0 [95%CI: 0.6 to 1.4]).

One non-RCT² (-) (USA; pre-intervention n=273, post-intervention n=293, control post-intervention n=306) showed that a mass media campaign specifically targeting a Latino population was not effective in decreasing the number of antibiotics bought without a prescription in the past 12 months (OR 0.85 [95%CI: 0.27 to 2.63]) and was ineffective at changing participants' beliefs that antibiotics should not be available without a prescription; 30.6% in the intervention community believed they should be available without a prescription before the intervention, compared with 48.0% after and 35.8% in the control post-intervention (p<0.05).

Applicability

The evidence is only partially applicable to people in the UK. This is because the study populations in these studies or the services available to them may differ from those in the UK. It should be noted that antibiotics cannot be legally obtained in the UK without a prescription.

1. Huang et al. 2007 (+)
2. Mainous et al. 2009 (-)

4.9.2. *Mass media (information leaflet, posters, nurse educators, newspaper articles) and GP intervention targeting parents at the community level*

1. An RCT by Trepka et al. 2001 (-) in the USA evaluated the impact of community-wide education interventions on inappropriate antibiotic use. The study included 430 participants: 215 household caregivers (usually parents) of children less than 4 years of age in an intervention community area and 215 participants in a control community area. The multicomponent intervention involved (1) an information leaflet titled 'Your Child and Antibiotics', of which 30,000 copies were distributed to clinics, pharmacies, child care facilities, and other agencies; (2) educational

posters delivered to clinics and community organisations; (3) two nurse educators who made presentations and distributed the educational materials to parents and staff at child care centres, local public health departments, schools, community organisation meetings and staff at each primary care clinic; (4) a newspaper article about antibiotic resistance; and (5) physician-oriented interventions, including 'grand rounds' presentations, small-group academic detailing to promote appropriate antibiotic use, and distribution of written materials. Telephone surveys were undertaken pre-intervention and approximately 10 months post-intervention. The survey assessed knowledge of appropriate antibiotic use based on indication of need for antibiotics for five respiratory diagnoses, beliefs and practices regarding antibiotic use in young children (details not reported) and familiarity with the problem of antibiotic resistance measured as the level of agreement with all three statements posed; 365 (84.9%) of participants completed the post-intervention survey and were included in the analysis (177 intervention, 188 control).

Findings: The authors found that a greater proportion of participants in the intervention area had increased AMR awareness post-intervention compared with participants in the control area (14.3% vs 4.3%, $p=0.015$). In logistic regression, only baseline AMR awareness (OR 4.0 [95%CI: 2.5 to 6.4]) and exposure to two or more local interventions (OR 1.9 [95%CI: 1.1 to 3.1]) were associated with a higher AMR awareness.

The proportion of respondents who were able to correctly identify when antibiotics are not needed significantly increased post-intervention for four out of the five respiratory diagnoses among those in the intervention and for three out of five among the controls. Overall, there was a non-significant larger decrease in the mean antibiotic knowledge score in the intervention group (a low score = less likely to think that antibiotics are indicated) compared with participants in the control area between the pre- and post-survey (-1.1 vs -0.8, $p=0.07$). The authors also reported, however, that at post-intervention the mean score was significantly lower (better) in the intervention area than in the control (2.7 vs 3.5, $p<0.001$).

In addition, the percentage of parents who expected an antibiotic for their child and who did not receive one decreased among the intervention group post-intervention, from 13.7% to 8.6%, but actually increased among the controls, from 7% to 10.2%. The difference in changes between the intervention and control was significant ($p=0.003$). Likewise, the percentage of parents who brought their child to another physician because they did not receive an antibiotic decreased from 4.6% to 1.7% in the intervention area and increased from 2.2% to 3.8% in the control area. The difference in change between the two areas was significant ($p=0.02$). Parents rarely reported using an antibiotic for a later infection in the same child, and few parents reported saving and using an antibiotic on another child for whom it was not prescribed.

Limitations/considerations: This intervention appears to show that community interventions may be effective even when parents or caregivers have a relatively high antibiotic awareness at baseline (58.3% in the intervention group and 60.2% in the control group had high scores at baseline). However, the way the data was presented does not allow us to assess which aspects of the intervention were effective.

Evidence Statement 1.12 Mass media campaign (information leaflet, posters, nurse educators, newspaper articles) and GP intervention targeting parents at the community level

There is weak evidence from one RCT¹ (-) (USA; n=430) that a community-based intervention involving an information leaflet ('Your Child and Antibiotics'), posters, nurse educators, newspapers articles, and a GP intervention to promote appropriate antibiotic use was effective at increasing parents' knowledge of AMR.

The difference in change in knowledge from baseline to post-intervention was significantly greater for the intervention group than the control, namely, 10% ([95%CI 1.9 to 18.1] p=0.015). In terms of decreasing parents' desire for antibiotics for their child, the change in desire from baseline to post-intervention was significantly greater for the intervention, namely, -8.4% (-13.9 to -2.8) (p=0.003). The evidence related to parents' understanding of when to use antibiotics was less clear; at post-intervention the mean score was significantly lower (better) in the intervention area than control (2.7 vs 3.5, p<0.001); however, the change from baseline for the intervention and control groups was not significantly different (-1.1 vs -0.8, p=0.07).

Applicability

While the study was not conducted in the UK, the evidence is directly applicable to people in the UK as there are no obvious differences in the population, context or setting of the study compared with the UK context.

1. Trepka et al. 2001 (-)

4.10. Interventions targeting the general public

4.10.1. *Interactive science show based on e-Bug educational packs delivered in a holiday resort targeting families with children*

1. A pre-post study by Lecky et al. 2014 (+) in the UK assessed the effectiveness of science shows based on the e-Bug educational packs on public knowledge and understanding of antibiotics and antibiotic resistance. The science shows were presented at holiday resorts targeting families with children between the ages of 5 and 11 years of age. The intervention consisted of a three-minute presentation on microbes, followed by a guided visit to five interactive stalls covering microbes, hand hygiene, respiratory hygiene, food hygiene, antimicrobial resistance and prudent antibiotic use. Questionnaires were conducted before and immediately after the show. They included the following five sections: microbes, hand hygiene, respiratory hygiene, food hygiene, and antibiotic awareness. The questionnaire was completed by 406 participants. In total, 342 (84.3%) questionnaires completed before and immediately after the intervention were analysed, involving 170 adults and 153 children.

Findings: The paper presented findings from the antibiotic awareness section of the questionnaire only, which consisted of seven questions (three related to antibiotics, two related to appropriate antibiotic use, two related to AMR). For children, there was a marked improvement in antibiotic

knowledge: the proportion of children correctly answering all of the seven questions significantly increased ($p < 0.05$). The greatest improvement was seen for the question on ‘antibiotics kill viruses’ (30.9% [95%CI: 20.7 to 41.1]) increase in correct responses), and the smallest knowledge gain was for ‘most coughs get better without antibiotics’ (11.8% [95%CI: 0.9 to 22.6]). Overall, antibiotic knowledge among the children increased by 25% ($p < 0.001$). For adults, the improvement was less marked, but there was a significant improvement for four out of the seven questions (three related to antibiotics and one related to AMR). The greatest improvement was observed for the question on ‘antibiotics kill bacteria’ (24.3% [95%CI: 15.6 to 33.1]). The overall change in knowledge among adults was not reported.

Limitations/considerations: The baseline knowledge for the parents was very high, with an overall correct response rate of 75%; consequently, there may have been little room for improvement for some questions.

Evidence Statement 1.13 Interactive science show based in a holiday resort targeting families with children

There is weak evidence from one pre–post study¹ (+) (UK; n=406) that a science show and interactive stalls based on the e-Bug educational packs can significantly improve knowledge of antibiotics, knowledge of appropriate antibiotic use (e.g. not keeping antibiotics for later use), and AMR in children aged 5 to 11 years old. Children’s knowledge significantly improved for all questions; overall, the percentage of children correctly answering questions increased by 25% ($p < 0.001$). For parents the impact was less marked; knowledge increased for all three questions related to antibiotics and for one of the two questions related to AMR, but not for questions related to antibiotic use. However, baseline knowledge was 95% for both questions.

Applicability

The evidence is directly applicable to parents and children in the UK.

1. Lecky et al. 2014 (+)

4.10.2. *Web-based intervention conducted in a museum*

1. A pre–post study by Madle et al. 2004 (-) in the UK evaluated the effect of a health information website, part of the National electronic Library of Infection, on user knowledge and attitudes towards antibiotics and antibiotic resistance. The site comprised a selection of frequently asked questions about microbes, antimicrobials and AMR and provided the users with links to evidence-based resources on the Internet if they required more information, with the aim of informing the public of current evidence-based guidelines on antimicrobial prescribing. The study was conducted in a science museum in London. The questionnaires contained seven statements about AMR, six statements about the use of antibiotics in acute otitis media (AOM) and two statements on attitudes to prescribing. Out of 277 participants, 177 (63.9%) participants completed pre- and post-questionnaires and were included in the analysis. Of these, 27 were health professionals.

Findings: Overall, 1.7% of users got all seven questions on AMR correct before using the website, compared with 10.7% after using the website ($p < 0.001$). The percentage of correct answers significantly improved for three out of the seven statements relating to antimicrobial resistance in general after use of the website: ‘Antibiotics kill viruses’ (63% vs 71%, $p = 0.05$); ‘People can become resistant to antibiotics’ (10% vs 46%, $p < 0.001$); ‘Antibiotics cure most sore throats’ (57% vs 75%, $p < 0.001$). No significant differences were observed for the remaining four statements, although for three of the statements the proportion who answered correctly after using the website actually decreased: ‘I can stop taking antibiotics when I feel better; I don’t need to take the whole course’ (92% vs 75% ($p = 0.15$); ‘Antibiotic resistance can spread between bacteria’ (47% vs 56%, $p = 0.07$); ‘Antibiotics have no side effects’ (91% vs 88%, $p = 0.21$); and ‘The use of antibiotics causes antibiotic resistance’ (73% vs 63%, $p = 0.32$). There was a significant difference in the proportion of health professionals and non-health professionals answering the question before using the website for four of the seven statements and no difference after using the website.

The percentage of inappropriate answers on AOM decreased (i.e. indicating improved knowledge) for the following statements: ‘Antibiotics are effective in AOM’ (64% vs 38%, $p < 0.001$); ‘Ten day courses are more effective than 3-day courses of antibiotics’ (42% vs 21%, $p < 0.001$); ‘You are more likely to have a complication from AOM if you do not have antibiotics’ (44% vs 23%, $p < 0.001$). There was no significant difference for the statement ‘Antibiotics help reduce the duration of pain in AOM’.

In relation to attitudes towards prescribing, a significant improvement was observed for both statement measurements after use of the website: for ‘Doctors should usually prescribe antibiotics for a child with AOM’ it significantly decreased, from 51% to 33% ($p < 0.001$), and for ‘I would expect an antibiotic for me/my child if I/they had AOM’ it significantly decreased, from 59% to 30% ($p < 0.001$). Non-health professionals were consistently more likely than health professionals to agree with the statements ‘Doctors should prescribe antibiotics for a child with AOM’ (before: 52% vs. 8%, $p = 0.0191$ and after 5% vs. 42% $p = 0.0183$) and ‘I would expect an antibiotic for me/my child if I/they had AOM’ (before 60% vs. 8%, $p = 0.0046$ and after 41% vs. 4%, $p = 0.0098$).

Limitations/considerations: Given that this study included some health professionals and that it was conducted in a museum setting, the results may not be applicable to the general public.

Evidence Statement 1.14 Web based educational intervention targeting the general public

There is weak evidence from one pre–post study¹ (-) (UK; n=277) that a health information website significantly improved peoples' attitudes towards prescribing (i.e. expectation of being prescribed antibiotics for acute otitis media decreased), but that, overall, it did not significantly improve peoples' awareness of AMR (significant for only three out of seven statements tested) or improve knowledge of appropriate antibiotic use (e.g. taking a full course) (significant for only three out of the six statements tested).

Applicability

While the study was conducted in the UK, it may not be directly applicable to the wider population given that it was conducted in a museum setting and almost a quarter of respondents were doctors.

1. Madle et al. 2004 (-)

4.10.3. *Mass media (advertisements in magazines and newspapers, posters and leaflets) and GP interventions at the population level*

Information leaflet, posters and GP education

1. A **pre–post study by Curry et al. 2006 (-) in New Zealand** assessed changes in public knowledge, attitudes, and reported behaviour of antibiotic use in the management of the common cold following a public information campaign launched in 1999 (titled Wise Use of Antibiotics). The campaign aimed to educate the public that antibiotics are ineffective against viruses. It included posters in family practice waiting rooms and pharmacies and leaflets given to patients in pharmacies and primary healthcare surgeries. The campaign also involved an element of GP education. The authors contacted adults aged 16 old or over whose phone numbers had been randomly selected from the 1998 (n=282) and subsequently from the 2002 (n=387) Auckland telephone book. In both years, 200 people were included in the analysis, with response rates of 72% and 55%, respectively.

Findings: Respondents had a similar understanding about the function of antibiotics and the nature of the common cold (i.e. viral, not bacterial) in 2003 as in 1998 (38% versus 41%; p=0.9). However, they were significantly less likely to feel positive about antibiotics in 2003 for the treatment of a cold (16% versus 33%, p=0.00001). The perception that antibiotics were beneficial for fever, dry cough, coloured phlegm/nasal discharge and runny nose, and to prevent complications, significantly reduced from 1998 to 2003, but for other symptoms, there was no significant change. The perceived benefit of antibiotics for tonsillitis increased from 83% to 91% in 2003 (p=0.014). There was a significant reduction in the number of people consulting the doctor about a cold or flu from 62% to 45% (p<0.001), and a significant reduction in self-reported incidences of doctors prescribing an antibiotic for a URTI from 86% to 74% (p=0.049).

Limitations/considerations: Only 30% of respondents were aware of the national Wise Use of Antibiotics campaign. Of those who recalled seeing the information, 75% were unsure as to where, and in what format. There are inherent difficulties with this type of study design such that it is

difficult to establish a direct association between the intervention and the results. Moreover, it is difficult to know what aspects of the intervention may have been effective.

Advertisements in magazines and newspapers, posters, leaflets and GP intervention

2. A **pre–post study (with a control at post-intervention) by McNulty et al. 2010 (-) in the UK** assessed the effect of the 2008 English public antibiotic campaigns on the general public's knowledge of appropriate antibiotic use. The campaign featured three posters displayed in magazines and newspapers. The key message was: 'The best way to treat most colds, coughs or sore throats is plenty of fluids and rest. For advice talk to your pharmacist or doctor'. A copy of the posters and some copies of a leaflet (to be given to patients instead of antibiotic prescriptions) were sent to GP surgeries and pharmacies in England. The population of Scotland served as the source population for the comparison group, on the assumption there was minimal exposure to the English campaign in Scotland. A survey was conducted in January 2008, before the campaign was launched, and another was conducted in January 2009, after the campaign's completion. The survey posed ten questions related to the public's knowledge and attitudes towards antibiotics and AMR and three questions on behaviour with respect to antibiotic use. At baseline a sample of 1888 participants (at least 15 years of age or older) participated (1706 in England and 182 in Scotland), the follow-up survey was completed by 1830 people (1707 in England and 123 in Scotland).

Findings: There was no significant change between the two surveys in English respondents' agreement for nine of the ten attitude statements, including the statement 'Antibiotics work on most coughs and colds', which was the main attitude the 2008 public campaigns aimed to change (2008 vs 2009, 40% vs 37%, $p=0.30$). The only significant difference was observed for the statement 'Resistance to antibiotics is a problem in British hospitals', with the number of incorrect responses decreasing from 37% to 32% ($p=0.03$). Comparing knowledge, attitudes and behaviour in 2009 between England and Scotland, there was no significant difference for nine out of the ten statements; Scottish respondents in 2009 were less likely to agree with the statement 'It is OK to keep leftover antibiotics and use them later without advice' than were English respondents (Scotland vs England 2009, 4% vs 14%; $p=0.01$). Reported antibiotic use did not improve; a similar percentage of English respondents reported asking their GP for an antibiotic in 2009 as 2008 (29% vs 28%, $p=0.70$). Moreover, there was a significant increase in the percentage of English respondents keeping any leftover antibiotic from their last course, from 2.2% in 2008 to 7.0% in 2009 ($p\leq 0.001$). Scottish respondents were significantly less likely than English respondents to have taken an antibiotic without being told to do so by a doctor or nurse in 2009 (3% vs 7.8%, $p=0.04$).

Limitations/considerations: We note that that the percentage of respondents who reported having seen one of the campaign posters appears to have been low (i.e. <25%). In addition, some participants in the control area (i.e. Scotland) reported seeing one of the posters (approximately 20%). The authors therefore calculated that the increase in exposure as a result of the campaign in England was only 2.3%. The authors noted that this may be due to a lack of recollection or due to poor dissemination in practices and pharmacies. No subgroup analysis accounting for level of exposure was undertaken.

3. A **pre–post study by Parsons et al. 2004 (+) in the UK** aimed to assess public attitudes in an area with high antibiotic prescribing where a nationwide public education campaign titled Campaign on Antibiotic Treatment and the National Advice to the Public (CATNAP) was locally enhanced. The study was set in Barking and Dagenham. The main message promoted to the public by CATNAP was the need to cherish and preserve your normal bacterial flora. The campaign was disseminated nationally (including in Barking and Dagenham) via advertisements in newspapers and magazines, bus stop advertising, and posters and leaflets in GP surgeries and pharmacies. GPs were also given a ‘non-prescription’ pad, so that they could tear off a ‘non-prescription’ to give to patients wanting antibiotics, which contained written advice on why antibiotics weren’t given and ideas on alternative treatments. Within Barking and Dagenham, unlike in the rest of the country, the campaign was specifically promoted by health visitors to their clients (mainly mothers and their children) via press releases in the local papers and via a letter from the primary care trust on prescribing to all GPs in the area, drawing their attention to the campaign to try to facilitate GPs’ involvement. A survey was sent one month before the campaign to 982 participants, of whom 442 (45%) participated, and three months after the start of the campaign to a different, randomly selected sample of 1941 adults, of whom 819 (42%) participated. The survey included seven questions related to general attitudes towards appropriate antibiotic use in adults and five questions related to the appropriate use of antibiotics in children, four of which related to specific symptoms of upper respiratory infections.

Findings: The authors reported that the responses to all of the general attitude questions towards antibiotic prescribing were equivalent in pre- and post-intervention surveys. Only for one out of the seven questions (‘Will antibiotics help a cough to get better more quickly?’) did the confidence level approach 10%, with a change from 42% to 38% (follow-up difference -4% [one-sided 95%CI: -9.1]). In relation to children, there was only a significant reduction in the proportion of respondents who agreed that children should be prescribed antibiotics for one out of the four symptoms (fever), from 56% to 49% (difference -8% [one-sided 95%CI: -13.5]). There was no significant change in the number of parents who agreed that ‘A child’s parents are the best people to decide whether or not they need antibiotics’, from 33% to 27% (difference -6% [one-sided 95%CI: 0.7]). Finally there was no significant difference in the actual number of prescriptions and the number predicted based on the preceding four years of data, suggesting that the dispensing rate may be falling regardless of the intervention.

Limitations/considerations: We note that this study appears not to exclusively target the general public (i.e. it also targeted GPs), and it is not clear whether or not the main message promoted to the public (i.e. ‘to cherish and preserve your normal bacterial flora’) would be adequate information to facilitate some knowledge changes (i.e. knowledge/attitude regarding when antibiotics should be appropriately taken). The locally enhanced campaign promoted the messages using similar channels to the national campaign, which were considered by the study author to be relatively passive channels. Additionally, the study did not account for the level of participants’ exposure to the campaign.

Editorial coverage in magazines, in newspapers, and on television; posters; leaflets; and GP intervention

4. A repeated **cross-sectional survey by Wutzke et al. 2007 (-) in Australia** reported on a community campaign to reduce inappropriate use of antibiotics for the common cold. The populations targeted included Australians 15 years of age and over; sample sizes in the surveys ranged from 712 to 1800. Initially, a small-scale, media-based community awareness campaign was run in 2000. This was followed by larger-scale interventions implemented during the winter months (June to August) in 2001, 2002, 2003 and 2004. Various printed and electronic resources were distributed, including an information brochure for adults, as well as posters for general practice, pharmacies, schools and community centres which detailed the causes of the common cold, influenza and coughs and encouraged symptomatic management. Stickers and badges with the campaign tagline ('Common colds need common sense') and logo were also distributed. Prescription pads for symptomatic management as well as patient information leaflets on sore throat and cough were distributed to GPs and included in some prescribing software. Information about the campaign and key messages were mailed to all general practices and community pharmacies across the country as well as to health professional trade press and other key stakeholders.

Findings: There was a significant decline in the proportion of participants who believed taking antibiotics for cold and flu is appropriate, from 28.7% pre-intervention, in 2002, to 21.7% post-intervention, in 2004 (percentage-point change 7.0 [95%CI: 3.5–10.5]). Comparison of successive yearly consumer surveys also revealed a significant decrease in self-reported use of antibiotics to treat cough, cold or flu, from 10.8% in 1999, to 7.4% in 2004 (percentage-point change 3.4 [95%CI: 1.3 to 5.5]).

Limitations/considerations: It appears that the general awareness of the campaign was low: in 2004 it was 21.5%. In addition, recall of the specific media message that 'antibiotics don't work in treating colds and flu' was 2.1% post the 2004 campaign. Given these figures, it is difficult to know if differences observed were due to the campaign or to other factors.

Evidence Statement 1.15 Mass media (advertisements in magazines and newspapers, posters and leaflets) and GP interventions at the population level

There is weak evidence from three pre–post studies (-)^{1,2,3} and one repeated cross-sectional survey (-)⁴ that mass media campaigns targeting the general public do not have an effect or have only a small effect on knowledge of and attitudes towards appropriate antibiotic use.

A pre–post study¹ (-) (New Zealand; 1998 n=282, 2003 n=387) that collected information on public views and use of antibiotics for colds in adolescents and adults in 1998 and subsequently from 2002 found that the national campaign did not change the public's understanding of antibiotic efficacy against viral infections (41% vs. 38% p=0.9). When specific symptoms were evaluated, however, there was significantly improved knowledge of appropriate antibiotic use for six out of the 13 symptoms. Despite limited impact on knowledge, however, the number of respondents reporting that they consulted a doctor about a cold or flu significantly decreased from 62% to 45% (p<0.001).

One pre–post study (with control post-intervention)² (-) (UK; 2008 n=1888 [England=1706, Scotland=182; 2009 n=1830[England=1707, Scotland=123]) reported that the 2008 English public antibiotic poster campaign had no impact on the proportion of incorrect answers among English respondents to the statement ‘Antibiotics work on most coughs and colds’. The incorrect response decreased from 40% in 2008 to 37% in 2009, p=0.30. Compared with Scotland, there was no significant difference for nine out of ten questions related to attitudes towards antibiotic use. Self-reported changes in use of antibiotics did not significantly change for two out of the three measures; the number of English respondents reporting that they kept left-over antibiotics significantly increased, from 2.2% to 7.0%, p<0.001. Compared with Scotland, self-reported changes in use did not significantly differ for two out of the three measures.

One pre–post study³ (+) (UK; 1999 n=982, 2000 n=1941) found that a nationwide public education campaign known as CATNAP (Campaign on Antibiotic Treatment and the National Advice to the Public) that promoted the need to cherish and preserve your normal bacterial flora, locally enhanced to include more channels of promotion, did not significantly change the public’s knowledge of appropriate antibiotic use. There was no change for all seven of the general questions posed, while for questions related to appropriate antibiotic use among children, a significant change was only observed for one out of the five questions – the proportion of adults who agreed that children should be prescribed antibiotics for fever significantly decreased, from 56% to 49% (follow-up difference -7% [one-sided 95%CI: -13.5]).

A repeated cross-sectional survey⁴ (-) (Australia; 1999 n=1614; 2000 n=1603; 2001 n=1800; 2003 n=1200; 2004 n=1200) reported on a community campaign to reduce inappropriate use of antibiotics for the common cold in adolescents and adults. There was a significant decline in those who believed taking antibiotics for cold and flu is appropriate, from 28.7% pre-programme in 2002 to 21.7% in 2004 (percentage-point change 7.0 [95%CI: 3.5 to 10.5]). A comparison of successive yearly consumer surveys revealed a significant decrease in self-reported use of antibiotics to treat a cough, a cold or the flu, from 10.8% in 1999 down to 7.4% in 2004 (percentage-point change 3.4 [95%CI: 1.3 to 5.5]).

Applicability

Two of the studies were conducted in the UK. The other two studies are directly applicable to people in the UK as there are no obvious differences in the population, context or setting in these studies compared with the UK context.

1. Curry et al. 2006 (-)
2. McNulty et al. 2010 (-)
3. Parsons et al. 2004 (+)
4. Wutzke et al. 2007 (-)

5. Infection and/or hand hygiene

Twenty two studies, in 23 publications, reported on infection and/or hand hygiene (five of which also reported outcome data on knowledge of antimicrobials and/or AMR and are presented above as well as in this section [5-9]):

- 2 intervention was based in a healthcare centre led by a nurse targeting veterans with spinal cord injuries and disorders [34 35];
- 2 interventions were home-based, led by researchers, targeting Latino families [6 36];
- 4 interventions were based in preschools or primary schools, led by a teacher, targeting young children [37-40];
- 7 interventions were based in a school targeting children 9 years of age or older [5 7-9 41-43];
- 5 interventions were based in universities targeting students [44-49]; and
- 2 interventions targeting the general public [50 51].

A brief overview of the studies and their results are presented in Table 4. The studies are presented within the table by setting, as outlined above. Some sections are further subdivided by who led the intervention, who was the target population and/or the type of intervention; within a subsection studies are presented alphabetically. The studies within a subsection inform each Evidence Statement. A more detailed overview of the interventions, findings and limitations/consideration for each study is presented in text below the summary table.

Table 4 Summary of studies relating to infection and/or hygiene that addressed research question 2. For the direction of effect to be classified as effective/improved, p-values had to be less than 0.05.

Reference/ study type/ country/ (quality assessment)	Population and setting	Comparisons		Key outcomes evaluated that are relevant to this review	Direction of effect for intervention
		Intervention/ (sample size)	Comparator/ (sample size)		
Intervention based in a healthcare setting					
Led by nurses targeting veterans with spinal cord injuries and disorders					
Evans et al. 2014 RCT (pilot) USA (-)	Veterans with spinal cord injuries and disorders in a health centre setting	Nurse-administered patient education intervention about methicillin-resistant Staphylococcus aureus (MRSA) (n=37)	Care as usual (n=32)	Knowledge of MRSA; assessed by summing the scores for all 21 questions posed Hand hygiene behaviour related to 8 self-reported hand hygiene activities (e.g. after using the toilet) Participants' perception of whether they had changed their behaviour	No difference in the mean change in knowledge score between intervention and control No difference in hand hygiene practices between intervention and control for any of the activities Significant effect

Reference/ study type/ country/ (quality assessment)	Population and setting	Comparisons		Key outcomes evaluated that are relevant to this review	Direction of effect for intervention
		Intervention/ (sample size)	Comparator/ (sample size)		
Based in A&E targeting paediatric patients and their parents					
Fishbein et al. 2011 RCT (pilot study) USA (+)	Paediatric patients (aged 8 to 18 years old) and their parents, attending an emergency department in an urban paediatric hospital, triaged to a lower-acuity urgent care track	Washed hands using Glo Gel and received proper hand hygiene washing technique instructions and bathroom poster from the National Sanitation Foundation Scrub Club that uses pictorials to reinforce the steps for proper hand washing. (paediatric patients n=29, parents n=27)	Glo Gel handwashing but received no additional hand hygiene education (paediatric patients n=31, parents n=30)	Handwashing ability; assessed using Glo Germ to score the cleanliness of 7 areas of the right hand. Self-reported handwashing habits, assessed based on three questions: 1) 'Did you use cold or warm water when you washed your hands right now?'; 2) 'Did you wash your hands before dinner last night?'; 3) 'Did you wash your hands after the last time you used the bathroom?'	<ul style="list-style-type: none"> Significant improvement in mean scores for all paediatric patients from pre to post intervention. No difference in size of improvement between intervention and control No significant effect among parents from pre to post intervention. Results for intervention vs. control not reported. Paediatric patients significant improvement from pre to post intervention for 'use warm water only', no difference between intervention and control for any questions (baseline compliance was high) No effect from pre to post intervention or between intervention and control among parents (baseline compliance very high)

Reference/ study type/ country/ (quality assessment)	Population and setting	Comparisons		Key outcomes evaluated that are relevant to this review	Direction of effect for intervention
		Intervention/ (sample size)	Comparator/ (sample size)		
Interventions based in the home led by researchers targeting Latino community					
Larson et al. 2009 Pre-post USA (+)	Predominantly Latino neighbourhood in upper Manhattan, New York	Bi-monthly home visits, Spanish-language educational materials, and a CDC information leaflet regarding appropriate use of antibiotics (n=422)	NA	Awareness of causes of infection and how to prevent infection Improved changes in behaviour; based on self-reported frequency of carrying out 2 hand hygiene practices and the number of households with one or more members receiving an influenza vaccination	Significant effect • Frequency of good hand hygiene practice significantly improved for 1 of the practices (use of alcohol-based sanitizer) but significantly decreased for the other (use of antibacterial soap) • Significant increase in influenza vaccination
Larson et al. 2010 Pre-post USA (-)	Predominantly Latino neighbourhood in upper Manhattan, New York	Education only (as above) (samples sizes not clearly reported)	(1) Education plus hand sanitizer; (2) education plus hand sanitizer and face masks (sample sizes not clearly reported)	Knowledge of infection prevention; details not provided Influenza vaccination rates; details not provided	Effective in all groups (most effective in the education plus hand sanitizer group) Effective in all groups (most effective in the education plus hand sanitizer group)
Interventions based in preschool or primary school led by a teacher targeting young children					
Hand hygiene instruction (and other educational activities)					
Ramseier et al. 2007 Cluster RCT Switzerland (-)	Children aged 4 to 6 years old attending kindergarten classes	General hygiene education plus detailed instruction on hand washing and fingernail cleaning procedures (n=31)	General hygiene education plus tooth brushing instruction (n=30)	Hand hygiene; cleanliness of hands and nails measured as presence of visible dirt	Pre vs post: • Hand hygiene no change from baseline • Nail hygiene significant improvement from baseline for both intervention and control Intervention vs control: • Authors report significant improvement in both hand and nail hygiene compared with controls (data not reported)

