Are interventions for low-income groups effective in changing healthy eating, physical activity and smoking behaviours? A systematic review and meta-analysis

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ABSTRACT

Objective: To conduct a systematic review and meta-analysis examining the effectiveness of behavioural interventions targeting diet, physical activity or smoking in low-income adults.

Design: Systematic review with random effects meta-analyses. Studies before 2006 were identified from a previously published systematic review (searching 1995–2006) with similar but broader inclusion criteria (including non-randomised controlled trials (RCTs)). Studies from 2006 to 2014 were identified from eight electronic databases using a similar search strategy.

Data sources: MEDLINE, EMBASE, PsycINFO, ASSIA, CINAHL, Cochrane Controlled Trials, Cochrane Systematic Review and DARE.

Eligibility criteria for selecting studies: RCTs and cluster RCTs published from 1995 to 2014; interventions targeting dietary, physical activity and smoking; low-income adults; reporting of behavioural outcomes.

Main outcome measures: Dietary, physical activity and smoking cessation behaviours.

Results: 35 studies containing 45 interventions with 17 000 participants met inclusion criteria. At postintervention, effects were positive but small for diet (standardised mean difference (SMD) 0.22, 95% CI 0.14 to 0.29), physical activity (SMD 0.21, 95% CI 0.06 to 0.36) and smoking (relative risk (RR) of 1.59, 95% CI 1.34 to 1.89). Studies reporting follow-up results suggested that effects were maintained over time for diet (SMD 0.16, 95% CI 0.08 to 0.25) but not physical activity (SMD 0.17, 95% CI −0.02 to 0.37) or smoking (RR 1.11, 95% CI 0.93 to 1.34).

Conclusions: Behaviour change interventions for low-income groups had small positive effects on healthy eating, physical activity and smoking. Further work is needed to improve the effectiveness of behaviour change interventions for deprived populations.

INTRODUCTION

Health outcomes are strongly correlated with social position in societies across the western world: individuals from deprived backgrounds die younger and experience a greater proportion of their lives with a disability.1–5 In the most deprived areas of England, for example, life expectancy is approximately 8 years less, and disability-free life expectancy 15 years less than in the least deprived areas.6 Among several deprivation indicators, a person’s individual or household income is widely recognised as being strongly positively correlated with health outcomes.3 The social gradient in health is predicted to steepen further despite policy efforts aimed at maximising equality.2–5

Behaviours linked to health, particularly healthy eating, physical activity and smoking, show a similar social gradient to health outcomes. Consumption of tobacco, a poor diet and a lack of physical activity are major risks...
to premature morbidity and mortality. People of lower socioeconomic status are more likely to smoke, be sedentary and eat a poor diet compared with those of higher socioeconomic status. These behaviours have been suggested as mediators of the link between social position and health outcomes.

Changing health behaviours

Given the potential improvements that changes in behaviour can bring to health, health research and clinical practice devotes considerable time and effort to behavioural interventions. For instance, stopping smoking increases life expectancy at any age and halves the risk of cardiovascular disease within 1 year. Experts agree that major improvements in public health will be brought about through behavioural changes in the population. Targeting behaviour change efforts at people at the lower end of the income spectrum is seen as a major means to reducing health inequalities. Gruer et al (ref 12, p.5) for instance argued that “the scope for reducing health inequalities related to social position [...] is limited unless many smokers in lower social positions can be enabled to stop smoking.”

Health behaviour change in low-income populations

Existing behaviour change support for those disadvantaged by income may not be fit for purpose. Evidence suggests that people from low-income groups are more difficult to identify and successfully recruit to general population interventions. Moreover, it has been suggested that low-income populations may achieve poorer behaviour change outcomes following interventions compared with more affluent participants, resulting in poorer health outcomes and potentially leading to intervention-generated inequalities.

In studies targeted at the whole population rather than specific subgroups, Michie et al have argued that observed differences in outcomes between socioeconomic groups may reflect baseline differences in health behaviours, and that the interventions themselves may be effective across the socioeconomic spectrum. In their review of interventions targeted specifically at those disadvantaged by income, examining controlled studies (with or without random allocation) published between 1995 and 2006, they found 15 relevant studies with 17 available comparisons. Approximately half of interventions were reported as effective relative to controls, but no meta-analysis was performed to estimate an overall effect size. At present, there is a lack of evidence on the effectiveness of interventions specifically targeting health behaviour change in low-income individuals.

The aim of the current systematic review is to build on Michie et al’s work by (A) providing an updated review including studies published since 2006, (B) including only randomised controlled trials (RCTs) and (C) applying meta-analysis to estimate intervention effect sizes. We investigated whether studies of interventions targeted at participants from low-income groups are effective in changing diet, physical activity or smoking behaviour.