Reference/ study type/ country/ (quality assessment)	Population and setting	Comparisons		Key outcomes evaluated that are relevant to this review	Direction of effect for intervention
		Intervention/ (sample size)	Comparator/ (sample size)		
Tousman et al. 2007 Pre-post USA (-)	First and second grade students (age not explicitly reported)	Multicomponent hand hygiene education (n=406)	NA	Hand washing behaviour; changes reported by parents and teachers in whether children increased frequency and duration of hand washing and whether they needed to prompt children to wash hands	<ul style="list-style-type: none"> Majority of parents and teachers reported that the frequency of hand washing increased over the course of the intervention; significance not reported Half of parents reported improvement in duration of hand washing; significance not reported Majority of parent reported they did not have to prompt children to wash hands; significance not reported
Witt and Spencer 2004 UK Pre-post (-)	Children aged 3.5 to 5 years old from four preschool classrooms at a university-based child care centre	(1) Children were shown how to wash their hands; (2) children were asked wash hands while singing the 'A, B, Cs' for 10 seconds; (3) Glo Germ was used to show any 'germs' that did not wash off; (4) children listened to a story called 'Soap and Sudsy' and listened to jingles which encouraged children to sing while they washed their hands; (5) a 5-minute <i>Sesame Street</i> video about lead and lead poisoning (n=35)	NA	Appropriate hand washing behaviour; reported by parents and observed within day care whether children correctly washed hands (using soap and washing hands for at least 10 seconds) and whether children needed prompting to wash their hands	<ul style="list-style-type: none"> Both parents and observers noted an increase in children correctly washing hands; significance not reported Parents reported decrease in hand washing prompting needed before eating Observers reported decrease in prompting needed before eating or after using the toilet
				Knowledge about hand hygiene; parents reported children's understanding of relationship between germs and hand washing	<ul style="list-style-type: none"> Parents reported increase in children's knowledge; significance not reported

Reference/ study type/ country/ (quality assessment)	Population and setting	Comparisons		Key outcomes evaluated that are relevant to this review	Direction of effect for intervention
		Intervention/ (sample size)	Comparator/ (sample size)		
Multicomponent					
Stebbins et al. 2010 Cluster RCT USA (+)	Students in elementary schools, kindergarten to grade 5 (age not explicitly reported)	Schools with hygiene education, 'Flu 101', videos ('Scrub Club,' 'Why Don't We Do It in Our Sleeves'); placement of hand sanitizers in schools (n=82 teacher observers)	Schools receiving no intervention (n=85 teacher observers)	Infection prevention behaviour; 4 observations related to covering sneezes and coughs, 3 observations related to avoiding touching eyes, nose and mouth Hand hygiene behaviour; 4 observations on the frequency of hand washing and hand sanitizer use	<ul style="list-style-type: none"> Proportion of children covering sneezes/coughs significantly greater for all 4 observations in intervention No difference for 2 out of the 3 touching behaviours Frequency significantly higher among intervention than control for all 4 observations
Interventions based in schools and/or targeting children 9 years of age or older					
Farrell et al. 2011 Pre-post UK (+)	Children aged 9 to 12 years old from three schools and recruited online through school based contacts	e-Bug-developed computer games (n=1736 [in-school n=62, online n=1674])	NA	Knowledge of microbes/infection/hand hygiene	No significant effect

Reference/ study type/ country/ (quality assessment)	Population and setting	Comparisons		Key outcomes evaluated that are relevant to this review	Direction of effect for intervention
		Intervention/ (sample size)	Comparator/ (sample size)		
Hawking et al. 2013 Pre-post UK (†)	Key Stage 2 students, aged 9 to 11 years old, from seven junior 'rural' or 'town' schools in England	Modified e-Bug lesson plan (1-2 hours), consisting of an interactive class presentation, microbe and animal 'social networking' cards and a board game (n=210)	NA	<p>Knowledge of microbes; assessed based on asking children 8 questions</p> <p>Knowledge of farm hygiene and attitude to farm hygiene practices; assessed by 12 questions (6 on awareness of microbes, 4 on knowledge of safe behaviours and 2 on hand hygiene)</p> <p>Knowledge of hand hygiene and appropriate hand hygiene behaviour; assessed by 9 questions (2 on understanding of why to wash hands, 4 on when to wash hands, 3 on technique)</p>	<ul style="list-style-type: none"> Improvement in knowledge for all 8 questions The proportion of students correctly answering all 8 questions significantly improved Significant improvement in the proportion of students correctly answering all 12 questions Improvement in 5 out of 6 questions on awareness of microbes Improvement in 3 out of 4 questions related to behaviour No effect for questions on hand hygiene Significant improvement in the proportion of students correctly answering all 9 questions Improvement for 1 out of the 2 questions on understanding of why to wash hands For remaining question stratified by gender there was improvement for girls but not boys Improvement for 1 out of 4 questions related to when to wash hands Improvement for 2 out of 3 questions related to technique

Reference/ study type/ country/ (quality assessment)	Population and setting	Comparisons		Key outcomes evaluated that are relevant to this review	Direction of effect for intervention
		Intervention/ (sample size)	Comparator/ (sample size)		
Lecky et al. 2010 Cluster non-RCT Czech Republic, England and France (-)	School children aged 9 to 11 years olds (junior school) and/or children aged 12 to 15 years old (senior school)	Classes receiving the e-Bug educational pack (n=2,168); 995 were English students (399 junior school students and 596 senior school students)	Classes taught the microbiology section of the school curriculum (n=1,356); 257 were English students (58 junior school students and 199 senior school students)	Knowledge of infection/microbes; assessed by 13 questions, but only an overall change in knowledge score was reported by the authors Knowledge of how infections are spread; assessed by 11 questions, but only an overall change in knowledge score was reported by the authors Knowledge of the treatment and prevention of infection; assessed by 7 questions, but only an overall change in knowledge score was reported by the authors	For the English students, the intervention was more effective than the control for senior school students only For the English students, the intervention was more effective than the control for senior school students only For the English students, the intervention was more effective than the control for senior school students only
McNulty et al. 2001 Pre-post (pilot study) UK (-)	Children aged 9 to 10 years old at a Gloucester state school	Two 90-minute workshops covering micro-organisms, bacteria, antibiotics and hand washing (n=48)	NA	Appropriate hand hygiene behaviour; children were asked if they should wash their hands after 7 activities (e.g. after petting animals, before eating)	The proportion of children who correctly identified the need to wash hands after all 7 activities did not change after the intervention, either as an overall score or for individual activities (but baseline levels of knowledge were high)
McNulty et al. 2007 Pre-post UK (+)	Children aged 10 to 11 years old in primary schools	'Bug Investigators' school resource pack (n=251)	NA	Appropriate hand hygiene behaviour; children were asked about 10 activities after which they should wash their hands	<ul style="list-style-type: none"> For 4 out of the 10 activities the proportion of children correctly identifying that they need to wash their hands improved The proportion of children who correctly identified the need to wash hand for all 10 activities (as an overall score) significantly improved

Reference/ study type/ country/ (quality assessment)	Population and setting	Comparisons		Key outcomes evaluated that are relevant to this review	Direction of effect for intervention
		Intervention/ (sample size)	Comparator/ (sample size)		
Baker et al. 2013 Pre-post USA (-)	Students 11 to 14 years of age enrolled in the NFL Youth Education Town of the Boys and Girls Club of Atlanta (an after-school club)	Hygiene intervention programme titled High Five for Healthy Living (n=73)	NA	Appropriate hand washing behaviour; details not provided	Effective; significance not reported
Losasso et al. 2014 RCT Italy (-)	Fifth grade students aged 9 to 11 years old, in 12 public schools	Health campaign titled Mission on the Invisible World, consisting of ad hoc multimedia and movies and using a practical approach (no detail on practical approach reported by authors) (n=162)	Health campaign titled Mission on the Invisible World, consisting of ad hoc multimedia and movies and using a theoretical approach (no detail on theoretical approach reported by authors) (n=87)	Knowledge of hand hygiene; measured based on one section of the knowledge questionnaire consisting of 7 questions Appropriate hand washing behaviour; assessed using 8 activities after which students should wash their hands	No change in combined knowledge of hand hygiene score for either group Based on children's survey responses: <ul style="list-style-type: none"> Improvement in hand hygiene behaviour based on combined score of all 8 questions achieved in both practical and theoretical classes For children in practical class there was an improvement in reported behaviour for 6 out of the 8 activities For children in the theoretical class there was an improvement in behaviour for 5 out of the 8 activities

Reference/ study type/ country/ (quality assessment)	Population and setting	Comparisons		Key outcomes evaluated that are relevant to this review	Direction of effect for intervention
		Intervention/ (sample size)	Comparator/ (sample size)		
Interventions based in university					
Poster campaigns in restrooms					
Lapinski et al. 2013 RCT USA (+)	Men using a restroom in the centre of a large Midwestern University campus	Posters with different message conditions: High prevalence: 'Four out of five college students wash their hands EVERY time they use the bathroom.' (n=113) Or Low prevalence: 'One out of five college students wash their hands EVERY time they use the bathroom.' (n=66). And different privacy conditions: someone else was present in restroom (n=108) Or Restroom was empty (n=144)	No poster (n=73, breakdown of data by private or public not reported)	Frequency of hand-washing; researcher observed hand-washing from within bathroom stall Quality of hand washing; length of time, use of soap and paper towel to dry hands observed by researcher	<ul style="list-style-type: none"> Significantly higher in the low and high prevalence message compared to no poster More frequent among low prevalence than high prevalence (significance not reported) No difference between privacy conditions Significantly longer in the low and high prevalence message compared to control Significantly longer in the high prevalence message compared low prevalence No difference in length of time for privacy condition No difference in use of soap or paper towel for message condition. Not reported for privacy condition Significantly higher in the low and high prevalence message compared to no poster No difference between privacy conditions Positive attitudes were high at baseline.

Reference/ study type/ country/ (quality assessment)	Population and setting	Comparisons		Key outcomes evaluated that are relevant to this review	Direction of effect for intervention
		Intervention/ (sample size)	Comparator/ (sample size)		
Mackert et al. 2013 Pre-post USA (+)	University students	'Think the Sink' hand hygiene poster campaign (n=1,005 observations, n=188 surveyed)	NA	Hand hygiene behaviour; observations on the frequency of hand washing and of hand washing with soap	<ul style="list-style-type: none"> Rates of hand washing did not change (but baseline rates were high) Rates of hand washing with soap increased Women were observed to wash their hands and use soap more frequently than men
Updegraff et al. 2014 Non-RCT USA (+)	Visitors to public buildings on a university campus	58 hand sanitizers dispensers in a university's public areas had one of four signs promoting hand hygiene placed next to it. Each sign had a different framing of the message: 1) perceived susceptibility ("Germs are out to get you. Get them first!"), 2) social norms ("Everybody is doing it. Are you?"), 3) gain-framed ("Stay healthy this season. Sanitize your hands"), and 4) loss-framed ("H1N1. Getting it is as easy as passing me by.")	Seven dispensers remained as a no-sign control.	Sanitizer usage measured as grams of sanitizer used per day.	<ul style="list-style-type: none"> All signs resulted in significantly greater usage of hand sanitizer than no sign. Gain-framed signs had the greatest usage of all, followed by loss-framed signs, then social norm framed signs and perceived susceptibility signs.
Message campaign and hand sanitizer dispensers					
Fournier and Berry 2012 Non-RCT USA (+)	University students	Informational poster ("Sanitize your hands to prevent cold and flu"), hand sanitizer dispenser and a researcher who encouraged and educated students about hand-sanitizer gels (n=6,454 observations)	Poster and access to hand sanitizer dispenser (sample sizes not reported)	Hand hygiene behaviour; observed number of students using a hand sanitizer each day	The percentage of students engaging in hand sanitizing behaviour increased on days when all three interventions were provided, and decreased when only the poster and dispenser interventions were provided; significance not reported

Reference/ study type/ country/ (quality assessment)	Population and setting	Comparisons		Key outcomes evaluated that are relevant to this review	Direction of effect for intervention
		Intervention/ (sample size)	Comparator/ (sample size)		
White et al. 2003, 2005 Non-RCT USA (+)	University students living in on-campus residence halls	Bulletin board messages (Top 10 gross things students have on their hands ¹) and flier messages in bathroom stalls; free hand sanitizer (n=188)	No intervention (n=203)	Knowledge of hand hygiene; based on cumulative score for 6 items assessing spread of infection and role of hand hygiene in preventing infection Hand hygiene behaviour; assessed based on perceived frequency of washing hands after 8 activities and the rates of hand washing recorded in a weekly report Attitudes towards hand hygiene	Significant effect • No difference between intervention and control in self-reported frequency after the 8 activities • Rates of hand washing were significantly greater in the intervention, and women recorded significantly higher rates than men • No difference between intervention and control for hand washing • Intervention expressed more positive attitude to hand sanitizer than control
Interventions targeting the general public					
Web-based					
Yardley et al. 2011 RCT UK (+)	Adults from the general public	Web-based interactive module to promote hand hygiene (n=324)	No intervention (n=179)	Hand washing behaviour; defined as self-reported frequency of hand washing with soap per day Attitude towards hand washing; asked respondent if behaviour was useful/useless or if it made them feel proud/embarrassed	Significantly more frequent among intervention than control Significantly more positive attitude among the intervention than control
Mass media					
Meilicke et al. 2013 Pre-post Germany (+)	Adults from the general public	Campaign titled Wir gegen Viren [Us Against Viruses], involving video, posters, flyers, a website and stickers (n=2006 in 2008, n=2006 in 2009)	NA	Perceived efficacy of hand hygiene as an infection control method. Perceived efficacy of coughing into the sleeve as an infection control method	Significant increase over time Significant increase over time

NOTE: NA – Not Applicable

5.1. Interventions based in healthcare setting

5.1.1. *Educational leaflet and one-to-one instruction led by nurse targeting veterans with spinal cord injuries and disorders*

1. A pilot RCT by Evans et al. 2014 (-) in the USA assessed the feasibility and effectiveness of a nurse-administered patient educational intervention about methicillin-resistant Staphylococcus aureus (MRSA) prevention on the knowledge and behaviour of 69 veterans with spinal cord injuries and disorders (SCI/D). The participants were randomised to receive care as usual or an educational intervention consisting of a brochure that addressed the following questions: (1) What is MRSA? (2) What puts someone with SCI/D at risk? (3) What puts others at risk? (4) What can you do to prevent spreading MRSA? and (5) What are important things to remember when cleaning your hands? An educational flip chart was used to facilitate interactive discussion between the nurse educator and the patient. It included similar information to that in the brochure and encouraged patients to ask questions. Sixty-one patients (88.4%) (30 (81.0%) intervention, 31 (96.9%) control) completed the post survey and were included in the final analysis. The survey was administered to assess participants' knowledge of MRSA (measured using 21 questions), self-reported hand hygiene behaviours (for 8 different activities, including after using toilet, coughing, sneezing, etc.), and self-reported change in behaviours (post-test only). It also solicited patients' and nurses' feedback on the provided intervention.

Findings: The authors reported that the mean change in knowledge score from pre- to post-intervention was not significantly different between the intervention and control: 1.70 vs 1.45, $p=0.81$. There was no change in the frequency in which participants undertook any of the eight individual hand hygiene practices from pre- to post-intervention between the intervention and control group. Overall, the mean number of improved hand hygiene behaviours increased by 2.50 in the intervention and 2.40 in the control, $p=0.83$. Additional questions related to changes in behaviour were asked at post-test only; when asked 'Have you changed your hand washing behaviour since your discussion with the research assistant or nurse?', 60.0% of the intervention group responded 'yes', compared with 29.0% of the control group ($p=0.02$). In addition, the intervention group was 10 times more likely compared with the control group to report that they intended to clean their hands more often. Intervention group subjects were also four times more likely to report having asked their provider about their MRSA status (46.7% vs 16.1%, $p=0.03$).

Limitations/considerations: There is some evidence of secular trends, as the mean knowledge score improved from pre- to post-test for both the intervention and the control groups. A number of the outcomes do not appear to be reliable, because they are self-reported, and it is possible that people would not actually admit if they did not wash their hands when it would be appropriate to do so.

Evidence Statement 2.1 Healthcare centre-based intervention led by nurses targeting veterans with spinal cord injuries and disorders

There is weak evidence from one pilot RCT study¹ (-) (USA; n=69) that a nurse-administered patient educational intervention about methicillin-resistant *Staphylococcus aureus* (MRSA) in veterans with spinal cord injuries and disorders does not alter participants' knowledge of MRSA (p=0.81) or their self-reported hand hygiene behaviours following such activities as using the toilet (p=0.83); it may, however, improve participants' perception that the intervention altered their hand hygiene behaviour (p=0.02).

Applicability

The evidence is partially applicable to people in the UK population, as the population in this study is likely to differ from the wider UK population.

1. Evans et al. 2014 (-)

5.1.2. Based in A&E targeting paediatric patients and their parents

1. A pilot RCT by Fishbein et al. 2011 (-) in the USA assessed the effectiveness of a A&E waiting-room based hand hygiene intervention on hand washing ability and self-reported hand hygiene habits. A total of 60 paediatric patients (aged 8 to 18 years old) and their parents (n=57) who had been triaged to a lower acuity urgent track care in the emergency department of an urban paediatric hospital were randomly assigned to receive the intervention. The intervention consisted of glow gel (Glo Germ) hand washing with hand hygiene instruction; participants were asked to apply the glow gel and then wash their hands. Placing hands under a black light allows participants' to view how thoroughly they had cleaned their hands. Participants were then instructed on proper hand hygiene washing technique using warm water and washing for 20 seconds by singing the songs 'Row, Row, Row Your Boat' or 'Happy Birthday'. Additionally they received a Spanish or English bathroom poster from the National Sanitation Foundation Scrub Club that uses pictorials to reinforce the steps for proper hand washing. Participants in the control group also undertook glow gel hand washing but received no additional education instruction. The cleanliness of participants' hands was measured based on the presence of glow gel on seven areas of the right hand. Hand washing habits were assessed based on three questions: 1) 'Did you use cold or warm water when you washed your hands right now?'; 2) 'Did you wash your hands before dinner last night?'; 3) 'Did you wash your hands after the last time you used the bathroom?'. Cleanliness of hands and self-reported hand washing habits were measured pre-intervention and two to four weeks post intervention. In total 46 (77%) paediatrics patients (intervention n=22 (76%), control n=24 (70%)) and 43 (75%) parents (intervention n=25 (77%), control n=20 (74%)) completed the follow-up.

Findings: The mean cleanliness score of hands (out of a possible 28) significantly improved from pre to post intervention for all of paediatric patients from 16.3 (± 3.66) to 17.9 (± 3.91), with mean improvement score of 1.60 (± 4.7) (p=0.02). There was no significant difference in mean improvement between paediatric patients in the intervention and control group (1.8 (± 4.72) vs. 1.4 (± 4.72) respectively, p=0.82). For adults there was no significant difference between pre and post intervention (18.5 (± 4.18) to 19.0 (± 3.88), mean improvement score 0.46 (± 5.03), p=0.55).

Comparison between parents in intervention and control not reported. In terms of hand hygiene practice there was a significant improvement among paediatric patients from pre to post intervention for washing hands with warm water only (70% vs. 85%, $p=0.01$), and there was no difference between intervention and control for all three questions ($p>0.6$ for all three questions). There was no difference either from pre to post intervention or between the intervention and control in parents self-reported hand hygiene behaviour ($p>0.9$ for all).

Limitations/considerations: Baseline compliance for hand hygiene practice was reported to be very high; for parents it ranged from 84% for using warm water to 100% compliance with washing hands after the using the bathroom, while for children it ranged from 70% for using warm water, to 91% for washing hands after using the bathroom. The author suggests that high rates of compliance particularly among parents, was likely to be a result of social desirability bias. The authors suggest that the interactive nature of the glow gel hand washing was sufficient to improve behaviour and that the additional education component was not necessary.

Evidence Statement 2.2 Waiting room of A&E based intervention targeting paediatric patients and their parents

There is weak evidence from one pilot RCT¹ (-) (USA; paediatric patients $n=60$, parents $n=57$) that hand hygiene education, with or without the use of Glo Gel (to show unclean hands under black light) in a hospital emergency department setting, significantly improved hand cleanliness in paediatric patients pre to post intervention 16.3 (± 3.66) to 17.9 (± 3.91), with a mean improvement score of 1.60 (± 4.7) ($p=0.02$); there was no significant difference between the groups ($p=0.82$). For adults there was no significant difference between pre and post intervention (mean improvement score 0.46 (± 5.03), $p=0.55$). There was also a significant improvement among paediatric patients from pre to post intervention for self-reported washing hands of with warm water (70% vs. 85%, $p=0.01$) but no difference in other behaviours (i.e. wash hands before dinner; wash hands after bathroom). There was no difference between intervention and control for any self-reported behaviour outcomes ($p>0.6$ for all three questions). There was no difference from pre to post intervention or between the intervention and control in parents' self-reported hand hygiene behaviour ($p>0.9$ for all), but baseline compliance with hand hygiene behaviour was high.

Applicability

The evidence is partially applicable to people in the UK population, as the population attending A&E for acute respiratory infections in the USA may be more likely to be uninsured and to have lower socio-economic status; in those respects it may differ from the population in the UK

1. Fishbein et al. 2011 (-)

5.2. Intervention based in the home led by researchers targeting the Latino community

Editorial coverage in magazines, newspapers, and television; posters and leaflets; GP intervention information leaflet; colouring book for children; influenza vaccination information; hand hygiene and coughing etiquette information

1. A **pre–post study by Larson et al. 2009 (+) in the USA** (also described above) assessed the impact of a culturally appropriate, home-based educational intervention on the knowledge, attitudes and practices regarding prevention and treatment of upper respiratory infections among 422 urban Latinos. The intervention involved bi-monthly home visits by a research coordinator who provided each household with a packet of Spanish-language educational materials, including a table describing symptoms of common cold and influenza; a child’s colouring book about germs; contact information regarding locations for influenza vaccination; prevention strategies, such as hand hygiene and coughing etiquette (e.g. cover your cough); and a CDC information leaflet regarding appropriate use of antibiotics. A survey was administered during the first home visit and six months later after the third home visit. It included 85 questions to assess knowledge, attitudes and self-reported practices regarding transmission, prevention and treatment of URIs and regarding prevention practices, such as hand hygiene and influenza vaccination. Analysis was conducted at the household level.

Findings: After six months, the authors reported significant improvements for some outcomes, including knowledge and attitude regarding the causes of URIs, how to prevent colds/flu, the modes of transmission, attitudes regarding ‘Who should stay home from school or day care’ and ‘Who should get an antibiotic’, knowledge of hand hygiene practices, and influenza vaccination (all $p < 0.01$). The mean composite knowledge scores (total maximum score 10) was 5.19 at baseline (SD 1.60) and 5.91 at end of study (SD 1.71) ($p < 0.001$). Significantly more participants reported using alcohol hand sanitizers after the intervention (1.4% baseline vs 66.8% post-intervention, $p < 0.001$), fewer reported using antibacterial soap after the intervention² (45.3% baseline vs 24.9% post-intervention, $p < 0.001$), and significantly more members in the household had received the influenza vaccination after the intervention (63.7% baseline vs 73.9% post-intervention, $p < 0.001$).

Limitations/considerations: The authors of this study only reported results for significant findings, and did not discuss the non-significant results in detail. Interestingly, they found that after the intervention people appeared to be less worried about antibiotic resistance ($p < 0.01$).

2. A second **pre–post study (nested in a RCT) by Larson et al. 2010 (-) in the USA** was also conducted among people living in a predominately Latino urban neighbourhood. It principally aimed to test the effectiveness of three household-level interventions in reducing rates of symptoms and secondary transmission of URIs. Additionally, the authors conducted a survey among study households to measure changes in knowledge of prevention and treatment strategies and vaccination rates before the intervention and at 19 months follow up. Households were randomised to receive one

² It is not clear if the authors consider this to be a positive or negative result.

of three interventions: (1) education only, in which households received written Spanish- or English-language educational materials regarding the prevention and treatment of URIs and influenza; (2) education plus hand sanitizer; and (3) education plus hand sanitizer plus face masks, with the instruction that both the caretaker and the ill person should wear them when an influenza-like illness occurred in any household member. Of the 509 households that participated in the study, 441 (86.64%) completed the survey at both baseline and the 19 month follow up (details on the numbers by intervention were not presented).

Findings: Participants' knowledge of prevention and treatment strategies significantly improved in all three groups (on a scale up to 10): education group 5.12 to 5.75, education plus hand sanitizer group 5.48 to 7.24, and education plus hand sanitizer plus face mask group 5.11 to 6.40. The change in knowledge score was significantly greater for the hand sanitizer group compared with the other two groups ($p < 0.001$) – the authors suggested, however, that the hand sanitizer and face mask groups potentially outperformed the education-only group because the hand sanitizer and face mask could have acted as a prompt, reinforcing the educational message. Likewise, the vaccination rate significantly increased in all three groups: education-only group 21.1% to 40.8%, hand sanitizer group 19.0% to 57.1%, and face mask group 22.4% to 43.5%. The change was greatest for the education plus hand sanitizer group ($p < 0.0001$).

Limitations/considerations: Details are not provided on the number of participants who completed the questionnaire relating to knowledge of prevention and treatment strategies by intervention group. In addition, details on what the questionnaire entailed were not provided.

Evidence Statement 2.3 Culturally appropriate, home-based educational intervention targeting Latino population

There is weak evidence from two pre–post (+)¹ (-)² that a culturally appropriate, home-based educational intervention significantly improved knowledge of respiratory infection prevention and improved hand hygiene behaviour (i.e. use of sanitizer) and uptake of influenza vaccination in urban Latinos.

One pre–post study¹ (+) (USA; n=422 analysed at end) found that a culturally sensitive, home-based educational intervention led to improved mean composite knowledge scores (out of 10) from 5.19 (± 1.60) pre-intervention to 5.91 (± 1.71) post-intervention ($p < 0.001$). While the proportion of participants reporting that they use alcohol-based hand sanitizer some of the time increased from 1.4% to 66.8% ($p < 0.001$), the proportion washing with antibacterial soap decreased from 45.3% to 24.9% ($p < 0.001$). Finally, there was a reported increase in the number of households with one or more members receiving an influenza vaccination, from 63.7% to 73.9% ($p < 0.001$).

One pre–post study² (-) (USA; n=509) reported significant improvements in households' knowledge of prevention and treatment strategies for all three interventions, namely, (1) education only; (2) education and hand sanitizer; and (3) education, hand sanitizer and face masks. The change in knowledge score was significantly greater for the education and hand sanitizer group compared with the other groups, from 5.48 to 7.24 (out of a score of 10) ($p < 0.001$). Likewise, while rates of vaccination increased in all three groups, it was greatest in the education and hand sanitizer group compared with the other groups, increasing from 19.0% to 57.1% ($p < 0.001$).

Applicability

The evidence is partially applicable to the wider UK population, as the studies' populations may differ from the population in the UK, although the intervention could be conducted in the UK context and is likely to be relevant to other ethnic minority groups.

1. Larson et al. 2009 (+)
2. Larson et al. 2010 (-)

5.3. Interventions based within pre-school or primary led by a teacher targeting young children

5.3.1. *Hand hygiene instruction (and other educational activities)*

1. A cluster RCT by Ramseier et al. 2007 (-) in Switzerland evaluated the outcomes of a 15-minute presentation on oral hygiene or hand and fingernail hygiene education on the oral hygiene status and cleanliness of hands and fingernails. The trial took place in four kindergarten classes and involved a total sample of 61 children aged 4 to 6 years old, of which two classes (n=30) were randomly selected to receive oral hygiene instruction and two (n=31) to receive hand/fingernail hygiene instructions. The intervention involved a presentation about the importance of body cleanliness for a child's general health, followed by instruction on tooth brushing or hand washing and fingernail cleaning

procedures. The cleanliness of hands and fingernails was assessed before the intervention and four weeks later using a hand hygiene index (HHI) and a nail hygiene index (NHI).

Findings: The authors reported no significant change in hand hygiene after the intervention (0% both hands clean; 50% one hand dirty; 100% both hands dirty). We note that these results presented by the study authors are not clear. In the hand hygiene group, the HHI score non-significantly decreased, from 33.9% to 22.6%, $p=0.30$, while in the oral hygiene group the score decreased from 31.7% to 30.0%, $p=0.87$. However, there was a significant improvement in nail hygiene for both groups (ranging from 0%, both sides of all ten fingers are clean, to 100%, both sides of all ten fingers are dirty): in the hand hygiene group the score decreased from 68.2% to 52.6%, $p=0.007$, and in the oral hygiene group it decreased from 81.6% to 70.8%, $p=0.005$. The authors stated in their discussion that children who specifically got instruction in hand and nail cleaning demonstrated significantly cleaner hands and nails after four weeks than did their fellow students who had not received the instruction. The authors also reported that girls' scores improved to a greater degree than boys' but that these differences were not statistically significant.

Limitations/considerations: This study did not evaluate hand washing behaviour *per se*, but used a hand/nail hygiene index as proxy outcome. This study had a very small sample size, and the reliability of the results is unclear.

2. A pre–post study by Tousman et al. 2007 (-) in the USA evaluated a hand washing program in 406 students in second grade (age not reported, but likely to be 6 to 7 years old) from seven schools. Staff from the Rockford Hand Washing Coalition implemented a 30-minute programme during four consecutive weeks. The programme involved the following: staff asking a number of open-ended questions of the class (for example, 'How can we remove germs?'); students using GlitterBug (a hand lotion with a UV fluorescent glow, which allowed the children to observe how well they had washed their hands) before and after learning about appropriate hand washing techniques; students touching an agar plate before and after washing their hands, and discussing results; students receiving a range of materials (such as stickers, hand hygiene colouring sheets, and a completion certificate for the hand washing program); and, finally, before the close of each session, students being prompted by staff to summarise the key learning points of that session. A survey was conducted in the third week of the intervention with parents and teachers to evaluate perceptions of changes in children's hand hygiene behaviour. In total, 193 (47.5%) parents and 16 (87%) teachers completed the survey.

Findings: Parents and teachers both reported an increase in the frequency of children's appropriate hand washing behaviour over the course of the intervention, from 64% to 94%. Half of the parents indicated that the duration of hand washing had increased, and 79% of the parents reported they did not have to remind the child to wash her or his hands before a meal. A total of 70% of the parents noticed that their child had enquired about controlling germs at home. In an open text response, nearly all parents (95%) indicated there were differences in their child's hand washing behaviour during the program. For example, one parent stated that their child now tells them when he is washing his hands.

Limitations/considerations: While the parents reported increases in appropriate hand washing behaviour, it is not clear what the frequency of hand washing actually was or what the magnitude of

the effect was – only that it had increased. Thus, while the results are positive, the figures presented are somewhat limited. Children were observed by their own parents, which may have resulted in measurement bias.

3. A **pre–post study by Witt and Spencer 2004 (-) in the USA** aimed to assess the effects of using one, three or five educational activities provided in a day care setting on the hand washing habits of 35 children aged 3.5 to 5 years old. Several different interventions were introduced to some or all of the children during different weeks: (1) children were shown how to wash their hands; (2) children were asked to wash their hands while singing the ‘A, B, Cs’ for 10 seconds; (3) Glo Germ was used to show any ‘germs’ that did not wash off; (4) children listened to a story called ‘Soap and Sudsy’ and listened to jingles which encouraged children to sing while they washed their hands; (5) children were shown a five-minute *Sesame Street* video about lead and lead poisoning. A survey was completed by the parents of the children before the intervention and one week after all the educational activities had been completed. The initial survey included questions on the hand washing habits and knowledge of their child, and the post-survey included additional questions related to perceived changes in the child’s hand washing habits at home. Children were also observed at the day care one week prior to the intervention and post-intervention to see whether they needed prompting to wash their hands, whether they used soap and water and whether they washed their hands for at least ten seconds.