METHODS

Eligibility criteria

A protocol for this review is not publicly available; however, this article does reflect the relevant components of the PRISMA checklist for the reporting of systematic reviews. The article was submitted with a copy of the checklist confirming this.

Studies included in this review had to meet the following inclusion criteria:

- **Population**: Adults aged 18 years and over, of low income and from the general population. Studies were considered to target a low-income group if they explicitly referred to their participants as ‘low income’. General population was defined as not belonging to a specific clinical group, such as those with diabetes or cardiovascular disease. Pregnant and overweight individuals were not considered to belong to a clinical group and were therefore included.

- **Interventions**: Interventions targeting a change in smoking, eating and/or physical activity behaviours. Studies could target a single behaviour or multiple behaviours in any combination.

- **Study design**: Published RCTs and cluster RCTs (cRCTs). Control condition could be no intervention, a less intense intervention or an intervention with different content.

- **Outcomes**: Behavioural outcomes relevant to smoking cessation, healthy eating and physical activity with no restrictions on length of follow-up. Self-reported individual-level behaviour, more ‘objective’ measures of behaviour and measures of behavioural change were all included, as in Michie et al. Studies were excluded if reported data were unsuitable for meta-analysis.

- **Date**: 1995–2014. Studies published from 1995 to 2006 were identified by screening Michie et al, the primary search included studies published between January 2006 and July 2014. We chose to focus on studies published within the previous two decades to ensure relevance to current financial, social, health and healthcare climates.

- **Language**: English language: in line with Michie et al’s review.

Search strategy

We used studies from 1995 to 2006 which had been identified by Michie et al’s review rather than running the search again because the previous review’s search criteria were similar but broader than our own and should therefore include all articles relevant to the current review. Specific search strategies were created (see online supplementary file 1) to search for studies published since Michie et al’s review of 1995–2006 papers. We searched eight databases: MEDLINE, EMBASE, PsycINFO, ASSIA, CINAHL, Cochrane Controlled Trials, Cochrane...
Systematic Reviews and DARE Electronic Databases. Search strategies were based on Michie et al and included three components: low-income population terms (eg, low-income, poverty, social class or socio-economic status), terms for the three targeted health behaviours (eg, physical activity, diet, smoking cessation, lifestyle, health behaviour or weight reduction) and intervention-relevant terms (eg, behaviour/behaviour change, health program, intervention, health promotion or program evaluation). The specific strategies were iteratively created and tailored to each database’s reference terms with an experienced NHS Clinical Librarian (PM). One author (ERB) initially ran the final searches on 1 December 2011 (January 2006–December 2011) and updated the search using the same search terms in the same databases on 10 July 2014 (December 2011–July 2014). In addition to the primary search, we checked the bibliography of each included study.

**Study selection**

One author (ERB) used the current review’s inclusion criteria to screen the full texts of the 13 studies published between 1995 and 2006 included in Michie et al.25 For the studies published from 2006 onwards ERB, NM and SUD initially screened titles and abstracts, and obtained potentially relevant studies for full-text screening. If no abstract was available the full text was scanned at this first screening stage. If no full text was retrieved, or screening information was missing, ERB contacted the corresponding study author requesting further information. NM and ERB double screened a random sample of 10% of titles and abstracts from the studies from 2006 onwards which they had not previously screened (n=257), agreement with the primary screener was 96%. Later in the screening process, NM screened a random sample of 10% of full-text articles assessed (n=12), agreement was 92%. The small number of disagreements were resolved through discussion.

**Data collection process**

Data were extracted using a prespecified and piloted data extraction form based on Davidson et al’s26 criteria, including study design, target behaviour, participants, recruitment strategies, intervention content and outcome data. Risk of bias in individual studies was assessed based on standard criteria adapted from Avenell et al.27 Where published online supplementary materials were available they were used to assist data extraction (these are referred to in online supplementary table S1), and if information was missing, the corresponding author was contacted. When interventions targeted more than one behaviour, then data were extracted for the different behaviours separately. ERB, SUD, NM and MJ jointly extracted the outcome data.

Data were extracted for all reported time points. The primary outcome was behaviour or behaviour change following the end of the intervention. For the dichotomous smoking outcomes proportions were extracted (eg, per cent of sample reporting smoking abstinence for the past 7 days). For continuous diet and physical activity outcomes means and SDs were extracted (eg, mean portions of fruit and vegetables consumed per week). Where there was a choice of outcome measures, the outcome chosen was the primary behavioural outcome measure specified by the authors, measured by the most objective means (eg, accelerometer data were preferred to self-reported minutes of physical activity) and adjusted for baseline differences if this had been seen as necessary by the authors.

**Synthesis of results**

Data from included studies were meta-analysed in RevMan (V5.2) using random effect models. For outcomes where a reduction (eg, mean percentage calories in fat) signifies a change in a healthy direction, data were reverse-scored before being entered for meta-analysis. For continuous diet and physical activity outcomes, standardised mean differences (SMD) were calculated using Hedges’ g to express the difference between the means for the intervention and control groups in SD units. For dichotomous smoking outcomes, we calculated relative risk (RR) of smoking abstinence and applied the Cochran-Mantel-Haenszel test.

Where studies had multiple comparisons (several intervention arms or reported outcomes for different behaviours) or were cRCTs, we adjusted participant numbers in line with Cochrane recommendations where possible.30 We conducted meta-analyses for the three behaviours separately at two time points: the most proximal time point postintervention and the longest follow-up time point where reported. A 95% CI was used and p<0.05 was taken as significant. We assessed variation in effect size between studies using the I2 statistic, with an I2 >50% interpreted as indicating the presence of heterogeneity.27 Following Cochrane Handbook recommendations,30 we compared independent subgroups of studies differing for two clinically relevant characteristics: interventions targeting women only versus a mixed sex sample, and interventions targeting a single behaviour versus multiple behaviours. Publication bias was assessed by visually inspecting funnel plots.

**RESULTS**

**Study selection**

A flow diagram is presented in figure 1. We identified 3999 references from the database search (including the updated search: numbers for this search are given in figure 1) along with the 13 studies identified in Michie et al’s23 review. After removing 1383 duplicates and excluding 2439 references on the basis of title and abstract screening 130 full texts were screened, of which 120 full texts were successfully retrieved, as 8 articles had no full text and 2 were irretrievable. Full-text screening initially led to the inclusion of 32 studies. Three further studies were identified from title screening reference
sections, so that 35 studies with 45 comparisons met inclusion criteria.25 31–71

**Study characteristics**

**Participant identification and recruitment**

Studies initially identified low-income participants through their place of residence (ie, living within an identified deprived area), by belonging to certain ethnic groups identified by the authors as suffering income inequality, being registered on a financial support programme, through belonging to a health clinic serving disadvantaged groups, by their employment (working in a manual workplace) or by an indicator of income (eg, quintile on the electoral role). Online supplementary table S1 describes how each study defined its study population as ‘low income’. Twenty-three studies reported having measured participants’ income as part of the study. Varying thresholds and income groupings were applied, but most commonly, incomes below US$15–US$20 000 (approximately £8840–£11 800) per year were considered ‘low’ and most studies reported that the majority of participants were in this category. Of the remaining 12 studies, 8 recruited participants from financial support programmes which required beneficiaries’ earnings to be equivalent or near to official US poverty levels (which vary over time and depending on the individual’s household size), 2 reported that the majority of participants held a manual, low wage occupation and the final 2 studies reported that participants’ neighbourhoods had a high proportion of residents living in poverty.

Following initial identification, participants were recruited through face-to-face contact, via letter, telephone, via media advertisement or most commonly a mixture of methods. Face-to-face opportunities described were door-to-door neighbourhood recruitment, organisation of a community health fair, invitation at medical or social services appointments, or through presentations at schools or other community groups. Telephone calls were usually a follow-up method of contact. Media advertisements included posters in community venues, newspaper, radio and television advertisements. In the majority of cases, it was the study investigators who initiated these recruitment activities. Timeframe of recruitment varied from 1 day to over 2 years. Techniques used to engage low-income groups in participating were poorly specified: those most commonly reported were offers of material incentives (eg, vouchers for signing up), prompts and cues (eg, a fridge magnet with the study telephone number) or social support to facilitate participation (eg, advising about crèche facilities).

**Study design and participant characteristics**

The characteristics of the 35 included studies are summarised in online supplementary table S1. The majority (k=30) were conducted in the USA; the remaining studies were from the UK (k=3), Australia (k=1) and Chile (k=1). Twenty-eight studies were RCTs; seven were cRCTs. Studies took place in community (k=22), healthcare (k=12) or workplace (k=1) settings. Seven studies tested a dietary intervention, 15 studies tested a physical activity intervention, and the remaining 6 tested interventions for multiple behaviours (5 tested diet and physical activity interventions, 1 tested diet and smoking interventions). Three studies had multiple intervention arms for one behaviour. In total, this yielded 16 interventions for the dietary meta-analysis, 12 interventions for physical activity meta-analysis and 17 for smoking meta-analysis. Each study randomised between 27 and 2549 participants, yielding a total of exactly 17 000 participants across the 35 studies. Of the 34 studies specifying participants’ sex, 19 targeted women exclusively and no study sampled only men. Women formed 72.4% of all participants. Mean average age of participants was 38.6, this ranged from 22.0 to 66.2 across study subgroups.
Intervention content