Findings: Hand washing behaviour at home was reported by parents to have improved after the intervention: 74% of children pre-intervention used soap when washing their hands always or most of the time, compared with 97% of children post-intervention (p-values were not reported), and 34% of children consistently rubbed their hands together for ten seconds while they washed always or most of the time pre-intervention, compared with 64% post-intervention (p-values were not reported). These findings were corroborated by the observations in the day care centre, which found that children used soap more frequently, from 54% to 87%, and rubbed their hands for longer than ten seconds more often, from 20% to 53%, following the intervention. Parents reported that children required to be prompted less often to wash their hands before eating following the intervention, from 97% to 84% (p-values were not reported). In the day care centre, children were observed to require prompting to wash their hands before eating or after going to the toilet less frequently following the intervention, from 89% to 57% (p-values were not reported). Parents reported that children had a greater understanding of the relationship between germs and hand washing following the intervention, from 63% to 68% (p-values were not reported). Children who received all interventions showed a higher rate of improvements than those who received fewer interventions.

Limitations/considerations: This study reported no statistical results and had a small sample size.

Evidence Statement 2.4 Preschool- or primary school–based interventions involving appropriate hand hygiene instruction and other educational activities

There is weak evidence from two pre–post studies (-)² (-)³ and one cluster RCT (-)¹ that hand hygiene instruction, with additional educational activities, may improve hand hygiene behaviour in preschool and primary school children.

One cluster RCT¹(-) (Switzerland; n=61) found that hand and nail hygiene instruction in kindergarten classes, for children aged 4 to 6 years old, had a limited effect in improving hand cleanliness (0% both hands clean to 100% both hands dirty) among children who received the intervention, from 34% to 22% (p=0.30) four weeks after the intervention, but that it did have a significant impact on nail hygiene (0% both sides of all 10 fingers clean to 100% both sides of all 10 fingers dirty), which improved from 68% to 53% (p=0.007) among children. The authors reported that the observed improvements for both hand and nail hygiene were significantly greater among children in the intervention than control (p-values were not reported). We note that the way in which the results are presented by the authors is not clear.

One pre-post study²(-) (USA; n=406) reported that parents and teachers observed a positive improvement in the hand hygiene of children attending the second grade of primary school over the course of a four-week, multicomponent education programme, broadly involving appropriate hand washing education, a UV fluorescent glow which allowed the children to observe how well they had washed hands, teacher–student discussions and a range of materials (e.g. stickers, colouring sheets): 64% of parents and 94% of teachers reported that the frequency of hand washing increased (p-values were not reported).

One pre–post study³ (-) (USA; n=35) found that a day care–based intervention for children aged 3.5 to 5 years old, involving hand washing instruction, the Glo Germ UV light, singing, a story, and a video, improved hand washing behaviour in preschool children: the use of soap was observed to increase from 54% to 87%, and rubbing hands together for more than ten seconds increased from 20% to 53% (p-values were not reported). Parents of the children perceived that children’s understanding of the relationship between germs and hand washing increased.

Applicability:

While none of the studies were conducted in the UK, the evidence is directly applicable to people in the UK as there are no obvious differences in the population, context or setting of the study compared with the UK context.

1. Ramseier et al. 2007 (-)
2. Tousman et al. (2007) (-)
3. Witt and Spencer 2004 (-)

5.3.2. Multicomponent hygiene and infection prevention education, and placement of hand sanitizers in school

1. A **cluster RCT by Stebbins et al. 2010 (-) in the USA** evaluated a suite of multilayered interventions in an urban elementary school, involving children from kindergarten to grade 5 (ages not specified, but likely to be 5 to 9 years), on changing hygiene behaviour. The trial included ten elementary schools, of which five were intervention group schools and five were control group schools. The ten schools combined had approximately 1900 students and 167 teachers. The intervention involved three components: (1) training for all students and staff, including hand

hygiene, hand etiquette and 'cover your cough' behaviours (according to 'WHACK' principles: 'Wash or sanitize your hands often', 'Home is where you stay when you are sick', 'Avoid touching your eyes, nose, and mouth', 'Cover your coughs and sneezes', 'Keep your distance from sick people'). In addition, in the intervention schools, (1) staff and teachers received grade-appropriate information about 'germs' and influenza, called 'Flu101'; (2) the schools placed and maintained supplies of alcohol-based hand sanitizer in all classrooms and common areas (schools were asked to adopt the use of hand sanitizer four times per day – upon arrival, before lunch, after lunch, and before departure); and (3) parents and guardians received educational materials. Schools in the control group received no intervention. Teachers observed their students, and an aggregate class behaviour score was calculated based on observations of individual students. Teachers in the intervention undertook observations prior to the intervention (October 2007), during the flu season (February 2008) and post-flu season (May 2008). Teachers in the control group undertook observations post-flu season only. Teachers were asked to observe students' behaviour related to hand washing behaviour; whether children were covering coughs and sneezes or touching their nose, eyes and mouth; and children's knowledge of the spread of germs. The observations were completed by 74 (90%) of teachers in the intervention classes and 77 (91%) of teachers in the control group.

Findings: In the intervention schools, the frequency of hand washing and covering coughs/sneezes was observed to significantly increase from pre-intervention to during the flu season; improvements were maintained at the post-flu season follow-up time point. No changes were observed for behaviours related to touching of eyes, nose and mouth. At post-flu season, the frequency of hand washing and use of hand sanitizer was observed to be significantly higher in intervention than in control schools (on a scale of 1=almost none do, to 5=almost all do): students wash hands more than three times per day, 3.71 vs 3.35 ($p=0.045$); students use hand sanitizer more than two times per day, 4.38 vs 2.82 ($p<0.001$); students use hand sanitizer more than four times per day, 3.18 vs 1.89 ($p<0.0001$); average number of times students wash/sanitize per day, 3.95 vs 3.08 ($p=0.014$). The incidence of covering of coughs and sneezes was observed to be significantly higher in intervention than in control schools: students cover coughs and sneezes, 3.76 vs 3.29 ($p=0.002$); students cough or sneeze into elbow or shirt, 3.13 vs 3.52 ($p<0.001$); students sneeze into base hand, 2.72 vs 2.78 ($p=0.003$); students cough/sneeze into air, 2.34 vs 2.37 ($p=0.03$). For behaviours related to avoiding touching one's eyes, nose and mouth, there was no difference between intervention and control for rubbing eyes or putting hand in mouth, but there was a significant decrease in frequency of picking nose, 2.32 vs 2.66 ($p=0.05$).

Students in the intervention schools were observed to have significantly improved their understanding of the main points of the 'Flu101' curriculum compared with control schools: students understand how to stop the spread of germs, 4.00 vs 3.14 ($p<0.001$); students care about the spread of germs, 3.82 vs 2.99 ($p<0.001$); students, faculty and staff care about spreading germs, 4.57 vs 4.15 ($p=0.0032$).

Limitations/considerations: Students were observed by their own teachers, which may have resulted in measurement bias. The methodology of the study is not clearly reported, including the method of randomisation.

Evidence Statement 2.5 Primary school–based interventions involving appropriate hand hygiene and respiratory etiquette, and placement of hand sanitizers for teachers and students

There is weak evidence from one cluster RCT (-)¹ (USA; n=167) that a multicomponent educational intervention may improve hand hygiene behaviour, hygiene etiquette and knowledge of germs in primary school students.

The intervention involved educating teachers and students about appropriate hand hygiene, hand etiquette, and ‘cover your cough’ behaviours; providing information about ‘germs’ and influenza; and placing hand sanitizer in all classrooms and common areas.

The average number of times students washed/sanitized their hands per day was 3.95 in the intervention school vs 3.08 in the control school (p=0.014). Appropriate behaviour related to covering coughs and sneezes was higher in intervention than control schools: 3.76 vs 3.29, p=0.002. Students in the intervention schools also had improved knowledge of how to stop the spread of germs (p<0.001).

Applicability:

While this study was conducted in the USA, there are no obvious differences in the population, context or setting of the study compared with the UK.

1. Stebbins et al. 2010 (-)

5.4. Interventions based in schools and or targeting students 9 years of age or older

e-Bug education delivered through a computer game

1. A **pre–post study by Farrell et al. 2011 (-) in the UK** (also described above) evaluated an e-Bug-developed junior computer game for 9- to 12-year-old children. The game consisted of a number of levels, each of which taught a set of learning outcomes. In the game, the players choose an avatar, which travels around the inside the human body meeting useful and harmful cartoon microbes in various contexts and scenarios. The learning outcomes were taught through the game’s mechanics (the rules of the game) rather than through its story or dialogue. For example, instead of telling the player that soap washes harmful microbes off the skin, the player was instructed to throw globules of soap at microbes to make the harmful microbes disappear. On average, the game took 30–40 minutes to play. The study was conducted in three schools, in Glasgow, Gloucester and London. In addition, several schools and school-related contacts were emailed to advertise the online game to children. In total the game was distributed to 1,736 students (62 in schools, 1,674 online). In order to test children’s increase in knowledge related to microbes, hygiene and antibiotics, a game show quiz was incorporated into the game’s structure. Overall 652 students completed level 1: Introduction to Microbes, 317 completed level 2: Harmful Microbes, 181 completed level 3: Useful Microbes, 81 completed level 4: Hygiene and 54 completed level 5: Antibiotics.

Findings: The authors reported that the majority of players did not change their knowledge of microbes, infection and hand hygiene as a result of the game. Significant differences were observed for

only 3 out of 21 questions (spread out over 5 game levels). The questions with the most significant knowledge change were: ‘We use good microbes to make things like bread and yogurt’ ($p=0.001$), ‘If you cannot see a microbe it is not there’ ($p=0.02$), and ‘Soap can be used to wash away bad bugs’ ($p=0.02$).

Limitations/considerations: The authors noted that many children had the required knowledge before playing the game, meant that potentially there was less room for improvement. Approximately 50% of the players who started the game dropped out before completing the first level. The authors hypothesised that levels may have been too easy or too difficult; the levels took too long to complete; or the participants were bored with the game.

e-Bug education pack

2. A **pre–post study by Hawking et al. 2013 (-) in the UK** assessed a one- to two-hour modified e-Bug lesson plan for key stage 2 (9–11 years old) students attending junior school. The intervention consisted of an interactive class presentation, microbe and animal ‘social networking’ cards, and a board game, and it was delivered by the students’ class teacher. A total of 210 students filled out a questionnaire immediately before and immediately after the intervention. The questionnaire included 29 true-or-false statements relating to 3 topics: microbes (8 questions), hand hygiene (9 questions), and farm hygiene (12 questions).

Findings: Overall, the number of students correctly answering all questions on a topic significantly increased for all three topics post-intervention ($p<0.001$). However, for the nine individual questions in the hand washing topic, there was a significant improvement in correct responses for only half of the questions; for example, there was no improvement in the number of children who correctly identified the need to wash your hands (1) after stroking a farm animal, (2) before eating or (3) after eating ($p=0.16$, $p=0.5$ and $p=0.7$, respectively). In contrast, the percentage of correct answers relating to knowledge of using hand gels was significantly increased after the intervention (‘Washing hands with alcohol gel/wipes will remove all bad microbes on the farm’ and ‘Using alcohol hand gel is better than washing hands with hot running water and soap’ (both of which are false statements) (15.1% to 31.0%, $p<0.001$, and 1.3% to 18.2%, $p=0.02$, respectively). The authors considered the impact of gender for one of the hand hygiene questions and found that improvement in knowledge related to the statement ‘Bad microbes can spread when you touch someone’s hands’ was significantly greater for girls than for boys, 17.5% vs 1.9% ($p=0.02$). For the individual questions on farm hygiene, those related to awareness of microbes on the farm showed high knowledge improvement, and the majority of statements related to health behaviours also showed improvement. The two questions related to hand washing showed the lowest level of improvement. Note that of the two questions, one is a repeat of a question asked in the section on hand hygiene related to the need to wash hands after stroking an animal. There was only a 2.4% increase in children correctly stating that washing hands is the best way to stop the spread of harmful microbes ($p=0.4$).

Limitations/considerations: The study authors stated that there was an improved awareness of microbes and how to prevent infection and an improved knowledge of hand gels. However, there was a continued lack of understanding of when to wash hands when visiting a farm. The baseline for some

outcomes was high, including the statements ‘There is no need to wash hands after stroking an animal’, ‘There is no need to wash hands before eating’, ‘Washing hands is the best way to stop spread of microbes’, and ‘Washing hands with soap and water removes more microbes than just water’ (95.1%, 88.9%, 87.5% and 87.5%, respectively), which potentially meant there was less opportunity for knowledge gain.

3. A **cluster non-randomised controlled study by Lecky et al. 2010 (-)** in the Czech Republic, England and France evaluated the e-Bug educational pack on children’s knowledge about prudent antibiotic use and hygiene immediately after the intervention, and whether this knowledge was retained six weeks post-teaching. State schools teaching junior (9- to 11-year-old) and/or senior (12- to 15-year-old) students were selected from regions each of the Czech Republic, England (Gloucester) and France. The teaching programme involved two interactive teacher resource packs, each comprising eight distinct lesson plans covering three themes: (1) an introduction to microbes, (2) the spread of infection, and (3) treatment and prevention of infection. The e-Bug resource links to a specific area of the school national curriculum in each country. Each 45-minute lesson involved student hand-outs, worksheets and factsheets; a teacher-mediated introduction to the subsection; an interactive activity; and a follow-up plenary question-and-answer session. Control classes were taught the microbiology section of the school curriculum using their usual materials. Further details were not reported on the control condition, other than that the teachers were asked not to use e-Bug learning materials. In total, 2,168 students received the intervention (955 in England; 399 juniors and 596 seniors) and 1,356 students (257 in England; 58 juniors and 199 seniors) were in the control classes. The results were presented separately by junior and senior students.

Findings: Although the students were asked a number of specific questions, only overall ‘knowledge’ results were presented for the three topic areas described above. Regarding the findings for England, there were no significant differences in the percentage knowledge change between the intervention and control groups for ‘knowledge of microbes’ in junior students immediately after the intervention (33% vs 34%, with lower scores indicating improvements) or at follow up, but there were differences between groups among the senior students (19% vs 12% immediately after intervention, and 19% vs 8% at follow up). Similarly, there were no significant differences in the percentage knowledge change between the intervention and control groups for ‘knowledge of the spread of infection’ in junior students immediately after the intervention (11% vs 11%) or at follow up, but there were differences between groups among the senior students (15% vs 7% immediately after intervention, and 14% vs -2% at follow up). For the third outcome (knowledge of treatment and prevention), the results were similar: there were no significant differences in the percentage knowledge change between the intervention and control in junior students immediately after the intervention (15% vs 17%) or at follow up, but there were differences between groups among the senior students (24% vs 14% immediately after the intervention, and 25% vs 3% at follow up).

Limitations/considerations: This study demonstrated that the e-Bug pack was effective in senior English students; however, only overall ‘knowledge’ data are reported, which limits our ability to understand what specific types of knowledge improved or did not improve. The authors reported that there were statistical differences, but they did not report p-values.

Workshops: Antibiotics and Your Good Bugs

4. A **pilot pre–post study by McNulty et al. 2001 (-) in the UK** (also described above) assessed the impact of two 90-minute workshops entitled Antibiotics and Your Good Bugs on the knowledge of children aged 9 to 10 years old of ‘good’ bacteria and the effect of antibiotics on them. The workshops took place in a Gloucester state school on consecutive days at the end of the half-term in which children had learned about micro-organisms and had visited Severn Trent waterworks. The workshops were given by a microbiologist, and two class teachers were present. They consisted of a theoretical part, covering such points as the existence of good bacteria and the effect of antibiotics, and a practical part. Forty-eight children took part in the workshops; 38 (21%) completed a post-workshop questionnaire assessing children’s knowledge two weeks after attending and were included in the analysis. A questionnaire was completed before the workshop and repeated two weeks afterwards. It comprised six sections: ‘where bugs are found’ (7 questions), ‘our good bugs’ (4 questions), ‘what antibiotics do’ (6 questions), ‘how bugs spread’ (5 questions), ‘hand washing’ (7 questions) and ‘antibiotic resistance’ (3 questions).

Findings: The percentage of children who correctly identified the need to wash their hands after all seven activities (e.g. after holding an animal) did not significantly increase, neither as an overall score nor for each independent activity.

Limitations/considerations: Students’ baseline knowledge about ‘the importance of hand washing’ was very high, at 94.0% (ranging from 89% to 97% for each of the activities), which may partially explain why there was a non-significant increase in knowledge.

‘Bug Investigators’ pack

5. A **pre–post study by McNulty et al. 2007 (+) in the UK** (also described above) aimed to measure the effectiveness of the ‘Bug Investigators’ pack in improving primary school children’s knowledge about microorganisms, hygiene and antibiotics. This study was conducted in primary schools targeting children aged 10 to 11 years old. The resource pack was taught by class teachers, and it encompassed classroom, homework and optional web-based educational elements. It included information about infections and how they are spread, and it aimed to raise awareness about the appropriate use of antibiotics and the drawbacks of overuse. A questionnaire was distributed before the intervention and one to six weeks after the intervention. It comprised 6 sections: ‘bugs/bacteria are found’ (10 questions); ‘bugs/bacteria spread’ (5 questions); ‘you need to wash your hands’ (10 questions); ‘our own bugs/bacteria all over our body’ (4 questions); ‘antibiotics’ (7 questions); ‘resistant bacteria and superbugs’ (3 questions); and ‘when given an antibiotic by a doctor or nurse’ (2 questions). Of the 251 children who participated, 198 (78.9%) completed both questionnaires and were included in the analysis.

Findings: Overall, the percentage of children identifying that they need to wash hands after all ten activities significantly increased, from 90% to 94% ($p < 0.001$). In relation to the ten individual activities listed, the number of correct responses significantly improved for four of the activities; the greatest improvement was observed for ‘to get rid of good bugs’, which increased by 22% [95%CI: 14.0 to 29.5], $p < 0.001$).

Limitations/considerations: Even though knowledge of hand hygiene was high at baseline, the authors reported significant improvements after the intervention.

Evidence Statement 2.6 E-bugs educational interventions targeting children 9 years of age or older

There is inconsistent evidence from five studies (four pre–post studies (-)^{1,2,4} (+)⁵ and one non-RCT (-)³) concerning whether or not e-Bug-based interventions improve knowledge of microbes, awareness of infection, infection prevention and/or hand hygiene among children aged 9 to 15 years old.

One pre–post study¹ (-) (UK; n=1736 [school n=62, online=1674]) found that an e-Bug computer game for 9- to 12-year-old children did not lead to a significant improvement in children’s knowledge of microbes/infection/hand hygiene. Knowledge significantly changed for only 3 out of 21 questions: 2 related to knowledge of microbes (p=0.001 and p=0.02) and 1 related to the benefits of using soap (p=0.02).

One pre–post study² (-) (UK; n=225) found that, following a modified e-Bug lesson plan, 9- to 11-year-old children showed a significant improvement in overall knowledge of microbes, hand hygiene and farm hygiene (p<0.001). However, improvements were not shown for all questions within each topic.

One non-RCT study³ (-) conducted in the Czech Republic, England and France, found that the e-Bug educational pack focussing on knowledge of prudent antibiotic use and hygiene significantly improved children’s ‘knowledge of infection’ in some countries/regions, but not in others. In England (n=2136), knowledge of microbes, of how infections are spread, and how to treat and prevent infection did not significantly differ in junior school children (9- to 11-year-olds) exposed to the intervention compared with children in the control schools. But the authors reported that there were significant improvements among senior school children (12- to 15-year-olds) for all outcomes immediately following the intervention and at six months follow up (p-values were not reported).

One pre–post study⁴ (-) (UK; n=48) found that a two-day workshop titled Antibiotics and Your Good Bugs, for children aged 9 to 10 years old, did not significantly increase the number of children who correctly identified the need to wash their hands after various activities. However, baseline values were high: the overall score increased from 94% to 96% (p=0.5).

One pre–post study⁵ (+) (UK; n=251) found that use of a ‘Bug Investigators’ pack for children aged 10 to 11 years old resulted in a significant increase in the proportion of children who correctly identified that they needed to wash their hands after all 10 activities presented, from 90% to 94% (p<0.001).

Applicability

While one of the studies included study sites outside of the UK, the evidence is directly applicable to people in the UK, as there are no obvious differences in the population, context or setting of the study compared with the UK context.

1. Farrell et al. 2011 (-)
2. Hawking et al. 2013 (-)
3. Lecky et al. 2010 (-)

4. McNulty et al. 2001 (-)
5. McNulty et al. 2007 (+)

Hygiene programme titled 'High Five for Healthy Living'

1. A **pre–post study by Baker et al. 2012 (-) in the USA** evaluated a five-week hygiene intervention programme called High Five for Healthy Living, which consisted of five training modules on oral hygiene, hand washing techniques, physical activity, male/female personal hygiene, and nutrition and food safety. The study was conducted among predominantly African American students (aged 11 to 14 years old) enrolled in the NFL Youth Education Town of the Boys and Girls Club of Atlanta afterschool programme (n=73). The module on hand washing addressed proper hand washing techniques, as well as common bacterial and fungal infections transmitted via hand-to-hand contact. The hand washing module was presented by two medical students and consisted of three parts. The first was an informative matching game in which written descriptions of common bacterial and fungal infections were matched with pictures correlating to clinical symptoms. The second was a lecture that provided information about locations of bacteria and fungi, methods of transmission, and descriptions of the organisms' clinical manifestations; the basis of the lecture was the importance of proper hand washing techniques. And the third was a bacterial/fungal hand swab culture. A questionnaire undertaken pre- and post-test consisted of ten questions related to each module. In total 18 children participated in the hand washing module.

Findings: Only findings about hand hygiene are reported here; outcomes relating to food safety were not reported in the study. The number of children who passed the hand washing module (that is, who answered at least six out of ten questions correctly) increased from 14 (78%) to 16 (89%), and 67% of all participants improved their test scores by 10%. Overall, 88% (14 of 16) of the participants positively changed their hand washing behaviour (p-values were not reported).

Limitations/considerations: The sample size was small, and no statistical analyses were presented.

Multimedia and movies

2. An **RCT by Losasso et al. 2014 (-) in Italy** (also described above) assessed the effect of an educational food safety campaign titled Mission on the Invisible World on 249 fifth grade students' (aged 9 to 11 years old) knowledge of bacteria, hand hygiene and food handling, and hand hygiene behaviour. Participating classes were randomised to either a practical (n=162) or a theoretical class (n=87), based on different teaching approaches that covered the same content. These different teaching approaches were not described in detail. Teaching material used for both classes consisted of *ad hoc* multimedia and movies. A questionnaire was implemented pre- and post-intervention and completed by both participating children and their parents. The questionnaire consisted of two sections; one on knowledge and the other on behaviour. The knowledge section consisted of nine topics each composed of seven questions, while the hand hygiene behaviour section comprised eight questions.

Findings: Overall, based on the children's survey results, the authors found a significant pre–post improvement in children's knowledge (based on nine topics) for both those in the practical and those

in the theoretical class (IRR was 1.2 [95%CI: 1.1 to 1.2], $p < 0.001$, and 1.10 [95%CI: 1.1 to 1.2], $p < 0.001$, respectively). When each of the 9 topics were analysed separately, neither of the groups showed statistically significant progress in knowledge for two of the topics, 'hand hygiene' and 'insight into flu and antimicrobial resistance' (p -values were not reported). Overall children's hand hygiene behaviour (based on correct answers to all 8 questions of when to wash hands) was significantly improved in both the practical and the theoretical class (IRR was 3.4 [95%CI: 2.2 to 5.2], $p < 0.001$ and 3.2 [95%CI: 1.9 to 5.5], $p < 0.001$, respectively). Children's behaviour in the practical class significantly improved for six out of the eight questions, and for children in the theoretical class it improved for five out of the eight questions. Parents of children in both classes also reported an improvement in children's hand washing behaviour (practical IRR 2.6 [95%CI: 1.7 to 3.9] and theoretical IRR 2.8 [95%CI: 1.7 to 4.8]).

Limitations/considerations: The authors suggested that children already had high baseline scores for hand hygiene (although pre and post scores were not reported).

Evidence Statement 2.7 School-based educational interventions targeting children 9 years of age or older

There is weak evidence from one pre-post study (-)¹ and one RCT (-)² that school-based interventions can improve hand washing behaviour.

One pre-post study¹ (-) (USA; $n=73$) found that a five-week hygiene intervention programme called High Five for Healthy Living was effective in improving hand washing behaviour in 11- to 14-year-olds (predominantly African American) attending an afterschool club; 67% of students improved their test scores by 10% (p -values were not reported).

One RCT (-)² (Italy; $n=249$) found that an educational programme involving multimedia and movies taught in either a practical or a theoretical class, targeting fifth grade students (aged 9 to 11 years old), significantly improved appropriate hand hygiene behaviour in both classes (Incidence Risk Ratio (IRR) 3.4 [95%CI: 2.2 to 5.2] and 3.2 [95%CI: 1.9 to 5.5]), but did not improve knowledge of hand hygiene in either class (IRR 1.1 [95%CI: 1.0 to 1.2] and 1.0 [95%CI: 0.9 to 1.2]).

Applicability

While neither study was based in the UK, the evidence is directly applicable to people in the UK, as there are no obvious differences in the population, context or setting of the study compared with the UK context.

1. Baker et al. 2012 (-)
2. Losasso et al. 2014 (-)

5.5. Interventions based in a university

5.5.1. *Poster campaigns in restrooms*

1. An RCT by Lapinski et al. 2013 (-) in the USA sought to test whether messages designed to modify perceived descriptive norms could affect hand-washing behaviour in men's public restrooms under 'private' and 'non-private' conditions. In total 252 observations of men's hand washing practice when using a restroom in the centre of a large University campus was made, and a sub-sample of 95 men completed a questionnaire which assessed their attitude towards hand washing. The intervention consisted of a poster with two descriptive norm message conditions; either a high-prevalence message ('Four out of five college students wash their hands EVERY time they use the bathroom.') or a low-prevalence message ('One out of five college students wash their hands EVERY time they use the bathroom.'). Control restrooms had no poster. In total 113 participants entered the restroom when there was a high-prevalence message, 66 when a low prevalence message and 73 when no poster. **Findings:** The message had an impact on the frequency of hand washing and attitude towards hand washing but limited impact on hand-washing quality. Whether the behaviour was enacted in the presence of another person or in private had limited impact on behaviours. For message condition the frequency of hand washing was high ranging from 70% in the no poster group to 88% in the low prevalence. The frequency of hand washing was significantly higher in both the low prevalence and high prevalence poster compared to no poster (a OR 19.39 [95%CI: not reported] p=0.006, and aOR 6.53 [95%CI: not reported] p=0.033, respectively). There was a non-significant higher frequency when hand washing activity was observed (public vs. private aOR 1.63 [95%CI: not reported] p=0.43). There was no interaction between message condition or privacy condition (p=0.46). The length of time (mean number of seconds) that men washed their hands was significantly higher in the high-prevalence poster and low prevalence poster compared to no poster (9.94 (±7.78) vs. 9.57 (±7.78), 6.04 (±7.58), p=0.04). There was no significant difference in length of time between men who viewed the high or low prevalence poster (p>0.05) and no difference by privacy condition (p=0.74). There was no difference in the use of soap (p=0.54), use of a paper towel to dry hands (p=0.24) or turning the tap of with a towel (p=0.39) by message condition. Men's attitude towards hand washing was significantly more positive in the high and low-prevalence message condition (p=0.01) but not by privacy condition (p=0.69).

Limitations/considerations: The authors measured the change in behaviour at a single point at time. The average attitude score at baseline was above the midpoint making it difficult to bring about a significant increase in mean score on attitudes.

2. A pre-post study by Mackert et al. 2013 (-) in the USA aimed to promote hand washing among US college students by reinforcing norms regarding hand hygiene after using the toilet through the 'Think the Sink' poster campaign. Copies of poster 1, highlighting that approximately two out of five people do not wash their hands after using the toilet were hung in public areas of a university campus. Copies of poster 2 were placed in toilet stalls and above urinals. The wording of the posters was not reported. Three 10-hour direct observation sessions were conducted; at one week before the campaign, and then at two and four weeks into the campaign. Two graduates concealed in toilet stalls

observed 1,005 people in restrooms where the posters were hung. In addition, a survey was conducted among 188 students recruited from a participant pool for survey studies to evaluate the theory of planned behaviour and poster effectiveness.

Findings: The authors observed no difference in the rate of hand washing after the introduction of the posters. However, hand washing with soap did significantly increase, from 58.0% to 70.1% ($p < 0.001$). Women were observed to wash their hands and use soap significantly more frequently than men; 90% of women washed their hands, compared with 80% of men ($p < 0.001$). In the survey, women demonstrated more positive attitudes towards hand washing ($p = 0.01$), as well as greater behavioural intention ($p = 0.07$) and higher social expectations regarding hand washing ($p = 0.001$).

Limitations/considerations: The authors suggest that the study provides support for gender-targeted messages and that social norms may be more appropriate for women. It is interesting to note these significant results, despite self-reported exposure to the posters being low; 25.4% of respondents recalled having seen poster 1, and only 17.5% recalled seeing poster 2. Rates of hand washing at baseline were observed to be high (88%), which means there were less potential room for improvement.

3. A **non-RCT Updegraff 2009 (-) in the USA** assessed the effects of signs promoting hand hygiene during the 2009 to 2010 H1N1 pandemic. Fifty eight hand sanitizer dispensers in university public buildings were randomly assigned to have one of four signs placed next to it, or no sign. The signs were professionally designed and printed and contained a message promoting hand hygiene. Each sign used a different framing of the message in order to test which type of messaging might be most effective. These were: 1) perceived susceptibility headline ('Germs are out to get you. Get them first!'); 2) a social norms headline ('Everybody is doing it. Are you?'); 3) a gain-framed headline ('Stay healthy this season. Sanitize your hands'); and 4) a loss-framed headline ('H1N1. Getting it is as easy as passing me by'). Each sign was accompanied by a 'fact box' with more detailed information reinforcing the theme. Every three weeks, these dispensers were randomly assigned a different sign that had not already been placed at that location, so by the end of the study period each location had been assigned to all four sign conditions in a random order. During the sign period, seven dispensers remained as a no-sign control. The main outcome measured in the study was sanitizer usage, operationalised as grams of sanitizer used per day. A single estimate of baseline usage was created for each dispenser by dividing the total amount of sanitizer used by the number of days in the baseline period. In addition, the researchers also recorded the level of public interest in H1N1, measured by the volume of Google web searches in the Cleveland metropolitan area for the term 'H1N1' to assess whether it affected sanitizer usage.

Findings: All four signs resulted in significantly greater sanitizer usage than no sign; however, the four types of signs were not equally effective. Dispensers with the gain-framed messages had the greatest usage, with 66.4% more use than dispensers with no signs ($p < 0.001$). Loss-framed signs were associated with a 58.4% increase in use over no sign ($p < .001$), the social norms signs with 44.3% ($p < 0.01$) and the perceived susceptibility signs with 40.6% ($p < 0.01$) more usage than no sign. Dispensers with gain-framed signs received 12.5% more usage than dispensers with any of the other sign conditions combined ($p = 0.029$). The worst-performing sign was the perceived susceptibility sign,

which had 9.7% less usage than dispensers in the other sign conditions combined ($p=.059$). Usage of sanitizer dropped consistently over time, closely mirroring temporal trends in public interest in H1N1. However, the use of sanitizer was not significantly moderated by temporal trends ($p > 0.10$).

Limitations/considerations: Information on individuals' usage is not available. Therefore, no data is available on who was actually using the dispensers. Similarly, the study collected no data on individuals' exposure to the signs and therefore no information is available on who was reached by the intervention.

Evidence Statement 2.8 Poster campaigns displayed in university restrooms

There is inconsistent evidence from one RCT (-)¹, one pre-post study (-)² and one non-RCT (-)³ concerning whether or not posters placed in public toilets in university buildings improve the frequency of hand washing or the use of soap, but there does appear to be a significant increase in the use of hand sanitizer.

One RCT¹ (-) (USA; n=252 observations, n=95 surveys) conducted in public toilets on a university campus found that posters with different descriptive norm messages (a high-prevalence message: 'Four out of five college students wash their hands EVERY time they use the bathroom.' or a low-prevalence message: 'One out of five college students wash their hands EVERY time they use the bathroom.') led to a significant increase in the frequency (low prevalence vs. no poster aOR 19.39 p=0.006; high prevalence vs. no poster aOR 6.53 p=0.033) and length of time that participants washed their hands in seconds (high prevalence 9.94 (±7.78), low prevalence 9.57 (±7.78), no poster 6.04 (±7.58), p=0.04) compared to no poster, but not for use of soap (p=0.54). Positive attitudes towards hand washing were significantly greater for the high and low prevalence message compared to no message (p=0.01).

One pre-post study¹ (-) (USA; n=1,005 observations, n=188 surveys) found that a hand hygiene poster campaign targeting university students did not increase observed rates of hand washing but did significantly increase the use of soap during hand washing, from 58.0% to 78.1% (p<0.001). Women were observed to wash their hands and use soap significantly more frequently than men (90% vs 80%, p<0.001).

One non-RCT³ (-) (USA, n=not measured) conducted in public buildings on a university campus found that signs promoting hand hygiene placed next to a hand sanitizer significantly increased hand sanitizer use. Depending on the framing of the message on the sign, the usage increase ranged from 40.6% to 66.4% compared to dispensers with no sign (p<0.01). The greatest usage was observed when the message 'Stay healthy this season. Sanitize your hands' was placed next to dispensers and the smallest increase was for the message ('Germs are out to get you. Get them first!'). The signs had a consistent influence on usage over time and were not significantly moderated by temporal trends (p>0.10).

Applicability

While the studies were not conducted in the UK, the evidence is directly applicable to people in the UK, as there are no obvious differences in the population, context or setting of the study compared with the UK context.

1. Lapinski et al. 2013 (-)
2. Mackert et al. 2013 (-)
3. Updegraff et al. 2014 (-)

5.5.3. *Message campaign and hand sanitizer dispensers*

1. A **non-RCT by Fournier and Berry 2012 (-) in the USA** examined the effect of interventions to increase hand hygiene behaviour of college students eating at a hall of residence cafeteria on a university campus. The intervention consisted of a round table outfitted with a dispenser for hand-sanitizer gel and an information poster placed next to the cashier counter en route to a food and drink service line in the cafeteria. The wording of the poster was ‘Sanitize your hands to prevent cold and flu’. In addition, a change agent (research assistant) was positioned by the table and dispenser and instructed to ask students if they wanted to clean their hands, kill germs, and avoid getting sick by using the hand sanitizer.

This was an observational study organised in five phases: (1) baseline – no intervention; (2) both sanitizer/poster and change agent; (3) sanitizer/poster only; (4) both sanitizer/poster and change agent; (5) sanitizer/poster only. Each phase lasted three to five days. During each phase, the use of the hand sanitizer was observed by two independent agents placed in the cafeteria, unbeknownst to the students. In addition, the number of entries into and exits from the cafeteria toilets was recorded to serve as a proxy for hand washing behaviour (this statement is as reported by the study authors, and further details are not reported). There was no comparison group, and 6,454 observations were made over the course of the study (3,226 men and 3,228 women).

Findings: Baseline (Phase 1) observations indicated that students did not use personal hand sanitizer (M = 0%), while the introduction of the hand sanitizer dispenser, information poster and change agent (Phase 2) showed a dramatic increase (60.44%) of student use of hand sanitizer from the dispenser provided. Removal of the change agent from the table outfitted with the information poster and the hand-sanitizer dispenser (Phase 3) showed a substantial decrease in student use of the hand sanitizer (17.96%). In phase four, the subsequent return of the change agent (Phase 4) saw another robust increase in hand sanitizer use (60.96%). Finally, in phase five, the removal of the change agent (Phase 5) saw a large decrease in student use of the hand sanitizer (14.83%) (no significance values were presented).

Limitations/considerations: This is a somewhat complicated study design. It is not clear exactly what information was given to the change agents by the researcher, only that they were instructed to ask students if they wanted to clean their hands, kill germs, and avoid getting sick by using the hand sanitizer. As such, the educational aspect of this study is not clear – and therefore it is difficult to assess the impact of education on behaviour in this study.

2. A **cluster non-RCT by White et al. 2003, 2005 (-) in the USA** reported in two papers aimed to assess whether a university-based health campaign designed to increase hand hygiene practices, coupled with the introduction of an alcohol-based antibacterial gel, would decrease the incidence of upper respiratory infections (URIs) and absenteeism among students. The health campaign consisted of information on bulletin boards (“Top 10 gross things students have on their hands”) and flier messages in toilet stalls (which changed weekly and which noted, for example, that most common infections are transmitted to others by touching contaminated surfaces). Participants also received free hand sanitizer. Four on-campus residence halls participated in the study; two were assigned to receive the intervention and two were assigned to the control. Students living in the control halls were told

they were participating in a study to examine wellness behaviours and their links to illness and did not receive the intervention. Participating students completed a pre- and post-intervention questionnaire which tested knowledge of spread of infection and role of hand hygiene (based on 6 items), attitudes towards hand hygiene (3 items), and behaviour related to frequency of hand hygiene after 8 activities. Students also completed weekly reports of their experience of cold or flu symptoms, hand washing and use of gel sanitizer. Overall, 188 students living in intervention halls and 203 students living in control halls completed both questionnaires and were included in the analysis.

Findings: The authors reported that self-reported knowledge of hand hygiene, and attitudes toward the health benefits of hand sanitizer, significantly improved in the intervention group compared with the control group ($p < 0.001$ for both), but that there were no significant differences between groups in attitudes towards hand washing or perceived hand hygiene behaviour. Self-reported frequency of hand hygiene (from 1=all of the time, to 5=never) for the intervention improved from 2.87 before intervention to 2.80 following the intervention, while in control group frequency decreased from 2.81 to 2.83. However, data from the weekly reports suggest that hand hygiene behaviour was significantly better in the intervention group: students in intervention halls reported washing their hands 0.48 times per hour, compared with 0.43 times per hour among control students, $p < 0.02$. Similarly, hand sanitizer use was significantly better in the intervention group compared with the control group, 0.26 uses/hour vs 0.03 uses/hour, $p < 0.0001$. Women were found to wash their hands more frequently than men ($p < 0.001$).

Limitations/considerations: The authors stated that it was not possible to determine whether the message campaign or sanitizer alone was effective in this study.

Evidence Statement 2.9 Message campaign and hand sanitizer targeting university students

There is weak evidence from one non-RCT (-)² and one non-RCT (-)³ indicating that university-based poster campaigns, with the provision of hand sanitizer and/or a researcher interacting with students, can lead to an increase in the rates of hand washing with had sanitizer and an increase in frequency of hand washing per day.

One non-RCT³ (-) (USA; n=6454) evaluated the impact of an information poster ('Sanitize your hands to prevent cold and flu') placed next to cashier counter en route to a food and drink service in a cafeteria, access to hand sanitizer, and a researcher promoting hand hygiene, compared with the poster and sanitizer alone. On days when all three interventions were implemented, the percentage of students using hand sanitizer was high (60%) compared with those days when only two components were implemented (15–18%) (p-values were not reported).

One cluster non-RCT² (-) (USA; n=430) found that a poster campaign detailing the 'Top 10 gross things students have on their hands', coupled with free hand sanitizer, posted in student halls of residence, effectively improved students' knowledge of the role of hand hygiene in infection control. While students' perceived frequency of engaging in hand hygiene did not differ between the intervention and control, the reported rates of weekly hand washing (students provided weekly reports documenting hand washing activity) were significantly higher among intervention students than controls; 0.48 vs 0.43 times per hour, p<0.02.

Applicability

While none of the studies are set in the UK, the evidence is directly applicable to people in the UK, as there are no obvious differences in the population, context or setting of the study compared with the UK context.

1. Fournier and Berry 2012 (-)
2. White et al. 2003, 2005 (-)

5.6. Interventions targeting the general public**5.6.1. *Web-based interactive module***

1. An RCT by Yardley et al. 2011 (+) in the UK evaluated whether a web-based intervention could encourage more frequent hand washing in the home and examined potential mediators and moderators of outcomes. The exploratory trial was conducted in Southern England among people aged over 18 years old who had home Internet access and lived with at least one other household member. Data was collected during the 2010 influenza pandemic. While the control group received no intervention (n=179), the intervention group (n=324) received a fully automated intervention comprising four sessions of tailored motivational messages and self-regulation support. The intervention consisted of four weekly web-based sessions, each containing new content in order to encourage repeat visits. Session 1 provided all the essential components of the intervention, including information about the medical team giving the advice (to enhance credibility); the need to prevent

seasonal and pandemic flu; the link between hand washing and virus transmission; expert recommendations for hand washing frequency and technique; and instructions for picking up a free supply of hand gel from the participant's local practice. Participants completed a hand washing plan to promote intention formation with situational cueing. Tailored feedback was provided to help users improve their plan where necessary. The three remaining sessions reinforced positive attitudes and norms and addressed common negative beliefs identified during piloting. Tailored feedback was given based on three items assessing current hand washing frequency, agreement that hand washing would prevent virus transmission, and perceived difficulty of carrying out the behaviour. A questionnaire assessing hand washing frequency (on a scale of 1=zero to two times per day, to 5=more than ten times per day) and theory of planned behaviour cognitions relating to hand washing was conducted at baseline (with only half of the controls), post-intervention (with all participants) and eight weeks later (with all participants). In total, 282 (87.0%) participants in the intervention completed all three questionnaires and 149 (83.2%) completed both the post-intervention and follow-up surveys.

Findings: The authors reported that the rates of hand washing were significantly higher post-intervention in the intervention compared with the control group (mean 4.40 vs 4.04, $p < 0.001$) and remained higher at follow up (mean 4.45 vs 4.12, $p < 0.001$). Furthermore, hand washing intentions and positive attitudes toward hand washing increased more from baseline to four weeks in the intervention group than in the control group. Mediation analyses revealed positive indirect effects of the intervention on change in hand washing via intentions (coefficient 0.15 [95%CI: 0.08 to 0.26]) and attitudes (coefficient 0.16 [95%CI: 0.09 to 0.26]). Multivariate analysis confirmed that the intervention was similarly effective for men and women, those of higher and lower socioeconomic status, and those with higher and lower levels of perceived risk.

Limitations/considerations: Less than 10% of participants who were invited to take part in the study did, and the study population overrepresented affluent, middle-aged women. The authors noted that all participants had been exposed to considerable media and government coverage of the need for hand hygiene during the pandemic and that this may have reduced the effectiveness of the intervention.

Evidence Statement 2.10 Web-based interactive module targeting the general population

There is weak evidence from one RCT¹ (+) (UK; n=517) that a web-based interactive module conducted over four weeks significantly improved self-reported rates of hand washing in adults and that the improvements were sustained eight weeks after the intervention (on a scale of 1[zero to two times per day] to 5 [more than ten times per day]): 4.45 in intervention vs 4.12 in the control ($p < 0.001$). The intervention also increased positive attitudes, and intentions of hand washing, when compared with controls who received no intervention.

Applicability

The evidence is directly applicable to the UK population.

1. Yardley et al. 2011 (+)

5.6.2. *Hygiene campaign: Wir gegen Viren [Us Against Viruses]*

1. A pre–post study by Meilicke et al. 2013 (+) in Germany conducted two cross-sectional telephone surveys, conducted in 2008 and 2009, to determine changes in the hygiene perceptions of the general population over time, and to assess whether these changes were consistent with the messages of a federal campaign promoting hygiene. Federal public institutions in Germany introduced the hygiene campaign titled *Wir gegen Viren [Us Against Viruses]*, which included recommendations around non-pharmaceutical interventions to protect people from seasonal respiratory infections and pandemic influenza. The recommendations included the following: (1) hand washing can reduce the risk of infections; (2) it is recommended to cough into your sleeve; (3) you are not supposed to go to work when you have caught a cold; and (4) there is currently a lack of evidence for the efficacy of hygiene masks during an influenza pandemic. These recommendations were disseminated through a video spot, a poster, a flyer, a website and stickers. The two cross-sectional telephone surveys were conducted with 2006 participants each time. The initial survey was carried out before the influenza A H1N1 pandemic in calendar week 49–51 of 2008, and the second was carried out in week 48 of 2009, directly after the peak of the pandemic in Germany. The questionnaire contained indicators about the perceived efficacy of hand hygiene at reducing spread of infection, preference for coughing into the sleeve, tendency to go to work while showing symptoms of a cold, whether they would be in favour of people wearing a face mask when they have a cold..

Findings: The perceived efficacy of hand hygiene as an infection control method increased from 50.9% in 2008 to 61.5% in 2009 (aOR 1.54 [95%CI: 1.31 to 1.80], $p < 0.001$). Women responded that hand washing was a ‘very good’ method of infection control more frequently than men. Reported preference for coughing into the sleeve increased from 4.8% in 2008 to 38.3% in 2009 (aOR 13.07 [95%CI: 10.00 to 17.08] $p < 0.001$). There was no change in whether people would be in favour of wearing face masks from 2008 to 2009.

Limitations/considerations: The authors do not report how many of the participants surveyed had been exposed to the campaign materials, and they do not present any subanalysis to compare with those who had or hadn’t seen the campaign, so it is not clear if the observed effects are a consequence.

Evidence Statement 2.11 Mass media campaign targeting the general population

There is weak evidence from one pre–post study¹ (+) (Germany; 2008 n=2006, 2009 n=2006), which investigated perceptions of hand hygiene before and after a public campaign titled Wir gegen Viren [Us Against Viruses], that the perceived efficacy of hand hygiene and coughing into the sleeve as an infection control method increased over time among the general public: aOR 1.54 [95%CI: 1.31 to 1.80] and aOR 13.07 [95%CI: 10.00 to 17.08], respectively.

Applicability

While the study was not conducted in the UK, the evidence is directly applicable to people in the UK, as there are no obvious differences in the population, context or setting of the study compared with the UK context.

1. Meilicke et al. 2013 (+)

6. Hygiene and/or food safety

A total of 16 studies focused on hygiene and/or food safety (2 of which are presented above as well as in this section [5 7]):

- 1 intervention was home-based targeting adults [52];
- 4 interventions were school-based targeting children [5 7 53 54];
- 3 interventions were based in universities targeting students [55-57];
- 8 studies were based within the community [58-65]; and

A brief overview of the remaining studies and their results is presented in Table 5. The studies are presented within the table by setting, as outlined above. Some sections are further subdivided by who led the intervention, the target population and/or the type of intervention; within a subsection studies are presented alphabetically. The studies within a subsection feed into one Evidence Statement. A more detailed overview of the interventions, findings and limitations/considerations is presented in text below the table.

Table 5 Summary of studies relating to hygiene and/or food safety that addressed research question 2. For the direction of effect to be classified as effective/improved, p-values had to be less than 0.05.

Reference/ study type/ country/ (quality assessment)	Population and setting	Comparisons		Key outcomes evaluated that are relevant to this review	Direction of effect for intervention
		Intervention	Comparator		
Interventions based in the home targeting adults					
Ghebrehewet and Stevenson 2003 Pre-post UK (+)	People > 16 years of age living in households within the Dingle area of Liverpool	Home-based food storage training by a community- based facilitator (n=904 households)	NA	Knowledge of appropriate food storage; measured as knowledge of correct refrigerator temperature Food safety behaviour; measured by observer-recorded refrigerator temperature; presence of food items past their 'use by' date in fridge; and correct refrigerator storage of raw meat and cooked or prepared foods	Participants significantly improved their knowledge of correct refrigerator temperature <ul style="list-style-type: none"> • Proportion of participants using incorrect refrigerator temperature significantly reduced • Proportion of participants having products past their 'use by' date in fridges significantly reduced • Inappropriate storage of raw meat and cooked or prepared food significantly reduced
Interventions based in schools and/or targeting school aged children					
School-based or school based contact					
Farrell et al. 2011 Pre-post UK (-)	Children aged 9 to 12 years old from three schools and recruited online through school based contacts	e-Bug-developed computer games (n=1736 [in-school n=62, online n=1674])	NA	Knowledge of appropriate food handling; assessed by asking children 3 questions regarding how certain foods should be kept in the fridge	No significant effect

Reference/ study type/ country/ (quality assessment)	Population and setting	Comparisons		Key outcomes evaluated that are relevant to this review	Direction of effect for intervention
		Intervention	Comparator		
Losasso et al. 2014 RCT Italy (+)	Fifth grade students aged 9 to 11 years old, in 12 public schools	Health campaign titled Mission on the Invisible World, consisting of ad hoc multimedia and movies and using a practical approach (no detail on practical approach reported by authors) (n=162)	Health campaign titled Mission on the Invisible World, consisting of ad hoc multimedia and movies and using a theoretical approach (no detail on theoretical approach reported by authors) (n=87)	Knowledge of appropriate food handling; assessed by evaluating knowledge of handling raw meat; cleaning fruit and vegetables; and 'food handling hygiene' as a topic (not specified further)	Improvement in knowledge of handling raw meat, washing fruit and vegetables, and 'food handling' in the practical approach class only
Lynch et al. 2008 Pre-post USA (+)	Children in grades 6 to 8 (ages not specified)	A web-based food safety instructional application. The contents were delivered by an animated character, and included video segments, quiz feedback and interactive games and activities.	NA	Food safety knowledge; combined mean score based on 30 multiple choice questions (details not provided)	All students combined significantly improved their cognitive score from pre to post test. Sub-group analysis: <ul style="list-style-type: none"> Grades 7 and 8 significantly improved scores Grade 6 no difference
Summer enrichment programme					
Comer 2002 Pre-post USA (+)	Youths aged 6 to 16 years old from inner cities in low- income counties	A holistic education programme titled Food Safety for Healthy Missouri Families to teach about food safety and agricultural literacy (n=22)	NA	Knowledge of foodborne illness Knowledge of food safety practices	Improvement in the post-test; significance not reported Improvement from pre- to post-test; significance not reported

Reference/ study type/ country/ (quality assessment)	Population and setting	Comparisons		Key outcomes evaluated that are relevant to this review	Direction of effect for intervention
		Intervention	Comparator		
Interventions based in a university targeting students					
Bramlett Mayer and Harrison 2012 Non-RCT USA (+)	University students from an introductory nutrition course	Five intervention groups: Lecture and/or Facebook fan page for online food safety education (n=627; 173 lecture and Facebook for less than 15 minutes, 101 lecture and Facebook for more than 15 minutes, 75 Lecture only, 190 Facebook for less than 15 minutes, 88 Facebook only for more than 15 minutes)	No intervention (n=83)	Knowledge of food safety; measured as the average score across 35 questions (further description not provided) Attitudes to food safety; measured as average of 4 attitude variables (further description not provided)	<ul style="list-style-type: none"> • Pre vs post: significant increase in scores for all 5 intervention groups but not for control • Significantly greater increase in knowledge scores among students who attended the lecture compared with those who only went on Facebook • Pre vs post: significant increase in scores for all 5 intervention groups but not for control • Control scored significantly lower than intervention groups • Lecture-only group had significantly lower scores than group that received the lecture and went on Facebook for more than 15 minutes
				Food safety behaviour; measured as average score for self-reported compliance with 12 practices	<ul style="list-style-type: none"> • Pre vs post: significant change in scores for all 5 intervention groups and control group • Lecture-only group had significantly lower scores than those groups who accessed Facebook

Reference/ study type/ country/ (quality assessment)	Population and setting	Comparisons		Key outcomes evaluated that are relevant to this review	Direction of effect for intervention
		Intervention	Comparator		
Maurer Abbot et al. 2012 Pre-post USA (+)	University students	Multimedia campaign focusing on four themes: Clean: Don't get caught dirty handed!; Cook: When the temp is right, take a bite! Chill: Are you cool enough? Leftovers: Leftovers help keep you alive, but only if you reheat 'em to 165! (n=1,159)	NA	Knowledge of food safety practices; assessed based on 4 questions related to recommended hand washing procedures, safe cooking temperature, safe refrigerator temperature and safe handling of leftovers Food safety behaviour; assessed by self-reported compliance with 2 activities (hand washing with soap before cooking and after using the toilet)	<ul style="list-style-type: none"> Overall combined scores showed significant improvement in food safety knowledge No significant change for 1 out of the 4 questions (hand washing procedure) Significant increase for both questions
Yarrow et al. 2009 Pre-post USA (+)	University students	Three web-based interactive modules about food safety (n=71)	NA	Food safety attitudes, beliefs and knowledge Food safety behaviour; combined score for self-reported compliance with safe food practices	<ul style="list-style-type: none"> Overall, participants significantly increased their scores on food safety attitudes, beliefs and knowledge Health majors scored significantly higher than non-health majors Overall scores for self-reported food safety practices were significantly improved Health majors scored significantly higher than non-health majors
Interventions based within the community					
Targeting parents					
Dollahite et al. 2014 RCT USA (+)	Low-income parents > 18 years of age	Workshops including such topics as diet quality, food safety and food security (n=85)	Waiting list control (n=83)	Food safety behaviour; self-reported measurement based on construct of 2 items (appropriate defrosting of food and maximum time of having food outside the fridge)	Participants improved their food safety practice (however, there was no separate control group for the follow-up period of the group that received the immediate intervention)

Reference/ study type/ country/ (quality assessment)	Population and setting	Comparisons		Key outcomes evaluated that are relevant to this review	Direction of effect for intervention
		Intervention	Comparator		
James et al. 2013 Cluster non- RCT USA (+)	Any adult aged 19 to 40 years old with children aged 10 years old or younger	Traditional and social media campaigns, consisting of posters, magnets, radio, television, Facebook page, Twitter, YouTube videos, and an iPhone/iPadR application (n=300)	Community control (n=300)	Food safety behaviour; self-reported compliance with throwing away of leftovers within 4 days Intended behaviour for food safety; measured by participants' level of comfort in throwing away all leftovers after 4 days	Significantly more participants who received the intervention reported throwing away leftovers within 4 or fewer days No significant difference between groups in their level of comfort in throwing away leftovers after 4 days
Trepka et al. 2008 RCT USA (+)	Pregnant or female caregivers (usually mothers) who were clients of the Special Supplemental Nutrition Program for Women, Infants, and Children	Interactive multimedia food programme on a computer kiosk (n=195)	Food safety information leaflets, containing the same information that was provided through the computer kiosk (n=199)	Knowledge of food safety; overall score for 6 constructs related to washing of hands and surfaces (6 questions), prevention of cross- contamination (4 questions), cooking thoroughly (2 questions), use of thermometer throughout cooking and in refrigerator (3 questions), refrigerating foods (3 questions) and refrigerating baby foods (2 questions)	<ul style="list-style-type: none"> Overall food safety score increased in both groups; difference between groups only significant when controlling for age Significant difference between groups for only 1 (cooking thoroughly) out of the 6 constructs Pre-post effect (for all participants pooled) significant for 4 out of 6 constructs (not for cross- contamination or refrigerating baby foods)
Targeting adults and children					
Brown and Hermann 2005 Pre-post USA (+)	General population in 28 Oklahoman counties (youths and adults)	Classes on food preparation (n=602)	NA	Food handling behaviours; self- reported compliance with three behaviours (washing hands before preparing or eating fruits or vegetables, washing foods before preparation, using a clean knife and cutting board)	Youth and adults food handling behaviour significantly improved all 3 behaviours

Reference/ study type/ country/ (quality assessment)	Population and setting	Comparisons		Key outcomes evaluated that are relevant to this review	Direction of effect for intervention
		Intervention	Comparator		
Mass media campaign targeting adults					
Dharod et al. 2004 Pre-post USA (+)	Latino population living in inner city of Hartford, Connecticut	Campaign titled Fight BAC! ; a six-month media campaign delivered through radio, television, newspaper, posters, and the distribution of stickers, brochures, plastic bags displaying the Fight BAC! logo, and colouring books. It had four central messages: clean, separate, chill and cook (n=250)	NA	Awareness of cross-contamination and bacteria Food safety behaviour; self-reported compliance with 9 behaviours (washing hands with soap/disinfectant before cooking; washing food preparation area with soap/disinfectant; cleaning cutting board before placing food on it; defrosting meat in refrigerator; using thermometer when cooking hamburgers; not using the same knife to cut meat and vegetables; not using the same plate to place meats before and after cooking; not storing eggs at room temperature; not eating hamburgers when the meat inside is still pink	No change in participants' knowledge for both cross- contamination and bacteria • Improvement for 2 out of the 9 behaviours (hand washing behaviour and technique for defrosting meat)
Redmond et al. 2006 Non-RCT UK (-)	Older women from a community in Cardiff	Leaflets and posters, fridge magnets, a television documentary and a newspaper article (n=24)	No intervention (n= 14)	Food safety behaviour; mean scores for observed compliance with all targeted behaviours (hand washing and hand drying behaviour, use of chopping board and knives, indirect contamination of preparation environment with raw chicken packaging)	Participants in intervention showed improved food safety behaviour immediately after intervention but it decreased again at 4–6 weeks follow-up; significance not reported

Reference/ study type/ country/ (quality assessment)	Population and setting	Comparisons		Key outcomes evaluated that are relevant to this review	Direction of effect for intervention
		Intervention	Comparator		
Computer-based interventions targeting adults					
Kosa et al. 2011 RCT USA (+)	Adults aged 70 to 75 years old with a high school education or less	Printed materials or information on a website; both described older adults' risks for foodborne illness, and recommended safe food consumption and handling practices (n=295)	No intervention (n=151)	Food safety behaviour; self-reported compliance with 10 recommended food safety practices, such as hand washing, appropriate cooking and appropriate chilling Food safety behaviour; intention towards 12 examples of high risk food groups	No difference between intervention and control for any of the 10 questions No difference between intervention and control for any of the 12 food groups
Nydhall et al. 2012 Pre-post Sweden (+)	Adults living in Sweden (general public)	Computer-based education on food safety (n=92)	NA	Knowledge of food safety practices, meaning of cross-contamination and knowing the optimal storage temperature for smoked salmon and raw mincemeat Food safety behaviours; self-reported compliance with refraining from tasting raw mincemeat and checking the fridge temperature regularly	Participants significantly improved their knowledge of cross- contamination and storage temperatures for both smoked salmon and raw mincemeat No significant change in behaviour in tasting raw mincemeat and checking the temperature of the fridge (but baseline levels high)

NOTE: NA – Not Applicable

6.1. Intervention based in the home led by a community facilitator targeting adults living in a 'deprived' community

Home-based food storage training

1. A pre–post study by Ghebrehewet and Stevenson 2003 (+) in the UK aimed to assess how effectively domestic food hygiene awareness and behaviour could be improved in order to reduce food-related ill-health originating from the home. They evaluated the effect of an educational intervention carried out in Dingle, a deprived area of Liverpool. A total of 26 community-based facilitators from the area were actively recruited with the assistance of the local Adult Learning Centre (the Phoenix Centre), completed a one-week course on basic food hygiene, and received the Chartered Institute of Environmental Health (CIEH) certificate. Based on this course, they delivered home-based food hygiene training to 904 households in the area. They first measured participants' prior knowledge and behaviour in relation to a range of important food hygiene issues through a questionnaire and action sheet. Details of the latter were not provided. Within eight weeks of the first visit, the community-based facilitators returned to the participating households and completed a second questionnaire and action sheet, assessing changes in four areas: (1) knowledge of correct refrigerator temperature; (2) recorded refrigerator temperature; (3) refrigerators containing food items past their 'use-by' date; and (4) correct refrigerator storage of raw meat and cooked or prepared foods. The number of households that completed the second questionnaire varied by outcome measured: knowledge of correct fridge operating temperatures (n=903); recorded refrigerator temperatures (n=901); refrigerators containing food items past their 'use-by' date (n=902); correct storage of food (n=888).

Findings: Following the home-based hygiene training, the proportion of respondents who identified the correct operating temperature range for a refrigerator increased significantly, from 31.7 to 78.4% ($p < 0.01$). Data recorded during the first home visit indicated that 37.0% of refrigerators were operating at temperatures over 5°C. Following the home-based hygiene training, and the distribution of refrigerator thermometers, the proportion of refrigerators operating over 5°C was significantly reduced, to 15.8% ($p < 0.05$). Project facilitators recorded purchased food items past their 'use-by' date in refrigerators in 10.1% of households during the first home visits. This was significantly reduced, to 5.2%, in the second home visit ($p < 0.05$). In addition, after the home-based hygiene training, the number of refrigerators in which raw meat and cooked/prepared food were inappropriately stored was significantly reduced, from 16.2 to 7.1% ($p < 0.05$) and 14.7 to 7.2% ($p < 0.05$), respectively.

Limitations/considerations: Selection bias may have occurred as a result of using incentives to recruit participants into the study. No information was provided on the profile of the training facilitators and the way in which they were recruited. Little information was provided on the actual content and form of the educational intervention.

Evidence Statement 3.1 Home-based interventions targeting adults from a 'deprived' community

There is weak evidence from one pre–post study² (+) (UK; n=904) that a home-based food storage education intervention targeting adults living in a deprived community, provided by a community-based facilitator, effectively improved peoples' knowledge of and behaviour around appropriate refrigeration. The proportion of respondents who identified, and had their fridge set at, the correct operating temperature increased from 31.7% to 78.4% ($p<0.01$) and 69.3% to 84.2% ($p=0.03$), respectively; the proportion of refrigerators containing food past its 'use by date' significantly decreased, from 10.1% to 5.2% ($p=0.03$), and the proportion of refrigerators in which raw meat and cooked food were stored incorrectly decreased from 16.2% to 7.1% ($p=0.04$) and 14.7% to 7.2% ($p<0.05$), respectively.

Applicability

The evidence is partially applicable to the wider UK population, as the study population was a deprived community, and therefore may differ from the wider UK population.

1. Ghebrehewet and Stevenson 2003 (+)

6.2. Interventions based in schools and/or targeting school aged children**6.2.1. Primary school and school related contact interventions****Computer game**

1. A pre–post study by Farrell et al. 2011 (-) in the UK (also described above) evaluated an e-Bug-developed 'junior student'–level computer game for 9- to 12-year-old children. The game consisted of a number of levels, each of which taught a set of learning outcomes. In the game, the players choose an avatar, which travels around the inside the human body meeting useful and harmful cartoon microbes in various contexts and scenarios. The learning outcomes were taught through the game's mechanics (the rules of the game) rather than through its story or dialogue. For example, instead of telling the player that soap washes harmful microbes off the skin, the player was instructed to throw globules of soap at microbes to make the harmful microbes disappear. On average, the game took 30–40 minutes to play. The study was conducted in three schools in Glasgow, Gloucester and London. In addition, several schools and school-related contacts were emailed to advertise the online game to children. In total the game was distributed to 1,736 students (62 in schools, 1,674 online). In order to test children's increase in knowledge a game show quiz was incorporated into the game's structure to test children's knowledge related to microbes, hygiene and antibiotics. Overall 652 students completed level 1: Introduction to Microbes, 317 completed level 2: Harmful Microbes, 181 completed level 3: Useful Microbes, 81 completed level 4: Hygiene and 54 completed level 5: Antibiotics.