The content of interventions varied from provision of tailored self-help materials, to individual counselling or group programmes, but was often complex and poorly described (see online supplementary table S1). Control groups in the intervention tended to receive usual care, a less intense version of the intervention or an inactive version (eg, non-tailored materials). Intervention duration varied from a single episode to 2 years; the mode duration was 3 months. The intervention facilitator was described in 18 studies. In 13 studies this was either a routine healthcare provider such as a nurse or general medical practitioner, or a ‘non-routine’ healthcare provider such as a psychologist, dietician or smoking counsellor. Of the remaining five studies, the facilitator was a peer educator in three studies and a study administrator in two.

Intervention outcomes

Twenty-one studies assessed the behavioural outcome using self-report; 14 studies included an objective measure relating to behaviour such as biochemically confirmed smoking cessation. For dietary interventions, the primary outcome was fruit and vegetables consumed, grams of fat, dietary risk assessment score (which estimates saturated fat and cholesterol intake) or calories from fat consumed per day. For physical activity, studies reported a wider range of outcomes including mean number of minutes or hours of moderate physical activity per week, metres walked in 6 min, or metabolic equivalent minutes of activity per week. Smoking studies reported the number of participants who were abstinent from smoking, such as for the past 7 days, postpartum or for the previous 6 months. Studies differed in the delay between end of the intervention and most proximal assessment: this ranged from a few hours up to 8 months. Fourteen studies included follow-up data beyond the end of intervention time point. Overall 19.8% participants did not complete final assessments.

Risk of bias within studies

Online supplementary table S2 details the risk of bias assessment of the included studies. Risk of bias was variable. The majority of studies did not describe random allocation concealment procedures, provided numbers but not reasons for dropouts, did not mention blinding of any party and stated having used intention-to-treat analyses. There is therefore some risk of bias particularly during randomisation and surrounding blinding.

Quantitative data synthesis: effectiveness of interventions

Diet

Study outcomes are included in online supplementary table S3. The 16 dietary interventions were found to have an SMD of 0.22 (95% CI 0.14 to 0.29, I²=48%; figure 2). Eight dietary interventions provided longer term follow-up data, for 6–12 months postbaseline with combined SMD of 0.16 (95% CI 0.08 to 0.25, I²=41%).

Physical activity

Twelve physical activity interventions yielded an SMD of 0.21 (95% CI 0.06 to 0.36, I²=76%; figure 3). Three interventions provided longer term follow-up data 6–8 months postbaseline with a combined SMD of 0.17 (95% CI −0.02 to 0.37, I²=0%).

Subgroup analyses for heterogeneity suggested SMDs were not different (p=0.48) in four interventions targeting women only (SMD 0.14, 95% CI 0.00 to 0.27, I²=0%) compared with eight with a mixed sex sample (SMD 0.24, 95% CI −0.02 to 0.49, I²=90%). Effects were larger (p<0.001) in seven interventions targeting physical activity only (SMD 0.32, 95% CI 0.18 to 0.45, I²=32%) than five interventions targeting multiple behaviours including physical activity (SMD 0.00, 95% CI −0.07 to 0.08, I²=0%).

Figure 2

Standardised mean differences immediately postintervention for studies focusing on dietary change (ordered by effect size).

Bull ER, et al. BMJ Open 2014;4:e006046. doi:10.1136/bmjopen-2014-006046

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Smoking

Seventeen smoking interventions were found to have a RR of smoking abstinence of 1.59 (95% CI 1.34 to 1.89, I²=40%; figure 4). Ten interventions provided longer term follow-up data for 3–12 months postbaseline. Positive intervention effects were not maintained; RR of smoking abstinence was 1.11 (95% CI 0.93 to 1.34, I²=15%).

Publication bias

Visual inspection of funnel plots showed little evidence of publication bias.

DISCUSSION

Summary of evidence

We systematically reviewed the effectiveness of interventions targeted at changing the diet, physical activity or smoking of low-income groups. The review updates and extends a previous narrative review by including recently published studies; incorporating RCTs only and applying meta-analysis to examine intervention effect.

We identified 35 studies containing 45 dietary, physical activity and smoking interventions. Studies used a wide range of methods to identify and engage low-income participants. Most studies were conducted in the USA, contained mostly women and were often delivered by a healthcare professional. The quality of studies was variable with some risk of bias identified.