Findings: As part of their analysis, the authors asked 75 students to respond to three statements relating to food handling: 'Raw meat should go on the top shelf of the fridge'; 'Milk and other liquids should be in the fridge door'; and 'It is safe to put opened tins in the fridge'. No significant

differences in pre and post responses were observed for any of these statements. The results were presented in a complex manner, so they cannot be easily reproduced in this brief summary.

Limitations/considerations: Approximately 50% of the players who started the game dropped out before completing the first level. The authors hypothesised that levels may have been too easy or too difficult; the levels took too long to complete; or the participants were bored with the game.

2. A **pre-post study by Lynch et al. 2008 (-) in the USA** developed and tested the effectiveness of a web-based food safety instructional computer application targeting middle school students (approx. 10 to 13 years of age) on cognitive gain. In total 300 students in grades six to eight (age not specified) were recruited from seven schools in five states. In order to be able to participate, schools had to have access to broadband Internet, computers with headphones/speakers for every student, had to be willing to administer the assessment tools and learning styles inventory, and had to be willing to devote eight to 12 hours of classroom time to the computer application, and would use all parts of the curriculum. The programme was based on four units from the curriculum 'Food, Flies and Fungus': 1) Explore the Microworld, which describes the differences between bacteria, mould, parasites, viruses, and yeast and conditions necessary for their growth; 2) Challenge of the Microorganism, which explains the differences between beneficial, spoilage, and pathogenic microorganisms, the two types of foodborne illness, the factors required for a foodborne illness to occur, and the populations at the greatest risk of illness; 3) Microbes are Everywhere, which addresses the importance of cleaning and sanitising; and 4) A Cookbook of Consumer Food Safety and Preparation, which provides guidelines for preparing risky foods such as eggs, ground beef, and leftovers. Additional topics in the Web-based programme were derived from various 'Farm to Fork' curricula which taught students how a hamburger is made. Animated characters were used to deliver the lessons content, and the applications included video segments, quiz feedback and interactive games and activities. Teachers were given the option of when to start using the programme, how the modules would be integrated into their teaching schedule, and how long they would give the student to complete the unit. Cognitive gain was assessed in a questionnaire consisting of 30 multiple choice questions (although one was dropped from analysis as 94% of students answered it correctly at pre-test). The questionnaire was administered at first log in, and a follow-up questionnaire was conducted once the entire class completed the lessons and activities. In total 217 students (20 sixth graders, 157 seventh graders, 50 eighth graders) from six schools completed the post-intervention questionnaire and were included in the analysis.

Findings: When all students score were analysed together there was a significant increase in mean students' knowledge scores from pre to post test: 52.4% (± 15.51) vs. 63.7% (± 17.70), $p < 0.001$. In sub group analysis, there was a significant difference in scores for seventh and eighth grade students from pre- to post-test but not for students in the sixth grade. The completion of tasks (how far the student progressed through the computer programme's required lesson and activities, to completed a task students had to answer 6 out of 10 questions right) and the total usage of the programme (the sum of the number of times the student completed a lesson, quiz, game, activity, and used the library) were both significantly correlated with learning achievement: $r^2 = 0.065$, $p < 0.001$, and $r^2 = 0.0353$, $p = 0.005$ respectively. The use of the lessons ($r^2 = 0.0314$ $p = 0.009$) and quizzes ($r^2 = 0.0497$, $p = 0.001$)

were also significantly associated with learning achievement but the use of games ($r^2=0.0016$, 0.498) and activities ($r^2=0.0021$, 0.559) were not.

Limitations/considerations: The authors report that the overall improvement for students in seventh and eighth grade was low and potentially this was due to students knowing more than 50% of the material on average before using the programme. Other reasons why improvements might have been lower than anticipated could be due to the fact that the mean number of visits to the site was only eight (range three to 15), and students were observed to only complete the minimum task required, for example students repeated quizzes until they achieved a passing score rather than going back to review material. Teachers observed that one of the early modules was too difficult and quickly discouraged some students.

Multimedia and movies

3. An **RCT by Losasso et al. 2014 (-) in Italy** (also described above) assessed the effect of an educational food safety campaign titled Mission on the invisible world on 249 fifth grade students' (aged 9 to 11 years old) knowledge of bacteria, hand hygiene and food handling, and hand hygiene behaviour. Participating classes were randomised to either a practical (n=162) or a theoretical class (n=87), based on different teaching approaches that covered the same content. These different teaching approaches were not described in detail. Teaching material used for both classes consisted of *ad hoc* multimedia and movies. A questionnaire was implemented pre- and post-intervention and completed by both participating children and their parents. The questionnaire consisted of two sections; one on knowledge and the other on behaviour. The knowledge section consisted of nine topics each composed of seven questions, while the hand hygiene behaviour section comprised eight questions.

Findings: Three topic areas that were analysed in this study assessed the children's knowledge of food handling and the risk of foodborne illness. The authors reported a significant improvement in knowledge of 'food handling' (as a general topic) for children in the practical class (pre vs post: IRR 1.1 [95%CI: 1.0 to 1.3] $p<0.001$), as well as of handling raw meat (pre vs post: IRR 1.1 [95%CI: 1.0 to 1.2] $p=0.03$) and handling and fruit and vegetables (pre vs post: IRR 0.9 [95%CI: 0.8 to 1.0] $p=0.03$), but this finding was not observed in the theoretical class (p-values were not reported).

Limitations/considerations: The sample size for this outcome was small, and the study may be underpowered.

Evidence Statement 3.2 Primary school-based interventions targeting school children or interventions targeting school-aged children

There is inconsistent evidence from two pre–post studies (-)¹ (-)² and one RCT (-)³ that school-based educational interventions have an impact on children’s knowledge of appropriate food handling.

One pre–post study¹ (-) (UK; n=1736 [school n=62, online=1674]) found that an e-Bug computer game for 9- to 12-year-old children did not improve children’s knowledge of appropriate food handling, as assessed by means of three questions.

One pre–post study² (-) (USA; n=300) found that a web-based food safety programme targeting middle school students (approx.10 to 13 years of age) had a significant impact on mean knowledge food safety score for students in grade seven (52.2% (\pm 15.19) vs. 65.2% (\pm 16.44), $p<0.001$) and eight (49.8% (\pm 16.83) vs. 60.1% (\pm 20.35), $p<0.001$) but not among students in grade six 56.0% (\pm 15.62) vs. 56.0% (\pm 20.12) $p=ns$). How far the student progressed through the programme’s required lesson and the total usage of the programme were both significantly correlated with learning achievement: $r^2=0.065$, $p<0.00$, and $r^2=0.0353$, $p=0.005$ respectively.

One RCT² (-) (Italy; n=249) found that an educational programme involving multimedia and movies taught in either a practical or a theoretical class, targeting students aged 9 to 11 years old, significantly improved knowledge of appropriate ‘food handling’ among children attending a practical class (IRR 1.1 [95%CI: 1.0 to 1.3], $p<0.001$) but not among children attending a theory-based learning class (IRR 1.0 [95%CI: 0.9 to 1.1]).

Applicability:

One study was conducted in the UK, and the other was conducted in Italy. In the latter study, there are no obvious differences in the population, context or setting of the study compared with the UK.

1. Farrell et al. 2011 (-)
2. Lynch et al. 2008 (-)
3. Losasso et al. 2014 (-)

6.2.2. *Summer enrichment programme*

1. A pre–post pilot study by Comer 2002 (-) in the USA investigated changes in the level of understanding of and general knowledge about food safety among youths aged 6 to 16 years old from low-income families participating in a four-week summer enrichment programme. The intervention was a holistic education programme, titled Food Safety for Healthy Missouri Families, which was developed to both teach food safety information and foster agricultural literacy in young consumers. Students were surveyed on the first day of the programme and after four weeks, when the programme ended. It is not reported if all students participated in both surveys. The surveys were presented as trivia questions in a game show format and were answered in small groups of students. The individuals’ answers were recorded by observation, and the session was video-taped. Questions were categorised into five categories: kitchen safety, harmful bacteria, common myths, agricultural

perceptions and shopping practices. The questions were developed around knowledge and perceptions about agriculture, food safety practices at home, and knowledge and perceptions about foodborne illnesses. In total, 22 students were included in the study.

Findings: Post-test results showed an increase in knowledge for all questions related to: (1) food safety practices in the home. For example, correct responses to the statement ‘It is important to wash your hands before handling food’ increased by 76% among 13- to 16-year-olds and by 91% among 6- to 12-year-olds (p-values were not reported) and knowledge and perceptions about food-borne illnesses, for example that harmful bacteria are found in raw poultry and unpasteurised milk, increased by 77% among 13- to 16-year-olds and by 9% among 6- to 12-year-olds.

Limitations/considerations: The study size was very small. Moreover, analysis was limited, there is no effect size measured, and it is not mentioned whether the observed changes were significant. In addition, it is not clear if the methods of data collection had an impact on the results. Children completed the survey in groups, and an individual’s answers were recorded by observing the conversation/decision-making process among the children. It is therefore not clear if or how the answers would have differed if children had been surveyed individually.

Evidence Statement 3.3 Summer enrichment programme targeting school children

There is weak evidence from one pilot pre–post study¹ (-) (USA; n=22) that an education programme provided to youth aged 6 to 16 years old from low-income families may have effectively improved knowledge of food-borne illness and food safety across all survey questions asked. For example, knowledge of the importance of washing hands before handling food increased by 76% among 13- to 16-year-olds and by 91% among 6- to 12-year-olds (p-values were not reported), and knowledge that harmful bacteria are found in raw poultry and unpasteurised milk increased by 77% among 13- to 16-year-olds, but by only 9% among 6- to 12-year-olds.

Applicability

While the study was not conducted in the UK, the evidence is likely to be partially applicable to the UK population as the study population may differ from the wider UK population.

1. Comer (2002) (-)

6.3. Interventions based in a university targeting students

Lectures and/or Facebook fan page for online food safety education intervention

1. A **non-RCT by Bramlett Mayer and Harrison 2012 (+) in the USA** reported on a social media–based intervention for college students and its effectiveness for improving students’ food safety knowledge, attitudes and practices. The intervention targeted University of Georgia students attending an introductory nutrition course and consisted of multiple components: a traditional food safety lecture, a Facebook fan page for the online food safety education intervention with a food safety game, a video focused on outdoor cooking and food safety information related to tailgate parties at sporting events, a Food Network–style video recipe demonstration focusing on food safety in food

preparation and safe handling of leftovers, a video addressing common food safety questions posed by students, four polls developed on food safety topics, and five food safety updates. Several treatment groups were composed, depending on which intervention components were used for each group. Overall, 627 students were allocated various combinations (173 lecture and Facebook for less than 15 minutes, 101 lecture and Facebook for more than 15 minutes, 75 lecture only, 190 Facebook for less than 15 minutes only, 88 Facebook for more than 15 minutes) of the intervention components, and 83 students received no intervention. A questionnaire was conducted in the two week before the intervention a post-intervention questionnaire was open for the two weeks immediately following the intervention. It included 35 questions related to knowledge, 4 attitude variables and 12 food safety practices.

Findings: The change in knowledge score from pre- to post-intervention was significant for all five interventions groups ($p < 0.05$ for all) but not the control ($p = 0.06$). The change in knowledge score was significantly greater for students who attended the lecture compared with students who just went on Facebook (p -values were not reported). Women's knowledge scores improved significantly more than men's. The change in attitude score from pre- to post-intervention significantly increased for all five intervention groups ($p < 0.05$ for all) but not the control ($p = 0.29$); the control's attitude scores were significantly lower than all groups except the lecture only group (p -values were not reported); while the lecture only group's scores were significantly lower than the lecture and Facebook for more than 15 minutes group (p -values were not reported). For food safety practices there was a significant increase in positive scores from pre- to post-intervention for all six groups ($p < 0.05$ for all). The lecture only group's scores were significantly lower than the four Facebook groups' scores.

Limitations/considerations: The population may not be representative because it only included students attending a nutrition course. Baseline scores were high (all over 70%) potentially leaving little room for improvement. Additionally, observed improvements in knowledge scores among those who took the lecture could reflect the fact that the module was part of the students' course, so they had a motivation to study. The method of allocation to intervention and control is not clearly reported.

Multimedia campaign: refrigerator magnets, posters, table tents, cartoon videos, radio skits, newspaper advertisements

2. A **pre-post study by Maurer Abbot et al. 2012 (-) in the USA** evaluated a university campus-based food safety information campaign designed to target young adults. Students attending five geographically dispersed universities in the USA were eligible for inclusion. The campaign took place over a four-week period. Each week the campaign focused on one of the following four food safety themes: (1) CLEAN: Don't get caught dirty handed! (encouraged young adults to always use soap and water, rub hands together for 20 seconds, and rinse and dry hands before eating and drinking); (2) COOK: When the temp is right, take a bite! (encouraged using food thermometers to check the doneness of mincemeat and poultry); (3) CHILL: Are you cool enough? (promoted keeping refrigerators between 32 and 40°F); (4) LEFTOVERS: Leftovers help keep you alive, but only if you reheat 'em to 165! (encouraged safe handling of leftovers). The campaign materials included colourful and informative refrigerator magnets, posters, table tents, brief cartoon videos and recorded radio skits

and scripts with attention-getting sound effects (e.g., toilet flushing), and advertisements for student newspapers. Each week a campus-based event coordinated with that week's food safety theme was held, which included interactive exercises and games to reinforce messages. A questionnaire undertaken at pre- and post-intervention included four sections: food safety knowledge (4 questions), stage of change for safe food handling (1 question), food safety efficacy (4 questions), self-reported behaviour indicators (2 questions). Of a total of 1,159 students who completed the pre-test, 607 (52.37%) completed the post-test.

Findings: Overall, three of the four measures of food safety knowledge significantly increased between pre- and post- test (on a scale of 0 to 8): the overall mean food safety score increased from 3.29 (SD 1.61) to 4.17(SD 1.84) ($p<0.001$). The exception was those related to a hand washing procedure. There was an accompanying change in self-reported behaviour changes for outcomes from pre- to post-test for washing hands with soap before cooking ($p\leq 0.001$) and for washing hands with soap after toilet use ($p\leq 0.001$).

Limitations/considerations: The authors identified a number of confounding factors, but they did not undertake multivariate analysis. This media campaign appears to have been successfully disseminated: 90% of students recalled having seen or heard about the campaign and 65% reported they had encountered material related to all of the key campaign messages.

Web-based interactive module

3. A pre–post study by Yarrow et al. 2009 (-) in the USA explored food safety attitudes, beliefs, knowledge and self-reported practices among college students in health and non-health majors. Students took three education modules delivered via an interactive web lesson, which covered a food safety overview, information on common food safety beliefs, knowledge and food handling practices, and older adults' risk for foodborne illness. Students completed a pre-test before each education module, a post-test immediately after each module and a post-post-test five weeks later (nine tests in total). Of the 71 students enrolled, 59 (83.1%) completed all three education modules; 21 of them were non-health majors and 38 were health majors.

Findings: For all students, overall scores for food safety attitudes improved from pre- to post-test, from 114.5 to 122.2 out of a possible 147 points ($p\leq 0.001$). In subgroup analysis an improvement in attitudes was only observed among health majors, 120.3 vs 130.8 ($p<0.001$), not among non-health majors, 104.0 vs 106.6 ($p=ns$). Overall there was an improvement in food beliefs, from 85.8 to 97.6 out of a possible 199 points ($p\leq 0.001$). The change from pre- to post-intervention was significant among both the health majors, 87.9 vs 100.8 ($p<0.001$), and the non-health majors, 82.1 vs 92.0 ($p=0.018$), although the difference was significantly greater among the health majors ($p=0.003$). Self-reported safe food practices were also significantly improved after the intervention, from 19.0 to 21.0 out of a possible 27 points ($p=0.001$). Health majors improved practices significantly more than non-health majors ($p<0.001$).

Limitations/considerations: There were underlying differences between the health majors and non-health majors that were not controlled for in the analysis, which may explain why the health majors outperformed the non-health majors. For example, 58% of health majors had a food safety certificate,

compared with 29% of non-health majors. Health majors also spent considerably longer going through the educational module and referred back to the educational materials more frequently than non-health majors during the post-intervention survey. Finally, the health majors were likely to be more motivated to engage with the module, as it was more important to their future profession.

Evidence Statement 3.4 University-based interventions targeting students

There is weak evidence from one non-RCT (+)¹ and two pre–post studies (-)^{2,3} that food safety campaigns targeting students at university significantly improved food safety knowledge, attitudes and practice.

One non-RCT study¹ (+) (USA; n=710) found that a multicomponent university campaign involving food safety lectures and/or a Facebook fan page for online food safety education significantly increased knowledge scores from pre- to post-intervention for students in the intervention ($p<0.05$) but not the control ($p=0.06$). The change in knowledge was significantly greater among students who took the lecture compared with students who only looked at Facebook (p -values were not reported). The change in attitude was significantly greater in all intervention groups compared with the control (p -values were not reported). Change in food safety practices was significant from pre- to post-intervention for all groups, including the control ($p<0.05$); the group who just received the lecture had significantly lower scores than the groups who accessed the Facebook fan page (p -values were not reported).

One pre–post study² (-) (USA; n=1,159) found that a food safety campaign effectively improved most food safety knowledge measures of students (with the exception of hand washing procedure): overall mean scores (on a scale of 1 to 8) significantly increased, from 3.29 (1.61) to 4.17 (1.84) ($p<0.001$) and the campaign significantly improved students' use of soap before cooking ($p<0.001$) and after using the toilet ($p<0.001$).

One pre–post study³ (-) (USA; n=71) found that an interactive computer module had a significantly positive impact on students' food safety attitude scores, which increased from 114.5 to 122.2 out of a possible 147 points ($p\leq 0.001$). Beliefs scores increased from 85.8 to 97.6 out of a possible 119 points ($p\leq 0.001$) and self-reported food safety practices increased from 19.0 to 21.0 out of a possible 27 points ($p=0.001$). In subgroup analysis, health majors outperformed non-health majors across all three measures ($p<0.05$).

Applicability

While none of the studies were conducted in the UK, the evidence is directly applicable to people in the UK. There are no obvious differences in the population, context or setting of the study compared to the UK context.

1. Bramlett Mayer and Harrison 2012 (+)
2. Maurer Abbot et al. 2012 (-)
3. Yarrow et al. 2009 (-)

6.4. Interventions based within the community

6.4.1. Targeting parents

Workshops for parents

1. An RCT by **Dollahite et al. 2014 (-) in the USA** assessed the effectiveness of the Expanded Food and Nutrition Education Program (EFNEP) on nutrition behaviours (including food safety) among low-income parents in New York City. Parents were randomly assigned to receive the educational intervention immediately (n=85) or to a waiting list to receive the intervention immediately following the intervention group (n=83). The intervention consisted of eight weekly workshops, based on the 'Eating Right Is Basic-Enhanced' curriculum. The topics covered included diet quality, food safety and food security. The intervention was facilitated by six educators. For those in the immediate education group, data was collected at three time points: enrolment (T1), immediately after completion of the first cycle of the course (T2), and eight weeks later after completion of the second cycle of the course (T3). Data was collected from the delayed education group at T2, before they started the programme, and at T3, after they had completed the programme. A total of 134 (79.8%) participants (74 immediate education and 60 delayed education) completed the assessment at all three time points and were included in the analysis. A ten-item self-reported behaviour checklist on nutrition, food resource management, food safety, and food security was used to measure the frequency of behaviours. The food safety construct covered two items on the self-reported behaviour checklist and asked about appropriate defrosting of food and maximum time of having food outside the fridge.

Findings: The study presented pre–post comparisons within each group only. For items related to food safety practice only, both groups showed an improvement following the intervention; in the immediate education group mean scores (range from 1 to 50) increased from 34.9 at T1 to 42.8 at T2 (p-values were not reported), the change was reported to have been maintained at T3 43.9 (p-values were not reported), and in the delayed education group it increased from 35.4 at T2 to 42.8 at T3. The group that received the immediate education reported stable food safety practices from T2 to T3 (p-values were not reported). Between-group results were, however, not clear.

Limitations/considerations: There was no 'true' control because the authors did not conduct any analysis of observed differences between the two groups from time points T1 to T2, before the delayed education group commenced the programme. Furthermore, the findings may not be generalisable since the programme varies across the country in delivering strategies and curricula chosen.

Traditional and social media campaigns: posters, magnets, radio, television, Facebook page, Twitter, YouTube videos, iPhone/iPadR application

2. A **cluster non-RCT by James et al. 2013 (-) in the USA** evaluated both a traditional and a social media food safety social marketing campaign in the USA, titled 4 Day Throw Away, on awareness, knowledge, attitudes and intended behaviours for food safety practices of leftovers of parents with children under 10 years of age. The traditional campaign included displaying posters with pull-off

pads in locations the target audience frequented, such as grocery stores, day care centres, children's museums and libraries. In addition, magnets were distributed at local grocery stores and handed out at scheduled health and nutrition fairs. Public service announcements were developed and distributed to local radio and television programs. It also included appearance by the campaign mascot, #4. The mascot visited local grocery stores and fairs to hand out food safety materials and educate individuals on the '4 Day Throw Away' message. The magnet and poster with tear-off notecards directed the recipient to the website, so that individuals could learn information about safe handling of leftovers. The social media campaign consisted of a Facebook page with regular postings of 'leftover tips', which were also sent out via Twitter. In addition, six short informational videos with mascot #4 were created and posted on YouTube and on the website. In the videos, the mascot was portrayed as the 'super hero' who saved consumers from situations or scenarios that presented a food safety risk. Finally, an iPhone/iPad application was developed to inform families with young children about safe food handling of leftovers and other foods and about the risk of foodborne illness. The controls were selected from communities not participating in the campaign. A survey was conducted with 600 adults (300 intervention and 300 control) four months after the marketing campaign. Individuals were intercepted as they walked in the door of grocery stores and asked if they had children living with them under the age of 10. If they responded 'yes,' they were asked to orally respond to the survey questions.

Findings: The authors found that 50% of the respondents from pilot-test communities reported throwing away leftovers four days or less after preparation, compared with 38% from the control communities ($p=0.009$). Respondents were also asked to rank their level of comfort with throwing away all leftovers after four days, using a 5-point Likert scale; there was no significant difference between the pilot-test communities (95%) and the control communities (94%). For the website visitors ($n=400$), when asked how long leftovers stay in the refrigerator before being used, the most frequent response chosen was three to four days. Over 53% of respondents reported throwing out leftovers they brought home from a restaurant before four days. When asked how they determined if leftovers were safe to eat, 55% of respondents answered they did so by labelling leftovers and using them within four days.

Limitations/considerations: No details about the participant characteristics in the test and control groups were reported.

Interactive media or leaflets for parents

3. An RCT by Trepka et al. 2008 (-) in the USA aimed to determine if an interactive multimedia intervention was more effective than information leaflets for delivering food safety education to clients of the Special Supplemental Nutrition Program for Women, Infants, and Children. In total, 394 pregnant or female caregivers (usually mothers) were included in the study. The intervention group ($n=195$) completed an interactive multimedia intervention involving a food programme on a computer kiosk. Key messages provided were constructs of 'clean', 'separate' (not cross-contaminate), 'cook' and 'chill'. In addition, messages about foods to avoid during pregnancy and safe handling of bottles and baby food were included. The control group ($n=199$) received the same messages in a leaflet. Both the intervention and the control group were asked to complete a pre-intervention

questionnaire and a post-questionnaire at least two months after study enrolment. In total, 255 participants (119 in intervention and 136 in leaflet group) completed the post-intervention questionnaire. The self-administered questionnaires aimed to capture six constructs of food safety behaviour, including regular washing of hands and surfaces (6 questions), avoiding cross-contamination (4 questions), cooking food thoroughly (2 questions), using a thermometer while cooking and in the refrigerator (4 questions), refrigerating food (3 questions) and refrigerating baby food (2 questions). Questions about safe handling of baby bottles and baby food were also part of some of these constructs.

Findings: At two months follow up, the overall food safety score significantly increased for women in both groups (on a scale of 1 to 5); among the interactive multimedia group it increased from 3.8 to 4.1, while among the leaflet group it increased from 3.8 to 3.9. There was a statistically significant greater increase among those in the interactive multimedia group than among those in the leaflet group only when controlled for age ($p=0.005$), although the effect size was small ($\eta^2=0.03$). For the specific constructs of food safety, the changes from pre- to post-intervention were only greater in the interactive multimedia group compared with the leaflet group for the construct related to cooking food thoroughly ($p=0.02$). Overall, the largest improvement for both groups was observed for thermometer use, which increased from 2.0 to 2.6 among the interactive multimedia group and from 2.0 to 2.4 among the leaflet group. The change from pre- to post-intervention for all participants combined was highly significant ($p<0.001$). There was a small, but trivial, increase in scores for washing hands and surfaces, from 4.7 to 4.8 in the interactive multimedia group and from 4.6 to 4.7 in the leaflet group. The change from pre- to post-intervention for all participants combined was significant ($p=0.02$).

Limitations/considerations: Although the results of this study are limited in terms of determining the effectiveness of multimedia vs leaflet (there were few significant differences between the groups, except when some analyses were conducted by age), the study does show that the multimedia intervention was well accepted as a learning tool.

Evidence Statement 3.5 Community-based interventions targeting parents

There is weak evidence from two RCTs (-)^{1,3} and one cluster non-RCT (-)² that workshops or a multimedia intervention targeting parents result in modest improvements in food safety behaviour.

One RCT¹ (-) (USA; n=168) found that a workshop including topics on food safety (in addition to other topics) improved self-reported food safety behaviour among low-income parents. It is not clear how effective this intervention was compared with the control group, who received the intervention at a later time point to those in the intervention group, because results are presented pre–post intervention within each group: for those who received immediate education the mean score (on a scale of 1 to 50) increased from 34.9 to 42.8 (p-values were not reported), while for those who received the education later it increased from 35.4 to 42.8 (p-values were not reported).

One cluster non-RCT² (-) (USA; n=600 analysed at end) found that a mass media campaign involving traditional mass media (such as posters and radio advertisements) and newer social media methods, including YouTube videos and an iPhone/iPad application, had a significant impact on food safety behaviour (e.g. appropriately throwing away leftovers) among those in the intervention communities compared with those in the control; 50% vs 38% (p=0.009).

One RCT³ (-) (USA n=394) found that a multimedia intervention (computer kiosk) or information leaflets given to pregnant women and mothers improved the overall food safety score for women in both groups (on a scale of 1 to 5). The interactive multimedia group increased from 3.8 to 4.1; the leaflet group increased from 3.8 to 3.9. The difference in change between groups was only significant when controlling for age, though the size of the effect was small (p=0.03).

Applicability:

While none of the studies were conducted in the UK, the evidence is directly applicable to people in the UK. There are no obvious differences in the population, context or setting of the study compared with the UK context.

1. Dollahite et al. 2014 (-)
2. James et al. 2013 (-)
3. Trepka et al. 2008 (-)

6.4.2. Targeting adults and children

Food preparation classes led by an educator for youths and adults

1. A **pre–post study by Brown and Herman 2005 (-) in the USA** evaluated the impact of food preparation classes on fruit and vegetable intake and on food safety behaviours in youths and adults living in 28 counties in Oklahoma. The programme included classes, given by educators, on a variety of fruit and vegetable preparation methods. Overall, 602 people participated in the study (229 youths and 373 adults). Pre- and post-education questionnaires were used. No details on the content of the questionnaires were reported.

Findings: There were significant improvements in safe food handling behaviours: 38% of youths and 11% of adults (p<0.001 for both) increased their behaviour of ‘washing hands before preparing or

eating fruits or vegetables’, 29% of youth and 8% of adults ($p < 0.001$ for both) increased their behaviour of ‘washing fresh fruits and vegetables before preparation’, and 36% of youths ($p < 0.001$) and 7% of adults ($p = 0.013$) increased their behaviour of ‘using a clean knife and cutting board to prepare fruits or vegetables’ to avoid cross-contamination.

Limitations/considerations: The study does not report details on the content of the questionnaires and does not explicitly report how many participants completed both questionnaires. While this study showed effectiveness, very little information was provided about the study group characteristics. It is therefore not clear whom the results may apply to.

Evidence Statement 3.6 Classes for youths and adults

There is weak evidence from one pre–post study¹ (-) (USA; $n = 602$ [youths=229 youths, adults=373]) that food preparation classes provided to youths and adults are effective in improving all of the safe food handling behaviours tested. The proportion reporting that they washed their hands before preparing food increased by 38% for youths and 11% for adults ($p < 0.001$ for both); likewise, the proportion reporting that they washed fresh fruits and vegetables before preparation increased by 29% for youths and 8% for adults ($p < 0.001$ for both) and the proportion using a clean knife and cutting board to prepare fruits or vegetables to avoid cross-contamination increased by 36% for youths ($p < 0.001$) and 7% of adults ($p = 0.013$).

Applicability

While the study was not conducted in the UK, the evidence is directly applicable to people in the UK. There are no obvious differences in the population, context or setting of the study.

1. Brown and Herman 2005 (-)

6.4.3. *Mass media campaign targeting adults*

Fight BAC!, disseminated through radio, television, newspapers, posters, and logo placement

1. A pre–post study by Dharod et al. 2004 (+) in the USA assessed the coverage and consumer satisfaction with the Fight BAC! campaign and evaluated the influence of the campaign on food safety knowledge, attitudes, and behaviours among a predominantly Latino population living in an inner city in the USA. The campaign had four central messages: clean, separate, chill and cook. The campaign was delivered in English and Spanish through multiple culturally appropriate media sources; radio, television, newspaper and posters; and the distribution of stickers, brochures, plastic bags displaying the Fight BAC! logo, and colouring books. A survey was conducted among 250 participants before and two months after the campaign. The survey included sections on food safety knowledge (3 questions), food safety behaviour (5 questions related to good practice and 4 related to bad practice), and level of awareness of the campaign.

Findings: For questions related to food safety knowledge, there were no between-survey differences for any of the three questions: ‘knowledge of term cross-contamination’, ‘knowledge of bacteria’, and ‘knowledge of cutting vegetables on an unclean surface previously used to cut raw chicken’ (pre vs

post, 28% vs 33% ($p=0.22$), 87% vs 86% ($p=0.60$) and 73% vs 80% ($p=0.34$), respectively). Overall, however, for individuals exposed to the campaign compared with those not exposed there was a significant increase in food safety knowledge (aOR 3.54 [95%CI: 1.74 to 7.18]). For behaviour change, there was a statistically significant increase for only two out of the nine practices; proper hand washing increased from 94% to 99% ($p=0.04$), and meat defrosting technique increased from 7% to 14% ($p=0.01$). For three outcomes (meat defrosting technique, use of a thermometer, and using the same knife to prepare meat and vegetables) the number of participants reporting that they correctly carried out these practices remained low after the intervention.

Limitations/considerations: This study targeted a Latino community in the USA, and as such may not be generalisable to the general public in the UK. The baseline good/bad practices were high/low for a number of outcomes, which means that potentially there was therefore not much room for improvement.

Mass media, including leaflets, posters, a newspaper article and a television documentary

2. A **non-RCT trial by Redmond et al. 2006 (-) in the UK** aimed to improve specific food safety behaviours during food preparation. The intervention was implemented in a single community in Cardiff targeting older women from lower socio-economic groups. Materials strategically placed in the test community included leaflets and posters, fridge magnets, a relevant television documentary and a newspaper article about the desired behavioural determinants. Recruited participants were required to prepare a chicken salad in a model kitchen, in which food safety behaviours were observed. They did so three times: before the intervention was implemented, immediately after implementation, and 4–6 weeks after implementation. In total, 117 meal observations were undertaken, involving 24 participants who had received the intervention and 14 control participants. No loss to follow up was reported. Observations recorded were: (1) adequate hand washing and hand drying immediately after touching raw chicken; (2) use of separate or adequately washed and dried chopping boards and knives between preparation of raw chicken and ready-to-eat foods, or preparation of foods before handling raw chicken; (3) prevention of contamination of preparation environment with raw chicken packaging. After the final meal preparation, participants in the intervention group were asked to recall any food safety-based promotional materials they had seen in the past 2–3 months.

Findings: Overall, the mean score for food safety malpractice among controls ranged from 9,501 to 9,845 (scoring scale not reported) over the course of the study. For the intervention, the mean score decreased from 12,373 to 7,322 immediately after the intervention, but increased to 9,835 after a period of 4–6 weeks (p -values were not reported). In the intervention group, the immediate intervention effect upon all targeted behaviours (hand washing and hand drying and use of chopping board for preparation of raw chicken and ready-to-eat foods) was ‘moderate’ (effect sizes ranging from 0.40–0.47). For the remaining practices (potential contamination of the preparation environment with raw chicken packaging and use of knives for preparation of raw chicken and ready-to-eat foods), the immediate intervention effect was considered to be ‘low’ (effect sizes ranging from 0.18–0.23). For all behaviours the effect size decreased after 4–6 weeks (p -values were not reported).

Limitations/considerations: Given the small sample size of this study, the results are somewhat limited. Furthermore, the authors do not report any significance of effect, either between intervention and control or before and after implementation of intervention. The presence or absence of demographic differences between the intervention and control groups are not mentioned. Baseline risk scores in the control group were slightly lower than post-intervention scores at 4–6 weeks in the intervention group, suggesting that potentially there were systematic differences between the two groups; analysis did not control for any differences.

Evidence Statement 3.7 Mass media campaigns targeting adults

There is weak evidence from one pre–post study (+)¹ and one non-RCT (-)² that mass media campaigns may lead to minor short-term improvements in food safety knowledge and some short-term changes in food safety behaviour.

One pre–post study¹ (+) (USA; n=250) found that the mass media Fight BAC! Campaign, targeting the Latino community, was effective at improving food safety knowledge among participants who had seen the campaign compared with those who had not seen the campaign (aOR 3.54 [95%CI: 1.74 to 7.18]). However, the campaign only had a significant effect on two of nine food safety behaviour practices: proper hand washing increased from 94% to 99% (p=0.04) and proper meat defrosting technique increased from 7% to 14% (p=0.01).

One non-RCT² (-) (UK; n=38) found that a UK-based mass media intervention designed to improve safety behaviour during food preparation had some immediate effectiveness on observed food safety behaviour that was not sustained 4 to 6 weeks later. Overall the mean score for food safety malpractice score among controls ranged from 9,501 to 9,845 (scoring scale not reported) over the course of the study. For the intervention group, the mean score decreased from 12,373 to 7,322 immediately after intervention, but increased to 9,835 after a period of 4 to 6 weeks (p-values were not reported). In the intervention group, the immediate intervention effect upon all targeted behaviours was either ‘low’ or ‘moderate’ (effect sizes ranging from 0.18–0.47) (p-values were not reported).

Applicability

The evidence is only partially applicable to the wider UK population, as the studies populations may differ from the wider population of the UK, although for the US study the interventions could be conducted in the UK context and the results are likely to be relevant to other ethnic minority groups.

1. Dharod et al. 2004 (+)
2. Redmond et al. 2006 (-)

6.4.1. Computer based interventions targeting adults

Web-based and print materials for older adults

1. An RCT by Kosa et al. 2011 (+) in the USA evaluated the effectiveness of using web-based and print materials for improving food safety practices among 446 older adults (aged 70 to 75 years old) living in the USA. The print materials and website described older adults’ risks for foodborne illness and recommended safe food consumption and handling practices, under the following section titles:

(1) Let's Start With the Basics, (2) Better Safe Than Sorry, (3) Store It Right, (4) The Right Tools for the Job, (5) Clean It! Make It Safe!, (6) A Little Elbow Grease, and (7) What Is Hot and What Is Not. A short quiz (and answers) was included at the end of each section. A visual mascot named C-Les (short for Campylobacter, Listeria, E. coli, Staphylococcus and Salmonella) appeared throughout the materials to emphasise important behaviour recommendations. The intervention groups (printed materials: n=131; website: n=164) and the control group (who did not receive the intervention) (n=151) completed web-based surveys pre-intervention and approximately two months post-intervention. In total, 446 participants completed the pre-survey and 374 (250 participants from the intervention group (printed materials: n=113; website: n=137) and 124 from the control group) completed the post-survey. Only respondents who reported reading the educational materials were included in the analysis, namely, 93 participants reported reading the printed material and 55 reported using the website. Given small numbers, the intervention group was combined in the analysis. The questionnaire assessed changes in adherence to recommended food safety practices, including hand washing (1 question), appropriate cooking (5 questions), and appropriate chilling (4 questions), as well as intention to eat risky foods (12 food groups listed).

Findings: The authors found no significant differences between the intervention and control groups for any of the questions on adherence to food safety practices. For example, 'wash hands after handling raw meat poultry or seafood' increased among the intervention group from 69.9% to 72.2%, and in the control group from 66.1% to 68.8% (p=0.80); 'store leftovers containing raw meat, poultry, seafood or eggs for no more than 5 days' increased from 89.8% to 92.2% and control decreased from 96.9% to 93.8% (p=0.21); 'refrigerate leftovers within 2 hours' increased in intervention from 94.0% to 95.5% and in control from 85.9% to 89.9% (p=0.83). Likewise, there was no significant change in respondents' intention to eat any of the risky foods. For example consumption of blue, feta, camembert, brie or queso fresco cheese decreased in intervention from 25.7% to 19.6% and in control from 28.2% to 23.4% (p=0.87).

Limitations/considerations: Baseline scores for a number of relevant outcomes were high for adherence to food safety practices and low for consumption of risky food groups, which may have resulted in ceiling effects limiting the ability to detect change. The fact that the control also improved over time is potentially indicative of contamination or temporal effects.

Computer-based education for adults

2. A pre-post study by Nydhal et al. 2012 (-) in Sweden analysed the effect of computer-based education on food safety knowledge and behaviour. Adults living or working in a selected city district were invited to participate by letter, sent to households via children attending compulsory school in the selected area or posted on billboards throughout the city district. Out of approximately 600 households approached, 92 (15.3%) agreed to participate and attended a computer-based session at a local school. Information presented on a computer included cooking and food management at home, the benefits of personal hygiene, how to avoid cross-contamination, storage of food in proper temperatures, data about bacteria in minced meat and the risks of sampling raw minced meat. The other presentation was on 'five [servings of fruits and vegetables] a day'. This intervention was followed by a small-group discussion. Questionnaires were undertaken before intervention (including

questions on knowledge of the themes and behavioural questions about health), immediately after (including only questions about knowledge) and three weeks later (including questions on knowledge and behaviour). The number of questionnaires completed at baseline varied between 89 and 91; the number completed immediately after the intervention, between 87 and 91; and the number completed at the three-week follow up, between 72 to 76, with all samples depending on type of outcome assessed.

Findings: The results of this study point to a significant improvement in knowledge of food safety practices but did not result in significant self-reported behaviour change. Understanding of the concept of cross-contamination and the correct storage temperature for smoked salmon and raw mincemeat increased directly after the intervention, 52% vs 87% ($p \leq 0.001$), 22% vs 67% ($p \leq 0.001$) and 23% vs 67% ($p \leq 0.001$), respectively. The improvement in knowledge was maintained at three-week follow up for cross-contamination and salmon storage temperature, but non-significantly decreased for raw mincemeat storage, to 54%. The proportion of participants who reported refraining from tasting raw mincemeat non-significantly increased, from 80% before to 88% three weeks after, while the proportion checking the fridge temperature non-significantly decreased, from 51% to 41%, over the same time period.

Limitations/considerations: There were high rates of compliance with appropriate behaviours at baseline for refraining from tasting raw mincemeat. The outcomes measured in this study to evaluate 'knowledge and food safety' are somewhat narrow in scope. In the recruitment process, participants were recruited from the general population, and their initial knowledge or their intention for behaviour change was not measured at the recruitment stage. The impact of the small discussion groups was not analysed. Additionally, the analysis did not control for education or age, despite the authors acknowledging that these two factors are meant to have a great significance on how people comprehend risk factors relating to food.

Evidence Statement 3.8 Computer-based interventions targeting adults

There is weak evidence from one RCT (+)¹ and one pre–post study (-)², that education delivered via a computer, with or without printed materials, may improve food safety knowledge but not food safety behaviours.

One RCT¹ (+) (USA; n=446) found that neither web-based nor printed materials significantly improved adherence to any of the 10 food safety practices tested ($p>0.05$ for all) or intention to consume any of the 12 risky food groups ($p>0.05$ for all) among older adults (aged 70 to 75 years old). However, many appropriate practices, such as storing leftovers for no more than five days and refrigerating leftovers within two hours, were already high at baseline (89.8% and 94.0%, respectively).

One pre–post study² (-) (Sweden; n=92) found that a computer-based education programme significantly increased knowledge of food safety in adults immediately following the intervention related to cross-contamination (52% vs 87% ($p\leq 0.001$)) and knowledge of the correct storage temperature for smoked salmon and raw mincemeat (22% vs 67% ($p\leq 0.001$) and 23% vs 67% ($p\leq 0.001$), respectively). However, there was no significant improvement in food safety behaviours; the proportion of participants refraining from tasting raw mincemeat non-significantly increased, from 80% before to 88% ($p=ns$) three weeks after, while the proportion checking the fridge temperature non-significantly decreased, from 51% to 41% (p -values were not reported).

Applicability

The evidence is directly applicable to people in the UK. There are no obvious differences in the population, context or setting of the study compared with the UK context.

3. Kosa et al. 2011 (+)
4. Nydahl et al. 2012 (-)

7. Discussion

This systematic review aimed to present an overview of the current literature (published since 2001) that evaluates educational interventions to: (1) ensure appropriate demand for, and correct use of, antimicrobials and to (2) prevent infection and reduce the spread of antimicrobial resistance. A total of 60 studies, presented in 61 publications, met our defined inclusion/exclusion criteria (see section 2.1, Table 1). Randomised controlled trials, non-randomised controlled trials and pre–post/before and after studies were identified that addressed the following two research questions:

1. Which educational interventions are effective and cost-effective in changing the public's behaviour to ensure they only ask for antimicrobials when appropriate and use them correctly?
2. Which educational interventions are effective and cost-effective in changing the public's behaviour to prevent infection and reduce the spread of antimicrobial resistance?

Research Question 1: Appropriate antimicrobial demand and use

A total of 29 papers addressed the first research question. The educational interventions took place in a range of settings, including community pharmacies, general practices (or other primary care settings), an A&E department, schools, day care centres, a holiday resort, a museum³, and in the home. Additionally, some educational campaigns targeted specific communities and some targeted the general public.

The most frequently evaluated studies involved (1) interventions based in general practices, (2) interventions in schools, (3) interventions involving mass media campaigns. Many of the interventions in healthcare settings evaluated similar types of educational leaflets (e.g. 'Your Child and Antibiotics'), either alone or in conjunction with other interventions, such as videos or verbal education from a health professional. Given the setting, the participants targeted in many of these studies were patients or parents of paediatric patients.

Regarding the school-based interventions, many studies evaluated an educational intervention based on e-Bug – a Europe-wide antibiotic and hygiene teaching resource for junior and senior school children. One of the studies, however, uniquely evaluated an e-Bug interactive science show in a holiday resort.

The mass media interventions involved education dissemination through various channels, including advertisements in newspapers, and magazines, posters, or leaflets. Many of these studies also included a

³ We acknowledge that this particular educational intervention was evaluating a health education website, rather than the implementation of this intervention within a museum setting.

component that involved health professionals – largely as facilitators to promote the educational intervention.

The majority of the included studies were conducted in the USA or in the UK. While the USA has a different healthcare system than the UK, the vast majority of educational interventions evaluated for this question were believed to be applicable to the UK because there were no obvious differences in terms of the context, setting and/or population targeted.

The findings of the included studies – and the strength of the evidence – have been summarised in the Evidence Statements. Here, we identify broad themes from this literature.

- Educational interventions were more likely to lead to improvements in knowledge of appropriate use of antimicrobials rather than improvements in knowledge of antimicrobial resistance. This could be due to any number of reasons. One possible reason is that some of the studies were poorly conducted and therefore the results may not be reliable. Another reason could be that the participants had high baseline knowledge of AMR, so that there may have been little room for improvement. If we assume the studies were well conducted and that the participants did not have high baseline knowledge of AMR, this would seem to suggest that improved methods for communicating *antimicrobial resistance* need to be considered.
- The educational interventions appear to show a ‘patchy’ improved knowledge regarding when it is appropriate to use antimicrobials. For example, when participants were asked to state when antibiotics were appropriate for various symptoms or conditions, improvements in knowledge about appropriate use of antibiotics were observed for some, but not all, symptoms or conditions. This finding was observed in a number of the studies. It is not clear if some of the interventions presented all the information required to elicit the sought-after changes in knowledge.
- Based on the studies included in this review, it appears that direct contact types of educational interventions (e.g. interventions given by GPs, teachers, researchers, etc. face-to-face to patients, students, etc.) are consistently more effective than mass media-type interventions, but because there are no head-to-head studies that compare the two types of intervention, it is not known if this is a real difference. What is more clear, however, is that a number of mass media-type of intervention studies often report that a low percentage of the participants surveyed reported being aware of the campaign, and that this likely impedes the efficacy of these types of interventions.
- Some of the interventions had low completion rates (i.e. the participant did not finish the intervention), including those that used computer modules or games to facilitate learning. Reasons for this are unknown, but the issue of completion rates may need further consideration in terms of interpreting the data (i.e. a low completion rate could overestimate or underestimate the direction of effect depending on the participants’ reasons for not completing the intervention). This issue also indicates that further consideration is needed regarding how to improve uptake of this mode of educational delivery.
- A number of the studies used interventions based on e-Bug, but the results were mixed, suggesting that the mode of delivery (via computer, teacher or public ‘science show’) may be as important as the information itself. As stated above, however, it appears that many of the

interventions, including those based on e-Bug, are not effectively improving knowledge of AMR in students, so that it is possible that this element of e-Bug needs further consideration regarding content and/or delivery.

Research Question 2: Changing the public's behaviour to prevent infection and reduce the spread of antimicrobial resistance

We found that the studies that addressed this research question could be subdivided into two themes, namely, those that focused on infection and hand hygiene and those that focused on infection and food hygiene. A total of 22 studies, in 23 papers, focused on infection and hand hygiene, 5 of which also addressed the first research question. A total of 16 papers focused on food hygiene/food safety, 2 of which presented data relevant to the first research question and data on infection and hand hygiene.

The educational interventions that evaluated hand hygiene took place in a range of settings, including healthcare centres, the home, schools (including preschools, primary schools and secondary schools), universities, and the general community. Those that evaluated food hygiene took place in schools, universities and the general community.

The most frequently evaluated hand hygiene interventions were those based in general practice or in schools, with the majority in schools evaluating educational interventions based on e-Bug. In contrast, the majority of food hygiene interventions were based within the community and targeted high-risk groups including inner city youth, low-income parents, pregnant women or female caregivers, elderly adults who'd obtained the equivalent of a high school education or lower, older women, and Latino communities. Many of these studies focused on improving people's knowledge and behaviour regarding chilling, cooking and washing of food.

The majority of the included studies were conducted in the USA, followed by the UK. Most of the studies conducted outside of the UK, were considered applicable to the UK, as there were no obvious differences in terms of the context, setting and/or population targeted.

The findings of the included studies – and the strength of the evidence – have been summarised in the evidence statements. Here, we identify broad themes emerging from this group of studies:

- There seems to be somewhat inconsistent evidence concerning whether educational interventions improve knowledge of appropriate hand hygiene or lead to improvements in hand hygiene behaviour. These studies are however prone to self-reporting bias as people are less likely to accurately report poor hand hygiene behaviours than good hand hygiene behaviours. It should also be noted that in the majority of the studies hand hygiene knowledge or behaviour was often high at baseline.
- The evidence for food handling interventions was more consistent, with several authors reporting significant improvements in knowledge of food safety practices and behaviour.

7.1. Limitations of the studies/evidence base

There are several limitations of the studies included in this review. Very few were methodologically well reported, or without potential biases that could significantly affect their results. This is reflected in the

quality ratings for studies, with the vast majority rated as weak (-); only 12 were rated as moderate quality (+), and none as strong quality (++). In some studies, the baseline levels of knowledge were high, which may have left little room for improvement. In other studies, significant changes were reported, but the overall level of knowledge remained low, so that an 'effective' result may not be 'clinically significant' (i.e. it may not demonstrate a meaningful difference). Some of the authors only reported significant outcomes, and without the full picture of what was improved, or not improved, it was difficult to make an overall assessment of whether or not an intervention was effective. In addition, some of the studies only reported an overall 'knowledge' score for a particular topic, and it was unclear if these were meaningful or valid measures. Moreover, it was often the case that individual measures were found not to be significant, but when an overall score was used, the results became significant – a finding which further made interpretation of 'overall' scores difficult. It was also the case that some authors used different measures to evaluate an outcome. For example, questions evaluating hand hygiene behaviour ranged from 'you need to wash your hands after playing in the garden' to 'you need to wash your hands after coughing', so that an overall score 'knowledge of hand hygiene' may actually be a quite different compilation of behaviour measures, and may not be comparable between the studies.

The applicability of some of the food safety papers to address the second question in this review is uncertain. While food safety interventions may be effective, it is not clear whether or not this knowledge of food safety practices is associated with a clear understanding of the foodborne risk of illness. While improving knowledge and behaviour will lead to less illness, and hence less treatment with antibiotics, a direct relationship between the outcomes assessed in many of the papers (e.g. knowledge of storage temperatures for smoked salmon and raw mincemeat, or how to defrost meat) and antimicrobial resistance is tenuous.

The majority of the studies included in this review were pre–post studies. The results from these types of studies require a certain degree of caution. A number of the RCTs also reported within group pre–post data, and some reported significant results for these analyses. Given a comparison group, however, the results frequently became non-significant. As there regularly appeared to be an improvement over time in both intervention and control groups, we do not have a clear idea of whether the educational interventions evaluated with a pre–post study designs were effective or not, and a more rigorous method may be required to gain more reliable insight into effectiveness for these interventions. On the other hand, most of the controlled studies provided questionnaires about antimicrobials at baseline, and these questionnaires alone may have initiated knowledge or interest in antimicrobials, which may have resulted in an improvement in knowledge in both interventions and controls, and hence decrease the chances of significant differences between groups.

In addition, almost all of the studies relied on self-reporting, which is prone to bias as participants may not actually report their true attitudes or behaviours. Moreover, many of the studies evaluated outcomes immediately after the intervention, so that longer-term knowledge gain or behaviour change is unknown.

Other limitations of the included studies were that the data were often presented in complex ways, were often very difficult to interpret, and were not necessarily clearly reported. As such, this lack of clarity may be reflected in this report. There are, however, a few limitations of this systematic review which are worth

noting, including that the search was limited to English language papers, and also limited to published papers, so that some potentially relevant studies may have been missed.

7.2. Gaps in the evidence

- The largest gap in the evidence is the lack of cost-effectiveness papers. This reflects a lack of evidence rather than an indication that interventions are not cost-effective.
- Regarding effectiveness studies, there are very few studies that target people of different social and economic circumstances.
- The studies evaluating knowledge of antimicrobials and AMR were largely conducted within school age children and working age adults, with studies on older adults lacking.
- There are few studies on educating people on respiratory etiquette (e.g. using a tissue to cover the mouth when coughing or sneezing).
- We did not include studies that evaluated educational interventions on prescription rates. It appears, however, that more studies are needed (and perhaps a separate systematic review is required) that evaluate educational interventions on knowledge of antibiotics and awareness of AMR, *in association with* prescribing rates. This would perhaps facilitate an exploration of interactions between knowledge and behaviour.

7.3. Conclusion

In conclusion, accepting the limitations noted herein, this systematic review identified a number of potentially effective educational strategies to improve people's knowledge of antimicrobials and AMR, and/or to improve hand or food hygiene.

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Appendix A. Methods

A.1. PICOS inclusion/exclusion criteria

Population

For both research questions addressed, studies of people of all ages (including children and young people) and people living in all settings (at home, in the community and in hospital), were eligible for inclusion. Where possible, we aimed to focus on people who regularly take a lot of antibiotics, such as young children and older people, and people who misuse antibiotics (i.e. those who do not take the correct dose for the correct amount of time and via the correct route; those who keep antimicrobials to use at a later date; those who self-medicate, that is, who take antimicrobials without prescription or advice from a healthcare professional; those who share antimicrobials with others; and those who use counterfeit medications). We also aimed to consider groups identified by McNulty et al. (2007a) (and others) who have demonstrated less knowledge about antibiotics, including males; those with fewer educational qualifications; and those who may be more likely to misuse antibiotics (e.g. counter-intuitively, highly educated young women [see McNulty et al. 2007b]).

Where possible, we also aimed to focus on people whose social and economic circumstances or health put them at greater risk of acquiring or transmitting infectious disease and antimicrobial strains. This includes (but is not limited to) people who:

- Are immunosuppressed (for example, due to cancer treatment or an organ transplant)
- Have a chronic disease
- Live in crowded conditions⁴
- Are homeless
- Have been in prison
- Have migrated from countries with a high prevalence of infectious diseases, such as tuberculosis (e.g. South Asia and sub-Saharan Africa).

Studies of populations living in low-income countries were excluded.

⁴ Overcrowding has been defined as either having too many people sleeping in one room, or the amount of space in the house is too small for the number of people living in it (defined by Shelter: http://england.shelter.org.uk/get_advice/repairs_and_bad_conditions/common_problems/overcrowding)

Studies conducted in locations other than the EU-15 (the member countries in the European Union prior to the accession of ten candidate countries on 1 May 2004), Australia, New Zealand, and North America (USA, Canada) were excluded.

Interventions and comparisons

This systematic review focused on educational interventions – those that aim to change knowledge, awareness and behaviours regarding how, why and when to take antimicrobials, and those that aim to prevent the spread of infection and antimicrobial resistance.

To address question 1 above (*Which educational interventions are effective and cost-effective in changing the public's behaviour to ensure they only ask for antimicrobials when appropriate and use them correctly?*), studies that evaluated educational interventions that reduce the misuse of antimicrobials were eligible for inclusion. This included educating the general public about:

- When, why and how to use antimicrobials;
- The dangers of overuse and misuse (including self-medication, sharing medicines, not completing or missing doses, buying antimicrobials on the Internet, or using counterfeit antimicrobials); and
- Suitable alternatives to antimicrobials (e.g. using over-the-counter medicines for the symptoms of a cold).

To address question 2 above (*Which educational interventions are effective and cost-effective in changing the public's behaviour to prevent infection and reduce the spread of antimicrobial resistance?*), studies that evaluated educational interventions on how to reduce the spread of infections and antimicrobial resistance, at home and in the community, were eligible for inclusion. This included (but is not limited to) educating the general public about:

- Hand washing to prevent infection;
- Using a tissue to cover the mouth when coughing and sneezing; and
- Food hygiene to prevent and reduce transmission of infection.

For both questions, we included interventions that educate the general public about the type of healthcare they should ask for to prevent or treat infectious diseases. This may include education that informs patients that:

- Antibiotics should not be used for a cold or flu (e.g. for question 1) and
- Vaccines or other protection, such as anti-malarial medication, should be used when travelling abroad (e.g. for question 2).

For both questions, interventions that are delivered at the population, community, organisational or individual level in any setting and by any mode of delivery were included (e.g. via the Internet, apps, face-to-face). Examples include:

- Individual level: prescribers and dispensers telling patients how important it is to use antimicrobials properly and informing them about the dangers of over- and misuse (e.g. for question 1) and
- Population and community level: media campaigns on appropriate antibiotic use (e.g. for question 1) or media campaigns on infection prevention (hand washing, food hygiene) (e.g. for question 2).

Studies were excluded if they evaluated any of the following: national and international policy on AMR; surveillance to track antimicrobial use and resistance in bacteria; development of new drugs, treatments and diagnostics; education of prescribers about the diagnosis of infectious diseases and clinical decisions concerning whether to prescribe an antimicrobial; education of healthcare professional about hygiene practices to prevent the spread of infectious diseases; environmental cleanliness and cleaning products; promotion of safe sex; antimicrobial use in animals; antibiotic stewardship⁵ (i.e. studies that evaluate management or care of antibiotics – including prescribers or management at a higher level [hospital or government levels]); the use of herbal alternatives for antibiotics; or multicomponent interventions where education was not the main component.

Included studies had to comprise a comparison group (e.g. baseline comparison, different educational strategies, or different modes of delivery).

Outcomes

For question 1, studies eligible for inclusion must have evaluated one of the following outcomes:

- Knowledge and awareness of when, why and/or how antimicrobials should be used;
- Knowledge and awareness of antimicrobial resistance;
- Knowledge of the type of support people can expect from health professionals in relation to the use of antimicrobials;
- The ability and confidence of prescribers and dispensers to talk to people about the use and misuse of antimicrobials;
- Demand for antimicrobials (particularly antibiotics);
- Adherence to prescribed antimicrobials; and
- Inappropriate antimicrobial use.

We excluded studies that only reported prescribing rates, as prescribing rates may not always represent a proxy of demand. In the original protocol we sought to include studies that evaluated ‘inappropriate antimicrobial prescribing by healthcare professionals’, but we subsequently found that what was considered to constitute prescribing that was ‘inappropriate’ was not apparent or explicitly identified in the literature.

For question 2, studies eligible for inclusion must have evaluated one of the following outcomes:

- People’s knowledge and awareness of how they can prevent infection and/or reduce the spread of antimicrobial-resistant microbes;
- Hand washing behaviour;
- Behaviour to reduce the spread of airborne diseases, such as TB and flu (for example, use and appropriate disposal of tissues when coughing and sneezing); and
- Food hygiene practices.

Studies that addressed the above inclusion criteria and also reported any cost data were also included in the review.

⁵ This is the topic of another NICE systematic review, and thus has not been included here.

Study designs

Initially, we planned to include all types of studies, with the exception of letters, editorials and commentaries. However, given the large amount of potentially relevant studies, we excluded (in consultation with NICE) qualitative studies, one-group studies with post-intervention data only, studies published as abstracts or conference presentations, and unpublished dissertations. Studies eligible for inclusion included randomised controlled trials, non-randomised controlled trials, and pre–post (before and after) studies.

We also sought to include published economic evaluations, such as cost-effectiveness analyses, cost–utility analyses, cost–benefit analyses, cost-minimisation analyses, and cost-consequence analyses.

Studies not published in English were excluded from the review.

A.2. Search Strategy

Textbox 3. Search terms

NOTE: Ovid MEDLINE(R) 1948 to Present (including In-Process & Other Non-Indexed Citations)
Searched 17 November 2014

1	exp Drug Resistance, Bacterial/ or exp Drug Resistance, Multiple/	76170
2	anti-infective agents/ad, tu or anti-bacterial agents/ad, tu or antibiotics, antitubercular/ad, tu or antitubercular agents/ad, tu or antifungal agents/ad, tu or anti-infective agents, local/ad, tu or antiparasitic agents/ad, tu or anthelmintics/ad, tu or antiprotozoal agents/ad, tu or antiviral agents/ad, tu or anti-retroviral agents/ad, tu	241302
3	(antibiotic\$ or anti-biot\$ or 'anti biot\$' or antimicrob\$ or 'anti microb\$' or antibacter\$ or anti-bacter\$ or 'anti bacter\$' or antiviral\$ or anti-viral\$ or 'anti viral\$' or antiparasitic\$ or antiparasitic\$ or 'anti parasitic\$' or antifungal\$ or anti-fungal\$ or 'anti fungal\$').ti,ab.	431902
4	Hand disinfection/ or Hand sanitizer/ or Hand hygiene/	4853
5	(skin care/ or Anti infective agents, local/) and (hand or hands or handwash\$).tw.	872
6	((hand or hands or handwash\$) adj3 (wash\$ or disinfect\$ or sanitiz\$ or sanitis\$ or scrub\$ or clean\$ or soap\$ or hygiene\$)).tw.	6100
7	((tissue\$ or kleenex\$ or handkerchief\$ or hanky or hankie or hankies or hygiene or etiquette) adj3 (cough\$ or sneez\$)).tw.	56
8	Communicable Disease Control/ and (cough/ or sneezing/)	19
9	Communicable Disease Control/ and ((travel\$ or holiday\$ or tourist\$ or tourism or vacation\$ or journey\$ or trip or trips or flight\$) adj3 (oversea\$ or foreign\$ or international or abroad)).ti,ab.	162

10	exp Foodborne Diseases/pc or Food safety/ or Food contamination/ or exp Food handling/st, 37128 ae or Gastroenteritis/pc	
11	((food\$ adj2 (disease\$ or poison\$ or contamin\$) adj2 (prevent\$ or reduc\$ or decrease\$ or 7297 discourag\$)) or ((food\$ or cook\$) adj (safe\$ or handl\$ or hygiene\$))).tw.	
12	exp *travel/ or travel medicine/	12703
13	or/1-12	672853
14	health education/ or health promotion/ or Patient Education as Topic/ or exp Programmed 432567 Instruction as Topic/ or Health Communication/ or Consumer Health Information/ or attitude to health/ or Patient Acceptance of Health Care/ or Patient Satisfaction/ or 'Health Knowledge, Attitudes, Practice'/ or medication adherence/ or patient compliance/ or risk reduction behavior/	
15	Public Health/ed	3994
16	Education/ or Models, Educational/ or Education, Distance/ or Education, Nonprofessional/ or 163391 Education, Continuing/ or Faculty/ or Universities/ or Patient Education Handout/ or Curriculum/ or Teaching materials/ or Teaching/ or health literacy/	
17	Pamphlets/ or exp Audiovisual aids/ or communications media/ or exp marketing/ or 175110 Advertising as Topic/ or Persuasive Communication/ or Social Networking/ or internet/	
18	Libraries/ or Library materials/ or Library Services/ or Information services/ or Information 45868 Dissemination/ or access to information/ or Information Literacy/ or Information Seeking Behavior/ or Decision Support Techniques/	
19	behavior therapy/ or self efficacy/	37600
20	physician-patient relations/ or professional-family relations/ or professional-patient relations/ or 96949 Inappropriate Prescribing/ae, pc	
21	((outreach or written or printed or oral or campaign\$ or resource\$ or disseminat\$) adj1 5842 information).ti,ab.	
22	(marketing or advertis\$ or publicis\$ or publiciz\$ or publicity or mass media or media 37626 campaign\$ or communication\$ media).ti,ab.	
23	(internet\$ or social media or social network\$ or facebook or twitter or blog\$ or SMS or short 51146 messaging service\$ or smartphone\$ or mobile app or mobile apps or mobile application\$ or tweet or text messag\$ or texting or emailing or podcast\$ or ((mobile or cell\$ or smart) adj (phone\$ or telephone\$))).ti,ab.	