Our meta-analysis estimated a postintervention SMD of 0.22 for diet, 0.21 for physical activity interventions and a RR of smoking abstinence of 1.59 for smoking interventions. This means that the interventions had small positive effects on behaviour relative to controls. For studies reporting follow-up data, the small positive effects were maintained for diet (SMD 0.16) but not physical activity (SMD 0.17) or smoking cessation (RR 1.11). However long-term effects are based on a small subset of studies. Our exploration of the variation between physical activity interventions suggested that studies which focused on a single behaviour were more effective.

Implications of findings

We found small intervention effects on the behaviour of low-income groups compared with controls. For healthy eating, this was equivalent to intervention groups eating just under half a portion of fruit and vegetables more...
than controls each day. Similar reviews not targeting low-income participants tend to report larger effects: four such reviews targeting adults in the general population reported larger effects for diet (SMD 0.31), physical activity (SMD 0.28–0.32) and smoking (RR 2.17) interventions. Although true comparison is not possible unless the same interventions were compared in different population groups, this does suggest that interventions may be less effective for low-income populations. If other population groups benefit more from current interventions, even than those specifically targeted at low-income groups, then we can expect an overall gradual widening of health inequalities, as has been reported. Clearly research with more effective interventions is needed, including RCTs conducted in the UK, to increase our understanding of ‘what works’ for low-income groups.

Our analysis of the variation in physical activity studies showed a trend towards studies being more effective if they target a single behaviour than two behaviours. In addition, only one smoking study targeted both smoking and diet and this was the study with the lowest overall effect size. This resonates with the argument that human self-regulation draws on limited resources which may be best applied to one behaviour change target at a time. In contrast, physical activity studies including women only did not seem to vary widely in effectiveness from those with a mixed sex sample. Nevertheless there may be other unexplored sources of heterogeneity including other aspects of the delivery of interventions, such as those in the TIDIER checklist or use of techniques from the recently published Behaviour Change Technique taxonomy v1.

Limitations
This study was a systematic but not exhaustive review, for instance not including informally published reports or ‘grey literature’, which tend not to be indexed within conventional databases. It limited its scope to RCTs and cluster RCTs to gather the highest quality evidence available, but some authors argue that reviewers should include less well-controlled studies because they often have enhanced external validity. In common with similar reviews methodological quality of studies was variable: for example, few studies blinded participants, facilitators or outcome assessors to treatment group. However, blinding of treatment condition in behavioural interventions is notoriously difficult: this is a criticism common to many similar reviews. Definitions of and thresholds for ‘low income’ varied somewhat between studies, reflecting the fact that there is no one agreed-on ‘cut-off’ for low income. We specified that the term ‘low income’ had to be used to refer to participants for studies to be included, since this is a relevant deprivation indicator in our financial and social context, perhaps more so than others such as education level. However, relevant papers not using this term may have been missed, particularly studies from some settings (eg, perhaps a church setting) where income may have been less likely to have been measured than others (eg, the workplace). Nevertheless, our review did identify studies using a wide range of concepts to target low socioeconomic status, such as area of residence, belonging to certain ethnic groups, belonging to a health clinic serving disadvantaged groups, as well as concepts directly linked to low income, such as indicator of income. Therefore, using the term ‘low income’ allowed us to implement a clear, objective and replicable criterion for including studies in the review, while also allowing us to capture studies considering low socioeconomic status in a variety of ways.

Additionally, the majority of studies were conducted in the USA, limiting generalisability to the UK context, although effect sizes for the UK studies fell within the typical range. Interventions were generally poorly specified. Categorisation or coding of control group content was not possible, even though studies show that this may vary substantially and influence intervention outcomes. Our review is also limited in scope to studies written in the English language. A final caveat for our findings is that while we excluded a study where the authors advised us that the data were zero-inflated, this may have been true of other studies.

CONCLUSIONS
This systematic review with meta-analysis of randomised controlled interventions to improve the diet, physical activity or smoking behaviour of low-income groups found small positive effects of interventions on behaviour compared with controls, which persisted over time only for diet. Despite research highlighting the urgent need for effective behaviour change support for people from low-income groups to assist in reducing health inequalities, this review suggests that our current interventions for low-income groups are positive, but small, risking ‘intervention-generated inequalities’. Policy makers and practitioners alike should seek improved interventions for disadvantaged populations to change health behaviours in the most vulnerable people and reduce health inequalities.

Acknowledgements The authors are grateful for the assistance of Mr Paul Manson, NHS Grampian Clinical Librarian, in the design of search strategies. They would also like to sincerely thank Professor Susan Michie, University College London, Dr Linda Leighton-Beck, NHS Grampian Keep Well Programme Director and Mrs Dorothy Ross-Archer, NHS Grampian Keep Well Programme Manager. Finally, they are also very grateful to the study authors who kindly provided additional data or advice for the review.

Contributors ERB and MJ had the original idea for the paper and designed the review method and analyses. ERB, SUD, NM and MJ participated in study selection and data extraction. ERB and SUD conducted statistical analysis. ERB, SUD, NM and MJ participated in writing the manuscript. ERB is the guarantor for the study.

Funding This research received no specific grant from any funding agency in the public, commercial or not-for-profit sectors.
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Competing interests ERB is an employee of NHS Grampian. SJD is an employee of University of Stirling. NM is a PhD student at the University of Aberdeen. MJ is an emeritus professor at University of Aberdeen.

Provenance and peer review Not commissioned; externally peer reviewed.

Data sharing statement No additional data are available.

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43. Sanchez-Johnsen LA, Stolley MR, Fitzgibbon ML. Diet, physical activity, and breast health intervention for Latina women. Hispanic Health Care Int 2006;4:101–10.

44. Steptoe A, Perkins-Porras L, McKay C, et al. Behavioural counselling to increase consumption of fruit and vegetables in low-income adults: randomised trial. BMJ 2003;326:855.
### Supplementary File 1: Example Search Strategy

**Medline Database 1st December 2011**

| Step | Search Term                | Count  |
|------|----------------------------|--------|
| 1    | exp poverty/               | 18153  |
| 2    | exp poverty areas/         | 2800   |
| 3    | exp social class/          | 15096  |
| 4    | exp social conditions/     | 3188   |
| 5    | "low income".ti,ab.        | 10169  |
| 6    | 1 or 2 or 3 or 4 or 5      | 40230  |
| 7    | exp Life Style/            | 37377  |
| 8    | exp weight gain/           | 14266  |
| 9    | exp overweight/            | 77138  |
| 10   | exp Weight Loss/           | 17681  |
| 11   | exp obesity/               | 75542  |
| 12   | exp food habits/           | 10789  |
| 13   | exp fruit/                 | 32639  |
| 14   | exp vegetables/            | 47553  |
| 15   | exp exercise/              | 45754  |
| 16   | exp diet therapy/          | 16335  |
| 17   | exp diet/                  | 82764  |
| 18   | exp Smoking/pc, px, th [Prevention & Control, Psychology, Therapy] | 13314  |
| 19   | exp smoking cessation/     | 14366  |
| 20   | exp "Tobacco Use Cessation"/ | 14858  |
| 21   | exp "Tobacco Use Disorder"/| 5420   |
| 22   | exp health behavior/       | 58129  |
| 23   | "health behavio*".ti,ab.   | 6627   |
| 24   | 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17 or 18 or 19 or 20 or 21 or 22 or 23 | 83647  |
| 25   | exp program development/   | 16327  |
| 26   | exp program evaluation/    | 40639  |
| 27   | exp intervention studies/  | 4265   |
| 28   | exp health promotion/      | 32938  |
| 29   | 25 or 26 or 27 or 28       | 83647  |
| 30   | 6 and 24 and 29            | 728    |
| 31   | limit 30 to (english language and yr=":2006 -Current") | 425    |
**Table 1**: Study characteristics: organised by behavioural target and then by alphabetical order of lead study author