24	computer-assisted instruction/	9720
25	((shared or informed) adj3 (decision\$ or choice\$)).ti,ab.	10452
26	or/14-25	899567
27	13 and 26	14490
28	((counsel\$ or educat\$ or informat\$ or communicat\$ or pamphlet\$ or handout\$ or hand-out\$ or hand out\$ or booklet\$ or leaflet\$ or advice\$ or advis\$ or literacy or literature or video\$ or audio\$ or web\$ or website\$ or poster or posters or publication\$ or curriculum\$ or curricula\$ or teach\$ or trainer\$ or training or program\$ or intervention\$ or resource\$ or meeting\$1 or session\$1 or workshop\$1 or visit\$1 or material\$1 or initiative\$1 or outreach) adj3 (antibiotic\$ or anti-biot\$ or 'anti biot\$' or antimicrob\$ or 'anti microb\$' or antibacter\$ or anti-bacter\$ or 'anti bacter\$' or antiviral\$ or anti-viral\$ or 'anti viral\$' or antiparasitic\$ or anti-parasitic\$ or 'anti parasitic\$' or antifungal\$ or anti-fungal\$ or 'anti fungal\$' or 'antimalarial\$' or 'anti-malarial\$' or 'anti malarial\$')) and (misuse\$ or overuse\$ or 'self medicat\$' or 'self-medicat\$' or adhere\$ or 'missed dose' or counterfeit or prescri\$ or resist\$ or tolera\$ or compliance)).tw.	2940
29	((behavior\$ or behaviour\$) adj3 (change or changing or modification\$ or modify or modifying or modifies or modified or therapy or therapies) adj3 (antibiotic\$ or anti-biot\$ or 'anti biot\$' or antimicrob\$ or 'anti microb\$' or antibacter\$ or anti-bacter\$ or 'anti bacter\$' or antiviral\$ or anti-viral\$ or 'anti viral\$' or antiparasitic\$ or anti-parasitic\$ or 'anti parasitic\$' or antifungal\$ or anti-fungal\$ or 'anti fungal\$' or 'antimalarial\$' or 'anti-malarial\$' or 'anti malarial\$')) and (misuse\$ or overuse\$ or 'self medicat\$' or 'self-medicat\$' or adhere\$ or 'missed dose' or counterfeit or prescri\$ or resist\$ or tolera\$ or compliance)).tw.	12
30	((travel\$ or holiday\$ or tourist\$ or tourism or vacation\$ or journeys or trip or trips or flight\$) adj3 (oversea\$ or foreign\$ or international or abroad or vaccin\$)).ti,ab.	4100
31	(counsel\$ or educat\$ or pamphlet\$ or handout\$ or hand-out\$ or hand out\$ or booklet\$ or leaflet\$ or advice\$ or advis\$ or video\$ or audio\$ or web\$ or website\$ or poster or posters or curriculum\$ or curricula\$ or teach\$ or trainer\$ or training or resource\$ or meeting\$1 or session\$1 or workshop\$1 or initiative\$1 or outreach).tw.	136196
32	30 and 31	975
33	27 or 28 or 29 or 32	17846
34	limit 33 to yr='2001 -Current'	13601
35	limit 34 to english language	12529

36	animals/ not humans/	399817
		4
37	35 not 36	12255
38	(comment or letter or editorial).pt.	140832
		5
39	37 not 38	11650

Appendix B. Quality Assessment of Included Studies

Key to questions:

Population

- 1.1 Is the source population or source area well described? (RAND Europe note: The 'population' could be at the community level or could have been more specific, such as parents of children in a day care centre. The authors had to describe the population in enough detail that it would be possible to replicate the study.)
- 1.2 Is the eligible population or area representative of the source population or area? (RAND Europe note: To answer this question, we considered the method of recruitment reported by the study authors: Is it likely to have missed important demographic groups? Were all eligible participants enrolled? Did study authors choose a sub selection of 1.1 for inclusion?)
- 1.3 Do the selected participants or areas represent the eligible population or area? (RAND Europe note: This was difficult to assess in many of the pre-post papers reviewed because the selected participants were the same as the source population [e.g. if the authors included parents of children attending a day care centre in a particular region of the USA]. In this example, the source population was narrow [i.e. parents of children in a day care centre], and as such, the selected participants are the same as the source population. For RCTs, this criterion was judged as adequate if clear inclusion/exclusion criteria were reported in the study and if there were no other sources of bias. For example, a source of bias would be if there was a difference between samples who agreed to participate and those who did not agree to participate.)

Method of Allocation

- 2.1 Was selection bias minimised? (RAND Europe note: For RCTs, we considered this adequate if the method of randomisation was reported in detail and the authors used an appropriate methodology, such as random numbers tables.)
- 2.2 Were interventions (and comparisons) well described and appropriate? (RAND Europe note: For most of the studies, we considered that the interventions and comparisons were appropriate, so that we focused on whether or not they were well described.)
- 2.3 Was the allocation concealed?
- 2.4 Were participants and/or investigators blind to exposure and comparison?
- 2.5 Was the exposure to the intervention and comparison adequate? (RAND Europe note: We considered that educational interventions that were person-delivered (e.g. by a teacher or a GP) would be adequate because it is likely that the participant received, and understood, the intervention; we rated these '++'. In contrast, educational interventions delivered through posters or mass media do not guarantee exposure. Those studies that reported high levels of exposure were rated as '+', whereas those that did not provide an estimate of exposure were 'NR', and those that reported a low degree of exposure were rated as '-'.)
- 2.6 Was contamination acceptably low?
- 2.7 Were other interventions similar in both groups?
- 2.8 Were all participants accounted for at study conclusion? (RAND Europe note: We considered a loss to follow up greater than 20% as '-'.)
- 2.9 Did the setting reflect usual UK practice? (RAND Europe note: Most of the types of interventions evaluated in this review – e.g. leaflets, posters, teaching, given in a community or primary care setting – were considered to be applicable to the UK.)
- 2.10 Did the intervention or control comparison reflect usual UK practice?

Outcomes:

- 3.1 Were outcome measures reliable? (RAND Europe note: As this review focuses on behaviour and attitude, etc., most of the measures were self-reported. Measures that used a validated questionnaire and/or were observed were rated as '++'; those that used a self-reported questionnaire were rated as '+', unless any obvious source of bias was detected.)
- 3.2 Were all outcome measurements complete?
- 3.3 Were all important outcomes assessed? (RAND Europe note: As no harms were applicable/evaluated in this review, we did not consider this criterion to be relevant to our overall assessment of study quality.)
- 3.4 Were outcomes relevant? (RAND Europe note: As we did not include studies that evaluated surrogate outcome measures, we did not consider this criterion to be relevant to our overall assessment of study quality.)
- 3.5 Were there similar follow-up times in exposure and comparison groups?
- 3.6 Was follow-up time meaningful? (RAND Europe note: Most studies had a short-term follow up; studies that reported outcomes immediately following intervention were rated as '-'; those with longer-term follow up were rated at '++' (≤6 weeks) or '+++' (>6

weeks.)

Analyses

- 4.1 Were exposure and comparison groups similar at baseline? If not, were these adjusted?
- 4.2 Was Intention to Treat (ITT) analysis conducted?
- 4.3 Was the study sufficiently powered to detect an intervention effect (if one exists)? (RAND Europe note: if the authors reported power calculation using 0.8 and met that calculation, the study was rated as ‘++’; if no power calculation was presented but the sample size was relatively large (>200 individuals), the study was rated as ‘+’; if no power calculated was reported and if the sample size was small, the study was rated as ‘-’.)
- 4.4 Were the estimates of effect size given or calculable?
- 4.5 Were the analytical methods appropriate (RAND Europe note: For this criterion, we also assessed whether or not important confounders were controlled for in the analysis or if the authors provided reasons for not controlling for confounders.)
- 4.6 Was the precision of intervention effects given or calculable? Were they meaningful?

Summary

- 5.1 Are the study results internally valid? (i.e. unbiased) (RAND Europe note: For RCTs, we chose five key criteria to make an overall assessment (indicated by the shaded cells in the table below). In order for a RCT to get a ‘+++’ rating, the trial must have reported adequate (i.e. a rating of ‘+++’) 1) randomisation and 2) allocation concealment, 3) used intention-to-treat (ITT) analysis, 4) have controlled for confounding factors in the analysis, and 5) had an adequate sample size. If most of these criteria were given a ‘+’ rating, the study was given an overall rating of ‘+’; if one or more of these criteria were not met (i.e. given a ‘-’ rating), the study was given a ‘-’.
- In order for non-randomised (controlled studies) or before-and-after studies to get a ‘+++’ rating, all criteria had to be adequately addressed (i.e. all of the individual criteria had to have been scored as ‘+++’); for a ‘+’ rating, the majority criteria ratings had to be ‘+’ or ‘+++’ (with no ‘-’ for criteria in sections 3 and 4); a study was given a ‘-’ if one or more criteria in sections 3 and 4 were rated as ‘-’, or if too many criteria were ‘NR’. We felt that all the criteria in sections 3 and 4 were key criteria.
- 5.2 Are the study results generalisable to the source population? (i.e. externally valid) (RAND Europe note: To evaluate external validity, we made a judgement regarding whether or not the findings of the study were generalizable beyond the confines of the study itself to the source population.)

Table 6 Quality Assessment of Included Studies

Reference	Design	Population										Method of allocation to intervention/comparison										Outcomes						Analyses						Summary	
		1.1	1.2	1.3	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	2.10	3.1	3.2	3.3	3.4	3.5	3.6	4.1	4.2	4.3	4.4	4.5	4.6	5.1	5.2							
Alden et al. 2010	Non-RCT	(++)	NA	(++)	NA	(++)	NA	NA	NA	NA	NR	NA	(++)	(++)	(++)	NA	NA	NA	NR	(++)	NA	(-)	(-)	(-)	NA	(-)	(-)	(-)							
Alder et al. 2005	RCT	(++)	(++)	(++)	NR	(++)	NR	(++)	(++)	NR	(++)	(++)	(++)	(++)	(++)	NR	(++)	NA	(++)	(-)	(++)	(-)	(++)	(++)	(++)	(-)	(-)	(++)							
Baker et al. 2012	Pre-post	(++)	NA	(++)	NA	(++)	NA	NA	NA	NA	(-)	(++)	(++)	(+)	(++)	NA	NA	(+)	NA	(-)	NA	NR	NR	(-)	NA	(-)	(-)	(-)							
Bauchner et al. 2001	RCT	(++)	(+)	(++)	NR	(++)	NR	(+)	(++)	NR	(++)	(++)	(++)	(++)	(++)	NR	NA	(+)	(++)	(-)	(++)	(++)	(++)	(++)	(+)	(+)	(+)	(++)							
Bramlett Mayer and Harrison 2012	Non-RCT	(++)	(+)	(++)	NR	(++)	NR	(++)	(++)	NR	(++)	(++)	(++)	(++)	(++)	NR	NA	(++)	(++)	(+)	(++)	(+)	(++)	(+)	(++)	(+)	(+)	(+)							
Brown and Herman 2005	Pre-post	NR	NR	NR	NA	(++)	NA	NA	NA	NA	(++)	(++)	(++)	(++)	(++)	NA	NA	NA	NR	NR	NA	(+)	(-)	(-)	(++)	(-)	(-)	(+)							
Comer 2002	Pre-post	(-)	NA	(-)	NA	(-)	NA	NA	NA	NA	(++)	(++)	(++)	(++)	(+)	NA	NA	NA	NA	(-)	NA	(-)	(-)	(-)	(-)	(-)	(-)	(-)							
Groff et al. 2007	RCT	(++)	(++)	(+)	(-)	(++)	NR	(+)	(++)	(-)	(-)	(++)	(++)	(++)	(+)	NA	NA	NA	(++)	(-)	(++)	(++)	(++)	(++)	(+)	(-)	(+)	(+)							
Curry et al. 2006	Pre-post	(++)	(++)	(++)	NA	(++)	NA	(-)	NA	NA	NA	(++)	(++)	(+)	(++)	NA	NA	NA	NA	(++)	NA	(+)	(+)	(-)	NA	(-)	(-)	(++)							
Dharod et al. 2004	Pre-post	(++)	(+)	(+)	NA	(++)	NA	(+)	NA	NA	(++)	(++)	(++)	(++)	(++)	NA	NA	NA	NA	(+)	NA	(+)	(++)	(++)	(+)	(+)	(+)	(+)							

Reference	Design	Population			Method of allocation to intervention/comparison										Outcomes						Analyses						Summary			
		1.1	1.2	1.3	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	2.10	3.1	3.2	3.3	3.4	3.5	3.6	4.1	4.2	4.3	4.4	4.5	4.6	5.1	5.2		
Dollahite et al. 2014	RCT	(-)	(++)	(+)	NR	(++)	NR	(+)	NR	(++)	(+)	(++)	(++)	(++)	(++)	(++)	NA	NR	(++)	(++)	(++)	(++)	(++)	(++)	(++)	(++)	(+)	(-)	(+)	
Evans et al. 2014	RCT	(++)	(+)	(+)	(++)	(++)	(+)	(++)	(+)	(+)	(+)	(-)	(+)	NR	(+)	(+)	NA	NA	(++)	(+)	(++)	(-)	(++)	(++)	(++)	(++)	(-)	(-)	(-)	
Farrell et al. 2011	Pre-post	(-)	NR	(+)	NA	(+)	NA	NA	NA	NA	NA	NA	NA	NA	(+)	(+)	NA	NA	NA	(-)	NA	NR	NR	(-)	(-)	(+)	(-)	(+)	(+)	
Fishbein et al. 2011	RCT	(++)	(+)	(+)	NR	(++)	NR	(-)	NR	NR	(-)	(++)	(++)	(++)	(+)	(+)	NA	NR	(++)	(+)	(++)	(+)	(++)	(++)	(++)	(+)	(-)	(-)	(+)	
Fonseca et al. 2012	Pre-post	(++)	(-)	(++)	NA	(++)	NA	(++)	NA	NA	(++)	(++)	(++)	(++)	(+)	(+)	NA	NA	NA	(-)	NA	NR	(++)	(++)	(++)	(+)	(-)	(-)	(-)	
Fournier and Berry 2012	Non-RCT	(+)	NR	(+)	NA	(+)	NA	NA	NA	(-)	NR	(++)	(++)	(++)	(+)	(+)	NA	NR	(++)	(-)	NA	NR	(+)	(+)	(-)	(-)	(-)	(+)	(+)	
Francis et al. 2009	Cluster RCT	(++)	(++)	(++)	(++)	(+)	NR	(-)	(++)	(-)	(++)	(++)	(++)	(++)	(+)	(+)	NA	NR	(++)	(+)	(++)	(++)	(++)	(++)	(++)	(+)	(+)	(++)	(++)	
Ghebrehewet and Stevenson 2003	Pre-post	(++)	NA	(+)	NA	(++)	NA	(++)	NA	(++)	(++)	(++)	(++)	(++)	(++)	(++)	(++)	NA	NA	(++)	(++)	(++)	(++)	(++)	(++)	(++)	(+)	(+)	(+)	(+)
Hawking et al. 2013	Pre-post	(++)	(+)	(+)	NA	(++)	NA	(+)	NA	NA	NA	(++)	(++)	(++)	(+)	(+)	NA	NR	(++)	(+)	(++)	(++)	(++)	(++)	(++)	(+)	(-)	(+)	(+)	(+)
Huang et al. 2007	Cluster RCT	(++)	NR	(++)	(+)	(++)	NR	(-)	(++)	(-)	(++)	(++)	NA	NA	(+)	(+)	NA	NR	(++)	(+)	(++)	(++)	(++)	(++)	(++)	(+)	(+)	(+)	(+)	(+)
James et al. 2013	Non-RCT	(+)	NR	(+)	NA	(+)	NR	(+)	NA	(+)	(+)	(++)	(++)	(++)	(+)	(+)	NA	NR	(++)	(+)	(++)	(++)	(++)	(++)	(++)	(+)	(-)	(+)	(+)	(+)
Kosa et al. 2011	RCT	(+)	(+)	(+)	(++)	(++)	NR	(+)	NR	(+)	(+)	(++)	(++)	(++)	(+)	(+)	NA	NR	(++)	(+)	(++)	(++)	(++)	(++)	(++)	(+)	(-)	(+)	(+)	(+)
Lapinski et al. 2013	RCT	(-)	(-)	(-)	(++)	(+)	(-)	(-)	(++)	(-)	(+)	(++)	(++)	(++)	(+)	(+)	NA	NR	(++)	(+)	(++)	(++)	(++)	(++)	(++)	(+)	(-)	(-)	(-)	(-)
Larson et al. 2010	Pre-post	(++)	(+)	(++)	NA	(+)	NA	(++)	NA	NA	(-)	(++)	(++)	(++)	(+)	(+)	NA	NR	(++)	(+)	(++)	(++)	(++)	(++)	(++)	NR	(-)	(+)	(+)	(+)
Larson et al. 2009	Pre-post	(+)	NA	(+)	NA	(++)	NA	(++)	NA	(++)	NR	(++)	(++)	(++)	(+)	(+)	NA	NR	(++)	(+)	(++)	(++)	(++)	(++)	(++)	(+)	(+)	(+)	(+)	(+)
Lecky et al. 2014	Pre-post	(+)	(-)	(+)	NA	(++)	NA	(+)	NA	NA	(+)	(+)	(+)	(+)	(+)	(+)	NA	NR	(++)	(+)	(++)	(++)	(++)	(++)	(++)	(+)	(+)	(+)	(+)	(+)
Lecky et al. 2010	Cluster non-RCT	(++)	(-)	(-)	(+)	(++)	(-)	(-)	(++)	(-)	(-)	(++)	(++)	(++)	(+)	(+)	NA	NR	(++)	(+)	(++)	(++)	(++)	(++)	(++)	(-)	(-)	(+)	(+)	(+)
Little et al. 2005	RCT	(++)	(+)	(+)	(++)	(++)	NA	(+)	(++)	(+)	(+)	(++)	(++)	(++)	(+)	(+)	NA	NR	(++)	(+)	(++)	(++)	(++)	(++)	(++)	(+)	(-)	(+)	(+)	(++)
Losasso et al. 2014	RCT	(++)	(+)	(-)	NR	(-)	NA	(++)	NR	NR	(++)	(++)	(++)	(++)	(+)	(+)	NA	NR	(++)	(+)	(++)	(++)	(++)	(++)	(++)	(+)	(-)	(+)	(+)	(+)
Lynch et al. 2007	Pre-post	(+)	NA	(+)	NA	(++)	NA	(+)	NR	NR	(+)	(++)	(++)	(++)	(+)	(+)	NA	NR	(++)	(+)	(++)	(++)	(++)	(++)	(++)	(+)	(-)	(+)	(+)	(+)
Macfarlane et al. 2002	RCT	(++)	(+)	(+)	NR	(++)	(+)	(++)	(++)	(+)	(+)	(++)	(++)	(++)	(+)	(+)	NA	NR	(++)	(+)	(++)	(++)	(++)	(++)	(++)	(+)	(+)	(+)	(+)	(+)
Mackert et al. 2013	Pre-post	(-)	NA	(+)	NA	(++)	NA	(-)	NR	NR	NA	(++)	(++)	(++)	(+)	(+)	NA	NR	(++)	(+)	(++)	(++)	(++)	(++)	(++)	(+)	(-)	(+)	(+)	(+)
Madle et al. 2004	Pre-post	(+)	(-)	(+)	NA	(+)	NA	(+)	NR	NR	(+)	(++)	(++)	(++)	(+)	(+)	NA	NR	(++)	(+)	(++)	(++)	(++)	(++)	(++)	(+)	(-)	(+)	(+)	(-)

Reference	Design	Method of allocation to intervention/comparison										Outcomes						Analyses						Summary				
		1.1	1.2	1.3	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	2.10	3.1	3.2	3.3	3.4	3.5	3.6	4.1	4.2	4.3	4.4	4.5	4.6	5.1	5.2
Mainous et al. 2009	Non-RCT	(++)	NA	(+)	NA	(+)	NA	(-)	NR	(+)	(++)	(++)	(++)	(+)	(+)	NA	NA	NA	(++)	(+)	(+)	(+)	(++)	(++)	(++)	(++)	(-)	(+)
Maurer Abbot et al. 2012	Pre-post	(++)	NA	(++)	NA	(+)	NA	(+)	NA	(-)	(++)	(++)	(++)	(+)	(+)	NA	NA	NA	NA	NA	(-)	NA	(+)	(++)	(-)	(+)	(-)	(+)
McNulty et al. 2010	Pre-post	(-)	NA	(-)	NA	(+)	NA	(-)	(++)	(++)	(++)	(++)	(++)	(+)	(+)	NA	NA	NA	NA	NA	(++)	NA	(++)	(++)	(++)	(++)	(-)	(-)
McNulty et al. 2007	Pre-post	(++)	NA	(++)	NA	(+)	NA	(++)	NA	NA	NA	(++)	(++)	(+)	(+)	NA	NA	NA	NA	NA	(+)	NA	(++)	(++)	(++)	(++)	(+)	(+)
McNulty et al. 2001	Pre-post	(++)	NA	(++)	NA	(+)	NA	(++)	NA	NA	NA	(++)	(++)	(+)	(+)	NA	NA	NA	NA	NA	(+)	NA	NR	(+)	(+)	(-)	(+)	(+)
Meilicke et al. 2013	Pre-post	(+)	(+)	(++)	NA	(+)	NA	NR	NA	NA	NA	(++)	(++)	(+)	(+)	NA	NA	NA	NA	NA	(+)	NA	(+)	(+)	(+)	(+)	(+)	(+)
Muñoz et al. 2013	Non-RCT	(+)	(+)	(+)	NR	(+)	(+)	(++)	(++)	(+)	(+)	(++)	(++)	(+)	(+)	NR	NA	NR	NR	NR	(+)	(+)	(+)	(+)	(+)	(+)	(-)	(+)
Northey et al. 2014	RCT	(++)	(+)	(+)	(++)	(++)	(+)	(++)	(++)	(+)	(+)	(++)	(++)	(+)	(+)	(+)	NA	NA	NA	NA	(+)	(+)	(+)	(+)	(+)	(+)	(-)	(+)
Nydahl et al. 2012	Pre-post	(++)	NA	(-)	NA	(++)	NA	(++)	NA	NA	NA	(++)	(++)	(+)	(+)	NA	NA	NA	NA	NA	(+)	NA	(+)	(+)	(+)	(+)	(-)	(++)
Parsons et al. 2004	Pre-post	(++)	NA	(+)	NR	(+)	NA	NR	NA	NA	NA	(++)	(++)	(+)	(+)	NA	NA	NA	NA	NA	(+)	NA	(+)	NR	(++)	(++)	(+)	(++)
Price et al. 2011	Pre-post	(+)	NR	(+)	NA	(+)	NA	(+)	NA	NA	NA	(++)	(++)	(+)	(+)	NA	NA	NA	NA	NA	(+)	NA	(+)	(++)	(++)	(+)	(-)	(+)
Ramseier et al. 2007	Cluster RCT	(+)	(++)	(++)	NR	(-)	NR	(+)	NR	NR	NR	(++)	(++)	(+)	(+)	NR	NR	NR	NR	NR	(+)	NR	(+)	(+)	(+)	(-)	(+)	(+)
Redmond et al. 2006	Non-RCT	(-)	(+)	(-)	NA	(+)	NA	(+)	NR	NR	NR	(++)	(++)	(+)	(+)	NA	NA	NA	NA	NA	(+)	(+)	(+)	(+)	(+)	(-)	(-)	(+)
Rodis et al. 2004	Pre-post	(++)	NR	(++)	NA	(+)	NA	(++)	NA	NA	NA	(++)	(++)	(+)	(+)	NA	NA	NA	NA	NA	(+)	NA	(+)	(+)	(+)	(+)	(-)	(+)
Schnellinger et al. 2010	RCT	(+)	(-)	(+)	(++)	(-)	NR	(++)	NR	NR	NR	(++)	(++)	(+)	(+)	(+)	NR	NR	NR	NR	(+)	NR	(+)	(+)	(+)	(+)	(-)	(+)
Stebbins et al. 2010	Cluster RCT	(+)	NR	(+)	NR	(+)	NR	(-)	NR	NR	NR	(++)	(++)	(+)	(+)	NR	NR	NR	NR	NR	(+)	NR	(-)	(-)	(+)	(+)	(-)	(+)
Taylor et al. 2003	RCT	(++)	(+)	(+)	NR	(+)	NR	(+)	NR	NR	NR	(++)	(++)	(+)	(+)	(+)	NR	NR	NR	NR	(+)	(+)	(+)	(+)	NR	(+)	(-)	(+)
Tousman et al. 2007	Pre-post	(++)	NR	(+)	NA	(+)	NA	(++)	NA	NA	NA	(++)	(++)	(+)	(+)	NA	NA	NA	NA	NA	(+)	NA	(-)	(-)	(-)	(-)	(-)	(+)
Trepka et al. 2001	RCT	(++)	(+)	(+)	(-)	(+)	NR	(+)	NR	NR	NR	(++)	(++)	(+)	(+)	(+)	NR	NR	NR	NR	(+)	(+)	(+)	(+)	(+)	(+)	(-)	(++)
Trepka et al. 2008	RCT	(++)	(++)	(++)	(+)	(+)	(+)	(++)	NR	NR	NR	(+)	(++)	(+)	(+)	(+)	(+)	NR	NR	NR	(+)	(+)	(+)	(+)	(+)	(+)	(-)	(+)
Updegraff et al. 2011	Non-RCT	(-)	NR	NR	NA	(++)	NA	NR	NA	NA	NA	(++)	(++)	(+)	(+)	NR	NR	NR	NR	NR	(+)	NR	NR	NR	NR	(++)	(-)	(-)
White et al. 2003, 2005	Non-RCT	(++)	(+)	(++)	NA	(-)	NA	(-)	(-)	(-)	(++)	(++)	(++)	(+)	(+)	NR	NR	NR	NR	NR	(+)	(+)	(+)	(+)	(+)	(+)	(-)	(+)
Wheeler et al. 2001	Non-RCT	(+)	NR	(+)	(-)	(+)	NR	(+)	(-)	(-)	(++)	(++)	(++)	(+)	(+)	NR	NR	NR	NR	NR	(+)	NR	(+)	(+)	(+)	(+)	(-)	(+)
Witt and Spencer 2004	Pre-post	(++)	(-)	(++)	NA	(++)	NA	(++)	NA	NA	NA	(++)	(++)	(+)	(+)	NR	NR	NR	NR	NR	(+)	NR	(+)	(+)	(+)	(+)	(-)	(-)

Reference	Design	Population			Method of allocation to intervention/comparison										Outcomes						Analyses						Summary		
		1.1	1.2	1.3	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	2.10	3.1	3.2	3.3	3.4	3.5	3.6	4.1	4.2	4.3	4.4	4.5	4.6	5.1	5.2	
Wutzke et al. 2007	Pre-post	(++)	(++)	(+)	NA	(++)	NA	NA	NA	NA	NA	(++)	(++)	(+)	(++)	(+)	NA	NA	NA	(++)	NR	NA	(+)	(++)	(-)	(++)	(-)	(-)	(++)
Yardley et al. 2011	RCT	(++)	(++)	(+)	(++)	(++)	NA	(++)	(+)	NR	(+)	(++)	(++)	(+)	(++)	(+)	NA	NA	(++)	(+)	(++)	(+)	(++)	(++)	(++)	(++)	(+)	(+)	(+)
Yarrow et al. 2009	Pre-post	(++)	NR	(++)	NA	(++)	NA	(+)	NA	NA	(++)	(++)	(++)	(++)	(++)	(++)	NA	NA	NA	(++)	NA	NA	(-)	(++)	(-)	(+)	(-)	(+)	(+)

NOTE. NA: not applicable; NR: not reported

Appendix C. Excluded studies

In total, 121 studies were excluded from the review.