| Study ID, additional references, year and country of publication | Study design | Participants randomised | Intervention description | Control description | Primary outcome | Main outcome time point and follow-up (weeks) |
|---|---|---|---|---|---|---|
| **DIET** | | | | | | |
| Ahluwalia (diet) Supplemented by Okuyemi et al. (2007) | cRCT | ▪ 173 smokers in a low-income public housing development<br▪ 52 m, 121 f<br▪ Mean age = 48 (13.1)<br▪ 72.9-74.2% had individual income ≤$800/month | Motivational interviewing counselling, provision of fruit and vegetables, a cookbook and educational videos | Motivational interviewing for smoking and nicotine gum (see Ahluwalia smoking) | SR Portions of fruit and vegetables per day, last 7 days | 6 months |
| 2007 USA | | | | | | |
| Auslander | cRCT | ▪ 294 low-income overweight African American women<br▪ Mean age ranged from 40.2 (8.2) to 41.2 (7.8)<br▪ 60-70% below the poverty line (not defined). Mean family income $1,367.8 ±$1,047.0 to $1,619.1 ± $1,206.7/month | Culturally-tailored peer-led dietary change program | No intervention until after final follow-up | SR mean % of calories from fat | Posttest: 3 month post baseline<br6 month post baseline follow-up |
| Study | Type | Interventions | Measures | Timepoints |
|-------|------|---------------|----------|------------|
| Chang (diet)\(^{34}\) Supplemented by Chang et al. 2009\(^{35}\) 2010 USA | RCT | 129 overweight and obese mothers from WIC sites  Mean age ranged from 25.12 (4.10) - 25.53 (3.94). 18-34. Income not reported but mothers eligible for the Women, Infants and Children Supplemental Food and Nutrition Program (WIC) so have a household ≤185% of the federal poverty level, which in 2010 was $3677/month for a family of four\(^*\) | DVD, peer support group and telephone calls | Usual care | SR cups of fruit and veg per day | 2 month, 8 month 8 month follow-up |
| Elder\(^{36}\) (2 arms) 2006 USA | RCT | 257 low-income, Spanish-dominant Latina women  Mean age = 39.71 (9.93) 53% had an individual income <$2000/month | Tailored intervention: Tailored mailed materials Promotora intervention: Tailored materials and weekly home visits/telephone support | Non tailored, off the shelf materials | SR Mean grams of fat per day | M2 12 weeks M3 timepoint ‘6 m post-intervention’ M4 timepoint ‘12m post-intervention’ |
| Study | Type | Randomised Controlled Trial (RCT) | Description | Intervention | Control | Endpoint |
|-------|------|-----------------------------------|-------------|-------------|---------|----------|
| Emmons (diet)\(^{37}\) | cRCT | 1954 low-income multi-ethnic adults  
- 747 m, 1469 f  
- Age range 18-75  
- Income not reported but all participants lived in neighbourhoods classed as ‘impoverished’ (≥20% live below the federal poverty level) | Behavioural counselling, telephone support and mailings | Usual care: Not well specified | SR Fruit and veg servings per day | 4 month service  
7 months follow-up |
| Gans\(^{38}\) (3 arms) | RCT | 1841 low-income ethnically diverse adults  
- 275 m, 1566 f  
- Mean age = 40.4 (12.9), 18-52  
- 56.4% individual income <$20,000/year | Multiple Tailored (MT) intervention:  
4 tailored mailed educational packages + a DVD  
Multiple Re-tailored (MTI) intervention:  
4 tailored educational packages based on telephone reassessments + a DVD | Non tailored nutrition information | SR Fruit and veg servings per day | 4 month service  
7 months follow-up |
| Study | Intervention Details | Study Details | Counselling | Usual Care | End Point Data | Follow-Up Data |
|-------|----------------------|---------------|-------------|------------|----------------|----------------|
| **Jackson (diet)\[^{39}\]**<br>2011<br>USA | - 321 ethnically diverse low-income pregnant women<br>- Mean age 26.5 (6)<br>- Income not reported, but 85% of women received Medicaid, which in 2011 required pregnant women to have an individual income \( \leq \$1862/\text{month} \) | RCT | Counselling via a virtual video-doctor | Usual care: prenatal care appointment | SR fruit and vegetable intake per day | 4 weeks |
| **Keyserling (diet)\[^{40}\]**<br>Supplemented by Jilcott et al. (2006)\[^{41}\]<br>2008<br>USA | - 236 low-income women from the WISEWOMAN program<br>- Mean age ranged from 52 (0.64) – 54 (0.66).<br>- Eligible for study if at or below 200% of the federal poverty level. 93-96% of participants had household income \( \leq \$30,000/\text{year} \) | RCT | Counselling | Mailed diet and exercise leaflets | End point data: objectively measured fruit and veg intake, via median serum carotenoids (ug/dL). Follow-up data: fruit and vegetable consumption via Dietary Risk Assessment (score range 0-103,) | 6 month assessment 12 month assessment |
| Study | Design | Participants | Intervention | Assessment | Outcome | Duration |
|-------|--------|--------------|--------------|------------|---------|----------|
| Nitzke et al. 2007 | RCT | 2024 low-income young adults<br>- 786 m, 1238 f<br>- Mode age 18. Age range 18-24.<br>- 60% had individual income <$800/month | Tailored nutrition materials<br>Non-tailed materials | SR Fruit and vegetable intake per day | 12 months assessment |
| Parra-Medina 2011 | RCT | 226 low-income African American women<br>- Aged 35 and over, mode age range 35-49, mean not specified<br>- 50% had annual income <$20,000 | Stage-matched provider counselling and assisted goal setting plus 12 months of telephone counselling and tailored newsletters | Stage-matched provider counselling and assisted goal setting | SR dietary risk assessment score (rated between 0 and 104, where lower scores equal a lower intake of saturated fat and cholesterol) | 12 month assessment |