Table 7. List of excluded studies

Study reference	Reason for exclusion
Aagaard EM, Gonzales R, Camargo CA, Auten R, Levin SK, Maselli J, et al. Physician champions influence the effectiveness of interventions to improve antibiotic prescribing quality. <i>Journal of General Internal Medicine</i> . 2008 Mar;23:367.	Conference meeting abstract
Adinoff A. Information leaflet and antibiotic prescribing strategies for acute lower respiratory tract infection: A randomized, controlled trial. <i>Pediatrics</i> . 2006 Aug;118:413.	Conference meeting abstract
Agnew J, Taaffe M, Darker C, O'Shea B, Clarke J. Delayed prescribing of antibiotics for respiratory tract infections: use of information leaflets. <i>Irish Medical Journal</i> . 2013 Sep;106(8):243-4.	Conference meeting abstract
Ahern JW, Grace CJ. Effectiveness of a criteria-based educational program for appropriate use of antibiotics. <i>Infections in Medicine</i> . 2002 Aug;19(8):364-	Review
Alder S, Wuthrich A, Haddadin B, et al. Community intervention model to reduce inappropriate antibiotic use. <i>American Journal of Health Education</i> 2010;41(1):20-28	One-group post only study
Allison D, McGuinness E. How clean are your hands? Raising children's awareness of microbes. <i>Pharmaceutical Journal</i> 2011;287(7671):329	Outcome acceptability of face masks and hand gel
Altiner A, Brockmann S, Sielk M, Wilm S, Wegscheider K, Abholz H-H. Reducing antibiotic prescriptions for acute cough by motivating GPs to change their attitudes to communication and empowering patients: a cluster-randomized intervention study. <i>Journal of Antimicrobial Chemotherapy</i> 2007;60(3):638-44	Targets both prescriber and patient. Outcome prescription rates
Altiner A, Sielk M, Fiegen J, Stock K, Dullmann G, Groll A, et al. [Can the unnecessary prescription of antibiotics for acute coughs be reduced? Cluster randomised controlled intervention study (CHANGÉ)]. <i>Zeitschrift für Allgemeinmedizin</i> [Internet]. 2004	Study published in German
Angoulvant F, Rouault A, Prot-Labarthe S, et al. Randomized controlled trial of parent therapeutic education on antibiotics to improve parent satisfaction and attitudes in a pediatric emergency department. <i>PLoS ONE</i> 2013;8(9):e75590	Education delivered to parents in a paediatric emergency department. Outcome not measuring change in participants' understanding/knowledge/awareness.
Ashe D, Patrick PA, Stempel MM, Shi Q, Brand DA. Educational posters to reduce antibiotic use. <i>J Pediatr Health Care</i> 2006;20(3):192-7	Outcome prescription rates
Au WH, Suen LKP, Kwok YL. Handwashing Programme in Kindergarten: A Pilot Study. <i>Health Education</i> . 2010 01/01/;110(1):5-16.	Study conducted in Hong Kong
Bell N. Antibiotic resistance: the Iowa experience. <i>American Journal of Managed Care</i> 2002;8(11):988-94	Outcome prescription rates

Study reference	Reason for exclusion
Belongia EA, Knobloch MJ, Kieke BA, Davis JP, Janette C, Besser RE. Impact of statewide program to promote appropriate antimicrobial drug use. <i>Emerging Infectious Diseases</i> 2005;11(6):912-20	Targets both prescriber and patient. Outcome prescription rates
Belongia EA, Sullivan BJ, Chyou PH, Madagame E, Reed KD, Schwartz B. A community intervention trial to promote judicious antibiotic use and reduce penicillin-resistant <i>Streptococcus pneumoniae</i> carriage in children. <i>Pediatrics</i> 2001;108(3):575-83	Targets both prescriber and patient. Outcome prescription rates
Bernier A, Delarocque-Astagneau E, Ligier C, Vibet MA, Guillemot D, Watier L. Outpatient Antibiotic Use in France between 2000 and 2010: after the Nationwide Campaign, It Is Time To Focus on the Elderly. <i>Antimicrobial Agents and Chemotherapy</i> 2014;58(1):71-77	Outcome prescription rates
Bold approach curtails bronchitis antibiotic use. <i>Clin Resour Manag.</i> 2001 Jan;2(1):1-6.	Targets prescriber
Brennan A, Jackson T, O'Sullivan MB. Did the H1N1 hand hygiene campaign impact on the number of gastrointestinal disease notifications in Ireland? <i>Irish Journal of Medical Science.</i> 2011 Jul;180:223-4.	Conference meeting abstract
Briel M, Langewitz W, Tschudi P, Young J, Hugenschmidt C, Bucher HC. Communication training and antibiotic use in acute respiratory tract infections. A cluster randomised controlled trial in general practice. <i>Swiss Medical Weekly</i> 2006;136(15-16):241-7	Targets both prescriber and patient. Outcome prescription rates
Carling CLL, Kristoffersen DT, Flottorp S, et al. The effect of alternative graphical displays used to present the benefits of antibiotics for sore throat on decisions about whether to seek treatment: a randomized trial. <i>PLoS Med</i> 2009;6(8):e1000140	One-group post only study
Cebotarenco N, Bush PJ. Reducing antibiotics for colds and flu: a student-taught program. <i>Health Education Research</i> 2008;23(1):146-57	Study conducted in Moldova
Chen Y-C. Effectiveness of hand-washing teaching programs for families of children in paediatric intensive care units. <i>Journal of Clinical Nursing.</i> 2007;16(6).	Study conducted in Taiwan
Cizman M, Srovin T, Pokorn M, Pecar SC. The influence of educational and restrictive interventions on outpatient antibiotic consumption in Slovenia. <i>International Journal of Antimicrobial Agents.</i> 2004 Dec;24:S91-S.	Study conducted in Slovenia
Davis MP, Basco WT, Darden PM, Schmidt MG. Impact of a waiting room video on parental expectations for antibiotics. <i>Pediatric Research.</i> 2003 Apr;53(4):216A-A.	Conference meeting abstract
DeBisschop M, Robitaille B. Can a patient information sheet reduce antibiotic use in adult outpatients with acute bronchitis? <i>Journal of Family Practice</i> 2002;51(4):381	Summary of Macfarlane J, Holmes W, Gard P, Thornhill D, Macfarlane R, Hubbard R. Reducing antibiotic use for acute bronchitis in primary care: blinded, randomised controlled trial of patient information leaflet. <i>BMJ</i> 2002;324(7329):91-4
Devanathan A, Sheridan K, Shields R, Falcione B. Evaluation of infectious diseases pharmacists' interventions for patients receiving outpatient parenteral antimicrobial therapy after discharge from a large teaching hospital. <i>Pharmacotherapy.</i> 2014 Oct;34(10):E279-E80.	Conference meeting abstract
Dharod J, Perez-Escamilla R, Segura-Perez S, Bermudez-Millan A, Damio G. Influence of the USDA Fight BAC! Campaign on food safety knowledge among urban Latinos in Connecticut. <i>Faseb Journal.</i> 2003 Mar;17(4):A293-A.	Conference meeting abstract
Dixon Z, Huffman F. Food Safety Interventions are Effective in Increasing Knowledge within Different Ethnic Groups. <i>Faseb Journal.</i> 2008 Apr;22:1.	Conference meeting abstract
Dixon ZR, Huffman FG, Leon AA. Culturally appropriate intervention improved food safety knowledge in a hard to reach population. <i>Faseb Journal.</i> 2006 Mar;20(4):A174-A.	Conference meeting abstract

Study reference	Reason for exclusion
Dollman WB, LeBlanc VT, Stevens L, O'Connor PJ, Turnidge JD. A community-based intervention to reduce antibiotic use for upper respiratory tract infections in regional South Australia. <i>Medical Journal of Australia</i> 2005;182(12):617-20	Targets both prescriber and patient. Outcome prescription rates
Donovan J, Australian Pharmaceutical Advisory C. Consumer activities on antimicrobial resistance in Australia. <i>Commun Dis Intell Q Rep.</i> 2003;27 Suppl:S42-6.	Review
Doyne E, Alfaro MP, Kotagal U, Siegel R, Atherton H, Bernier J. Changing prescribing patterns in a community – A randomized controlled community-based intervention to reduce inappropriate antibiotic use in children. <i>Pediatric Research.</i> 2003 Apr;53(4):216A-A.	Conference meeting abstract
Doyne EO, Alfaro MP, Siegel RM, et al. A randomized controlled trial to change antibiotic prescribing patterns in a community. <i>Archives of Pediatrics & Adolescent Medicine</i> 2004;158(6):577-83	Targets both prescriber and patient. Outcome prescription rates
Dworkin MS, Burke AJ. Creation and Evaluation of a Food Safety Educational Curriculum for High School Students. 2013	Study type; student thesis
Educational materials do not substantially increase parents' knowledge and attitudes about the use of antibiotics. <i>AHRQ Research Activities</i> 2001(256):9-10	Summary of article by Bauchner 2001, which is extracted
El-Kafrawy U, Taylor RJ, Francis N, Boussabaine E, Badrideen M. Effectiveness of a neonatal intensive care unit access intercom linked audiovisual display monitor highlighting infection control procedures. <i>American Journal of Infection Control</i> 2013;41(8):749-50	Population is parents of babies in intensive care unit
Farquhar D. Reducing antibiotic use for acute bronchitis by giving patients written information. <i>Cmaj.</i> 2002 Mar 19;166(6):776.	Commentary on paper by Macfarlane J, Holmes W, Gard P, Thornhill D, Macfarlane R, Hubbard R. Reducing antibiotic use for acute bronchitis in primary care: blinded, randomised controlled trial of patient information leaflet. <i>BMJ</i> 2002;324(7329):91-4
Farrell, D., Kostkova, P., Weinberg, J., Lecky, D. and McNulty, C. (2010). Online games teaching children hygiene and antibiotic resistance: Evaluation of the e-Bug games. <i>International Journal of Infectious Diseases</i> , 14, p. E43.	Short conference abstract (full paper most likely: Farrell, D., Kostkova, P., Weinberg, J., Lazareck, L., Weerasinghe, D., Lecky, D.M., and McNulty, C.A.M. (2011). Computer games to teach hygiene: an evaluation of the e-Bug junior game. <i>Journal of Antimicrobial Chemotherapy</i> , 66 Suppl 5, pp. v39-44, which has been extracted)
Fenton G, Radhakrishna R, Cutter CN. Participation in 'Handwashing University' Promotes Proper Handwashing Techniques for Youth. <i>Journal of Extension</i> 2010;48(1)	One-group post only study
Filion K, KuKanich KS, Chapman B, Hardigree MK, Powell DA. Observation-based evaluation of hand hygiene practices and the effects of an intervention at a public hospital cafeteria. <i>American Journal of Infection Control.</i> 2011 Aug;39(6):464-70.	Intervention targets both healthcare workers and the general public. Data not reported separately for the general public
Finkelstein JA, Davis RL, Dowell SF, et al. Reducing antibiotic use in children: a randomized trial in 12 practices. <i>Pediatrics</i> 2001;108(1):1-7	Targets both prescriber and patient. Outcome prescription rates
Finkelstein JA, Huang SS, Kleinman K, Rifas-Shiman SL, Stille CJ, Daniel J, et al. Impact of a 16-community trial to promote judicious antibiotic use in Massachusetts. <i>Pediatrics.</i> 2008 Jan;121(1):e15-23.	Evaluated rates of antibiotics per person-year/trends in antibiotic prescribing.
Fitzpatrick KR, Pantle AC, McLaws M-L, Hughes CF. Culture change for hand hygiene: clean hands save lives, part II. <i>Medical Journal of Australia</i> 2009;191(8 Suppl):S13-7	Intervention targeting physicians. Not measuring change in patients' understanding/knowledge/awareness
Flottorp S, Oxman AD, Havelrud K, Treweek S, Herrin J. Cluster randomised controlled trial of tailored interventions to improve the management of urinary tract infections in women and sore throat. <i>BMJ.</i> 2002 Aug 17;325(7360):367.	Evaluated rates of antibiotic use/antibiotic prescribing

Study reference	Reason for exclusion
Formoso G, Paltrinieri B, Marata AM, et al. Feasibility and effectiveness of a low cost campaign on antibiotic prescribing in Italy: community level, controlled, non-randomised trial. <i>BMJ</i> 2013;347:f5391	Targets both prescriber and patient. Outcome prescription rates
Fox S. A message heard? Antibiotic prescriptions down. <i>Infections in Medicine</i> . 2004;21(4):151.	Not an intervention study
Francis NA, Hood K, Simpson S, Wood F, Nuttall J, Butler CC. The effect of using an interactive booklet on childhood respiratory tract infections in consultations: study protocol for a cluster randomised controlled trial in primary care. <i>BMC Family Practice</i> 2008;9:23	Paper that describes the study plan – no data are reported
Francis NA, Phillips R, Wood F, Hood K, Simpson S, Butler CC. Parents' and clinicians' views of an interactive booklet about respiratory tract infections in children: a qualitative process evaluation of the EQUIP randomised controlled trial. <i>BMC Family Practice</i> . 2013;14:182.	Qualitative study – to assess acceptability of an interactive booklet titled 'When should I worry?'
Fuentes EI. Trends in antibiotic utilization in Vancouver associated with a community education programme on antibiotic use. <i>Canadian Journal of Public Health</i> . 2010;101(4).	Outcome based on utilisation data/antibiotic prescribing
Garbutt JM, Jeffe DB, Spitznagel EL, Littenberg B, Shackelford PG. Evaluation of a practice based intervention to increase the judicious use of antibiotics. <i>Pediatric Research</i> . 2003 Apr;53(4):322A-A.	Conference meeting abstract
Gastelurrutia MA, Larranaga Arregui B, Ortega Arteaga B, Puntonet Garcia L. Assessment of the program for rational use of antibiotics in Gipuzkoa. First phase: 1999-2000. <i>Pharmaceutical Care Espana</i> 2002;4(3):143-57	Targets both prescriber and patient. Outcome prescription rates
Gibson JA. A program for outpatient intravenous antibiotic therapy... reprinted from NITA, the official journal of the National Intravenous Therapy Association, Inc., Vol. 1, No. 1, 1978. <i>Journal of Infusion Nursing</i> . 2007 2007 Jan-Feb;30(1):C15-7.	Intervention not related to change in patients'/public behaviour
Gilmartin HM. Provider-pharmacist education and adherence rates for the oral typhoid vaccine: a pilot study. <i>Journal of Travel Medicine</i> 2005;12(2):113-4	Outcome not measuring change in understanding/knowledge/awareness – measuring adherence to typhoid vaccination
Godoy P, Castilla J, Delgado-Rodriguez M, et al. Effectiveness of hand hygiene and provision of information in preventing influenza cases requiring hospitalization. <i>Prev Med</i> 2012;54(6):434-9	No intervention
Goktay NB, Telefoncu S, Kadioglu SB, Macit C, Sencan N, Clark PM. The role of patient education in adherence to antibiotic therapy in primary care. <i>Marmara Pharmaceutical Journal</i> 2013;17(2):113-19	Study conducted in Turkey.
Golding GR, Quinn B, Bergstrom K, et al. Community-based educational intervention to limit the dissemination of community-associated methicillin-resistant <i>Staphylococcus aureus</i> in Northern Saskatchewan, Canada. <i>BMC Public Health</i> 2012;12:15	Targets both prescribers and patients. Outcome incidence of infection
Gonzales R, Corbett K, Wong S, Deas A, Leeman-Castillo B, Maselli J, et al. Impact of a mass media campaign to improve antibiotic use. <i>Journal of General Internal Medicine</i> . 2004 Apr;19:162-.	Conference meeting abstract
Gonzales R, Corbett KK, Leeman-Castillo BA, et al. The 'minimizing antibiotic resistance in Colorado' project: impact of patient education in improving antibiotic use in private office practices. <i>Health Serv Res</i> 2005;40(1):101-16	Outcome prescription rates
Gonzales R, Corbett KK, Wong S, et al. 'Get smart Colorado': impact of a mass media campaign to improve community antibiotic use. <i>Medical Care</i> 2008;46(6):597-605	Outcomes prescription rates
Gonzales R, Sauaia A, Corbett KK, et al. Antibiotic treatment of acute respiratory tract infections in the elderly: effect of a multidimensional educational intervention. <i>Journal of the American Geriatrics Society</i> 2004;52(1):39-45	Outcome prescription rates

Study reference	Reason for exclusion
Gonzales R. 'Get Smart Colorado': Impact of a mass media campaign to improve community antibiotic use. <i>Medical Care</i> . 2008;46(6).	Outcome was retail pharmacy antibiotic dispenses per 1,000 persons
Goossens H, Coenen S, Costers M, De Corte S, De Sutter A, Gordts B, et al. Achievements of the Belgian Antibiotic Policy Coordination Committee (BAPCOC). 2008:Bulletin Europeen sur les Maladies Transmissibles = European Communicable Disease Bulletin. 13(46), 2008 Nov 13.	Not an intervention study, but an overview of several campaigns – specific data on understanding/knowledge/awareness are not reported
Greene JB, Dolder C, Wallis ML. The NC Tars Project: students leading the way to educate patients about proper use of antibiotics. <i>J Am Pharm Assoc</i> (2003) 2011;51(4):539-43.	No clear data are reported
Grover ML, Nordrum JT, Mookadam M, Engle RL, Moats CC, Noble BN. Addressing antibiotic use for acute respiratory tract infections in an academic family medicine practice. <i>American Journal of Medical Quality</i> 2013;28(6):485-91	Targets both prescriber and patient. Outcome prescription rates
Gudnason T, Hrafnkelsson B, Laxdal B, Kristinsson KG. Does hygiene intervention at day care centres reduce infectious illnesses in children? An intervention cohort study. <i>Scandinavian Journal of Infectious Diseases</i> 2013;45(5):397-403	Outcome incidence of infection
Guidance meetings plus education of assistants and patients reduces antibiotic prescription for respiratory tract infections by general practitioners. <i>Evidence-Based Healthcare and Public Health</i> 2005; 9(1)	Summary of Welschen I, Kuyvenhoven MM, Hoes AW et al. Effectiveness of a multiple intervention to reduce antibiotic prescribing for respiratory tract symptoms in primary care: randomised controlled trial. <i>BMJ</i> 2004; 329: 431–43
Harris R, Lundgren R, Esler A, Gonzales R, Mackenzie TD. Reducing desire for antibiotics: A randomized trial of touch-screen interactive computer education in acute respiratory infections. <i>Journal of General Internal Medicine</i> . 2003 Apr;18:206-	Conference meeting abstract
Harris R, Mackenzie T, Leeman B, Corbett K, Gershman K, Batal H, et al. Multidimensional education promotes the appropriate use of antibiotics in ambulatory care. <i>Journal of General Internal Medicine</i> . 2002 Apr;17:225-6.	Conference meeting abstract
Hedin K, Petersson C, Cars H, Beckman A, Hakansson A. Infection prevention at day-care centres: feasibility and possible effects of intervention. <i>Scand J Prim Health Care</i> 2006;24(1):44-9	Targets both prescribers and patients. Outcome incidence of infection
Heinrich ERE, KuKanich KS, Davis E, White BJ. Public health campaign to promote hand hygiene before meals in a college of veterinary medicine. <i>J Vet Med Educ</i> . 2014;41(3):301-10.	Intervention targeting veterinary students (i.e. not the general public)
Hemo B, Shamir-Shtein NH, Silverman BG, et al. Can a nationwide media campaign affect antibiotic use? <i>American Journal of Managed Care</i> 2009;15(8):529-34	Study conduct in Israel
Hennessy TW, Petersen KM, Bruden D, et al. Changes in antibiotic-prescribing practices and carriage of penicillin-resistant <i>Streptococcus pneumoniae</i> : A controlled intervention trial in rural Alaska. <i>Clinical Infectious Diseases</i> 2002;34(12):1543-50	Targets both prescriber and patient. Outcome prescription rates
Hickman DE, Stebbins MR, Hanak JR, Guglielmo BJ. Pharmacy-based intervention to reduce antibiotic use for acute bronchitis. <i>Annals of Pharmacotherapy</i> 2003;37(2):187-91	Targets both prescriber and patient. Outcome prescription rates
Hoekstra B, Lecky D, Young V. E-Bug: hygiene and antibiotic awareness for school-aged children. <i>Community Practitioner</i> . 2014 Jul;87(7):36-7.	Not a study – overview of e-Bug intervention
Jesus R, Virtudes PJ, Joaquin M. Informative campaigns about the use of antibiotics: What message we transmit to the general population? <i>Psychol Health</i> . 2009;24:220.	Conference meeting abstract
Kosa KM, Cates SC, Adams-King J, O'Brien B. Improving foodborne illness prevention among transplant recipients. <i>Health Promot Pract</i> 2011;12(2):235-43	Qualitative study
Kostkova P, Farrell D, de Quincey E, Weinberg J, Lecky D, McNulty C, et al. eBug-teaching children hygiene principles using educational games. <i>Stud Health Technol Inform</i> . 2010;160(Pt 1):600-4.	A description of e-Bug – full outcome data were not reported

Study reference	Reason for exclusion
Lambert MF, Masters GA, Brent SL. Can mass media campaigns change antimicrobial prescribing? A regional evaluation study. <i>Journal of Antimicrobial Chemotherapy</i> 2007;59(3):537-43	Targets both prescriber and patient. Outcome prescription rates
Lau CH, Springston EE, Sohn M-W, et al. Hand hygiene instruction decreases illness-related absenteeism in elementary schools: a prospective cohort study. <i>BMC Pediatr</i> 2012;12:52	Outcome incidence of infection
Leeman-Castillo BA, Corbett KK, Aagaard EM, Maselli JH, Gonzales R, Mackenzie TD. Acceptability of a bilingual interactive computerized educational module in a poor, medically underserved patient population. <i>Journal of Health Communication</i> . 2007 Jan-Feb;12(1):77-94.	The principal outcome variables were 'learned something new', a response to the statement, 'I learned something new about colds and flu from the computer today', and 'trust of the computer' – not fully measuring understanding/knowledge/awareness of antibiotics.
Levy SB, Star L, Kupferberg ED. The misuse of antibiotics. <i>Med</i> . 2004;11(1):5-8.	Full paper not available (appears not to be a study)
MacKenzie TD, Gonzales R, Levin SK, Maselli J, Camargo CA, Kersey AS, et al. Patterns of use and acceptability of a bilingual interactive computer kiosk designed to teach patients about appropriate antibiotic use for acute respiratory tract infections. <i>Journal of General Internal Medicine</i> . 2006 Apr;21:98-.	Conference meeting abstract
Mantovani C, Bissoli F, Barison B, et al. 'ALIMENTINSALUTE': A SOCIAL MARKETING PROJECT FOR PUBLIC HEALTH COMMUNICATION AND EDUCATION ON FOOD SAFETY AND NUTRITION IN VENETO REGION. 3rd International Conference of Education, Research and Innovation 2010:4553-62	Conference meeting abstract
McKay RM, Vrbova L, Fuertes E, et al. Evaluation of the Do Bugs Need Drugs? program in British Columbia: Can we curb antibiotic prescribing? <i>Can. J. Infect. Dis. Med. Microbiol</i> . 2011;22(1):19-24	Targets both prescriber and patient. Outcome prescription rates
Medicaid-insured parents could benefit from educational programs to promote more judicious use of antibiotics. <i>AHRQ Research Activities</i> 2008(329):3-3	This is a summary of: Huang SS, Rifas-Shiman SL, Kleinman K, et al. Parental knowledge about antibiotic use: results of a cluster-randomized, multicommunity intervention. <i>Pediatrics</i> 2007;119(4):698-706
Meeker D, Knight TK, Friedberg MW, et al. Nudging guideline-concordant antibiotic prescribing: a randomized clinical trial. <i>JAMA Internal Medicine</i> 2014;174(3):425-31	Intervention targeting physicians Not measuring change in patients' understanding/knowledge/awareness
Metlay JP, Camargo CA, Jr., MacKenzie T, et al. Cluster-randomized trial to improve antibiotic use for adults with acute respiratory infections treated in emergency departments. <i>Annals of Emergency Medicine</i> 2007;50(3):221-30	Targets both prescriber and patient. Outcome prescription rates
Metlay JP, Camargo CA, MacKenzie T, McCulloch CE, Maselli J, Levin SK, et al. Randomized trial of a multidimensional educational intervention to improve antibiotic use for adults with acute respiratory tract infections managed in the emergency department. <i>Journal of General Internal Medicine</i> . 2006 Apr;21:119-20.	Conference meeting abstract
Milton, A.C. and Mullan, B.A. (2012). An application of the theory of planned behaviour – A randomized controlled food safety pilot intervention for young adults. <i>Health Psychology</i> , 31(2), pp. 250-259.	Intervention is not clearly described.
Miner KR, McCurdy SM. Campus-Wide Food Safety Outreach Project Conducted by Students in a Coordinated Dietetics Program... Insights to Action. Academy of Nutrition and Dietetics. Food & Nutrition Conference & Expo, Houston TX, October 19-22, 2013. <i>Journal of the Academy of Nutrition & Dietetics</i> . 2013;113(s9):A76-A.	Conference poster

Study reference	Reason for exclusion
Mira JJ, Navarro I, Huttner B, et al. What do Spaniards read about the prudent use of anti-microbial agents and what do they really do? <i>Psychol Health Med</i> 2014;19(2):201-10	One-group post only study
Mitchell TJ. An educational poster at a university health center improves antibiotic knowledge. <i>Journal of Investigative Medicine</i> . 2004 Jan;52(1):S117-S.	Conference meeting abstract
Molstad S, Erntell M, Hanberger H, et al. Sustained reduction of antibiotic use and low bacterial resistance. A ten-year follow-up of the Swedish Strama programme. <i>International Journal of Antimicrobial Agents</i> 2007;29:S33-S33	Outcome prescription rates
Morisky DE, Malotte CK, Ebin V, et al. Behavioral interventions for the control of tuberculosis among adolescents. <i>Public Health Reports</i> 2001;116(6):568-74	The intervention was peer counselling and did not report an explicit educational intervention –interventions that only encouraged people to adhere to their medication were excluded.
Morris D, Penhollow T. Impact of a knowledge-based food-borne illness program on food safety practices among college students. <i>Res Q Exerc Sport</i> . 2005 Mar;76(1):A42-A.	Peer-reviewed abstract only
Papaevangelou V, Rousounides A, Hadjipanagis A, Katsioulis A, Theodoridou M, Hadjichristodoulou C. Decrease of antibiotic consumption in children with upper respiratory tract infections after implementation of an intervention program in Cyprus. <i>Antimicrob Agents Chemother</i> . 2012 Mar;56(3):1658-61.	Study was conducted in Cyprus; data on knowledge, attitudes, and practices were reported for parents and paediatricians together.
Patient education may reduce unnecessary use of antibiotics by adults. <i>AHRQ Research Activities</i> 2005(299):8-8	Outcome not measuring change in participants' understanding/knowledge/awareness – prescription rates
Perz JF, Craig AS, Coffey CS, et al. Changes in antibiotic prescribing for children after a community-wide campaign. <i>Jama</i> 2002;287(23):3103-9	Targets both prescriber and patient. Outcome prescription rates
Plachouras D, Antoniadou A, Giannitsioti E, et al. Promoting prudent use of antibiotics: the experience from a multifaceted regional campaign in Greece. <i>BMC Public Health</i> 2014;14:866	Targets both prescriber and patient. Outcome prescription rates
Pontes MCF, Pontes NMH. Debiasing effects of education about appropriate antibiotic use on consumers' preferences for physicians. <i>Health Care Manage Rev</i> 2005;30(1):9-16	Outcome not measuring change in participants' understanding/knowledge/awareness – respondents' rating of the physicians
Porzig-Drummond R (2009). Can the emotion of disgust be harnessed to promote hand hygiene? <i>Experimental and field-based tests</i>	Intervention focus lies on inducing disgust to promote hand hygiene
Price E, MacKenzie T, Camargo C, Gonzales R, Metlay J. Successful application of the health belief model: use of a bilingual computerized educational module to teach patients about appropriate antibiotic use for acute respiratory tract infection. <i>Journal of General Internal Medicine</i> . 2010 Jun;25:395-.	Conference meeting abstract
Pshetizky Y, Naimer S, Shvartzman P. Acute otitis media – A brief explanation to parents and antibiotic use. <i>Family Practice</i> . 2003;20(4):417-9.	Study conducted in the southern district of Israel; all parents were given antibiotics for acute otitis media in their children (some were also provided a brief explanation about the possibility of self-cure without antibiotics)
Quick V, Corda KW, Chamberlin B, Schaffner DW, Byrd-Bredbenner C. Ninja Kitchen to the rescue Evaluation of a food safety education game for middle school youth. <i>Br Food J</i> . 2013;115(5):686-99.	Conference poster
Ratnapradipa D, Quilliam D, Wier L, Rhodes DL. Food safety education: child-to-parent instruction in an immigrant population. <i>Journal of Environmental Health</i> 2011;73(6):70-5	Population is restaurant workers

Study reference	Reason for exclusion
Rosenberg NE, Schwartz IS, Davis CA. Evaluating the utility of commercial videotapes for teaching hand washing to children with autism. <i>Education & Treatment of Children</i> 2010;33(3):443-55	One-group post only study
Rubin MA, Bateman K, Alder S, Donnelly S, Stoddard GJ, Samore MH. A multifaceted intervention to improve antimicrobial prescribing for upper respiratory tract infections in a small rural community. <i>Clinical Infectious Diseases</i> 2005;40(4):546-53	Targets both prescriber and patient. Outcome prescription rates
Sabuncu E, David J, Bernede-Bauduin C, et al. Significant reduction of antibiotic use in the community after a nationwide campaign in France, 2002-2007. <i>PLoS Med</i> 2009;6(6):e1000084	Outcome prescription rates
Sahlan S, Wollny A, Brockmann S, Fuchs A, Altiner A. Reducing unnecessary prescriptions of antibiotics for acute cough: adaptation of a leaflet aimed at Turkish immigrants in Germany. <i>BMC Family Practice</i> 2008;9:57	Qualitative study
Sandora TJ, Taveras EM, Shih M-C, et al. A randomized, controlled trial of a multifaceted intervention including alcohol-based hand sanitizer and hand-hygiene education to reduce illness transmission in the home. <i>Pediatrics</i> 2005;116(3):587-94	Outcome incidence of infection
Smabrekke L, Berild D, Gjaever A, et al. Educational intervention for parents and healthcare providers leads to reduced antibiotic use in acute otitis media. <i>Scandinavian Journal of Infectious Diseases</i> 2002;34(9):657-9	Targets both prescriber and patient. Outcome prescription rates
Smeets HM. Intervention with educational outreach at large scale to reduce antibiotics for respiratory tract infections : a controlled before and after study. <i>Family Practice : an international journal</i> 2009;26(3):183-87	Targets both prescriber and patient. Outcome prescription rates
Stokes CE. Investigating the Efficacy of Video versus Text Instruction for the Recall of Food Safety Information. 2009	Summary of a master's thesis.
Sung L, Arroll J, Arroll B, Goodyear-Smith F, Kerse N, Norris P. Antibiotic use for upper respiratory tract infections before and after a education campaign as reported by general practitioners in New Zealand. <i>New Zealand Medical Journal</i> 2006;119(1233):U1956	Outcome prescription rates
Taylor JA, Kwan-Gett TSC, McMahan EM, Jr. Effectiveness of a parental educational intervention in reducing antibiotic use in children: a randomized controlled trial. <i>Pediatric Infectious Disease Journal</i> 2005;24(6):489-93	Outcome prescription rates
Taylor JA, Kwan-Gett TSC, McMahan EM, Jr. Effectiveness of an educational intervention in modifying parental attitudes about antibiotic usage in children. <i>Pediatrics</i> 2003;111(5 Pt 1):e548-54	Duplicate of: Taylor JA, Kwan-Gett TSC, McMahan EM. The effectiveness of parental educational materials in reducing antibiotic use in their children. <i>Pediatric Research</i> 2003;53(4):265A-65A
Thoolen BJ, De R. Promoting a more prudent use of antibiotics: How effective are patient-oriented interventions? <i>Psychol Health</i> . 2008 Sep;23:254-.	Conference meeting abstract
Turnbull A. PHE launches Antibiotic Guardian campaign. <i>Independent Nurse</i> . 2014:22-.	Newsletter describing campaign
Vinnard C, Linkin DR, Localio AR, et al. Effectiveness of interventions in reducing antibiotic use for upper respiratory infections in ambulatory care practices. <i>Popul Health Manag</i> 2013;16(1):22-7	Targets both prescriber and patient. Outcome prescription rates

Study reference	Reason for exclusion
von Lengerke T, Lutze B, Graf K, Krauth C, Lange K, Schwadtke L, et al. Applying psychological behaviour change theories on hand hygiene: First results of the PSYGIENE-project on social-cognitive and organisational resources. International Journal of Medical Microbiology. 2013 Sep;303:34-.	Conference meeting abstract
Walmsley C et al. (2012). Fostering hand washing before lunch by students attending a special needs young adult program. Research in Developmental Disabilities 34, p. 95-101	Not measuring change in participants' understanding/knowledge/awareness. Measures quantity and quality of hand washing only. Intervention focus lies on 'conditioned reinforcement'. This is a case study of five individuals.
Weischen I, Kuyvenhoven M, Hoes A, Verheij T. Reduced antibiotic prescribing for respiratory tract symptoms after following a postgraduate program: A randomized, controlled study. Huisarts en wetenschap [Internet]. 2005; 48(4):[154-7 pp.]	Study in Dutch
West B, Leek E, Galley T, Ryan D, Tsang A, Sweetman S, et al. Improving compliance with hand hygiene: 'Show & Tell'. Pediatric Pulmonology. 2011:422-.	Conference meeting abstract
Winter CK, Fraser AM, Gleason JB, Hovey SK, McCurdy SM, Snider OS. Food Safety Education Using Music Parodies. Journal of Food Science Education 2009;8(3):62-67	One-group post only study
Yardley L, Douglas E, Anthierens S, Tonkin-Crine S, O'Reilly G, Stuart B, et al. Evaluation of a web-based intervention to reduce antibiotic prescribing for LRTI in six European countries: quantitative process analysis of the GRACE/INTRO randomised controlled trial. Implement Sci. 2013;8:134.	Study aims to reduce antibiotic prescribing. The intervention is targeted at GPs.