| Sanchez-Johnsen 2006 | RCT | 27 overweight Latina women<br>- Mean age ranged from 43.2 (6.3) to 44.9 (8.2). 35-65<br>- 52% family income <$16,000/year | Diet classes | Mailed health education | SR fruit and veg servings per day | 6 week assessment |
| Steptoe 2003 | RCT | 271 adults from deprived areas<br>- Sex not specified<br>- Age range: 18-70<br>- 68% had an individual income £400 ($640) /week | Behavioural counselling sessions, tailored to motivation level | Non-tailed nutrition education counselling | SR fruit and veg servings per day | 12 months |
| **Tessaro**<sup>27</sup> | RCT | 395 low-income women  
Mean age 50.25  
67% household income <$20,000/year | Computer-based interactive nutrition intervention | No intervention: waiting list control | SR fruit and veg servings per day | 3 months |
|---|---|---|---|---|---|---|
| **Physical Activity** | | | | | | |
| **Armitage**<sup>25</sup> | RCT | 68 manual workers  
35 m, 33 f  
Mean age = 27 (12.71)  
Income not reported, though all had manual or clerical job roles | Volitional help sheet with implementation intentions | Help sheet without implementation intentions | SR metabolic equivalent minutes exercise per week (MET minutes) | 1 month |
| **Chang** (Physical activity)<sup>34</sup>  
Supplemented by Chang et al. 2009<sup>35</sup>  
2010 | RCT | See Chang (diet) above for description of the study’s participants | DVD, peer support group and telephone calls | Usual care | SR metabolic equivalent minutes exercise per week (MET minutes) | 2 months  
8 month follow-up |
| **Dangour**<sup>48</sup>  
Supplemented by Dangour et al. (2007)<sup>49</sup>  
2011 | cRCT | 1897 older adults registered with health centres in low-middle socioeconomic status municipalities  
656 m, 1346 f | Physical activity program | Educational materials on healthy eating, and information about healthcare | Objectively measured walking capacity: metres walked in six minutes | 24 month assessment |
| Country   | Study Type | Randomized Controlled Trial (RCT) | Description | Treatment | Control | Outcome Measure |
|-----------|------------|----------------------------------|-------------|-----------|---------|-----------------|
| Chile     |            |                                  | Mean age ranged from 66.1 (0.9) – 66.2 (1.0). 64-67.9 | Tailored weight loss intervention | Usual care | provision       |
|           |            |                                  | Income not reported, but all attended health centres where median 9.2% of the population live in poverty (per capita income less than twice the price of a basic basket of food in Chile) | | | |
| Dutton    | RCT        | 2007 USA                         | 158 overweight low-income African American women | Behavioural counselling and telephone support and mailings | Usual care | SR hours exercise per week Post-treatment |
| Emmons    | eRCT       | 2005 USA                         | See Emmons (diet) above for description of the study’s participants | Counselling via a virtual video-doctor | Usual care? Not well specified | Mean hours per week of physical activity Endpoint |
| Emmons    | cRCT       | 2005 USA                         | See Emmons (diet) above for description of the study’s participants | Behavioural counselling and telephone support and mailings | Usual care? Not well specified | Mean hours per week of physical activity Endpoint |
| Jackson   | RCT        | 2011 USA                         | See Jackson (diet) above for description of the study’s participants | Counselling via a virtual video-doctor | Usual care: pre-natal care appointment | SR minutes per week of physical activity 4 weeks |
| Keyserling| RCT        | 2011 USA                         | See Keyserling (diet) above for description of the study’s participants | Counselling | Mailed leaflets | Objectively measured PA; accelerometer 6 month assessment |
| Study | Design | Country | Participants | Description | Intervention | Measures | Follow-Up |
|-------|--------|---------|--------------|-------------|--------------|----------|-----------|
| Supplemented by Jilcott et al. (2006) | RCT | USA | 266 inactive Latina women | Tailored Spanish-language mailings of physical activity and individualised feedback reports | SR minutes of moderate to vigorous physical activity per week | 6 months post-intervention outcome |
| Marcus | RCT | USA | 266 inactive Latina women | Tailored Spanish-language mailings of physical activity and individualised feedback reports | SR minutes of moderate to vigorous physical activity per week | 6 month post-intervention outcome |
| Olvera | cRCT | USA | 46 low-income Latina mothers | Exercise and counselling | Same but 12 not 36 sessions | 12 week assessment |
| Pekmezci | RCT | USA | 93 Underactive Latina women | Tailored monthly mailings on physical activity | 6 monthly mailings on other topics | 6 months |
| Sanchez-Johnsen | RCT | USA | See Sanchez-Johnsen (diet) above for description of the study’s participants | Exercise classes | Mailed health education | 6 week assessment |
### Whitehead\textsuperscript{35} 2007 USA

- **RCT**
- 206 low-income African Americans
  - 36 m, 171 f
  - Average age 50
  - 64% household income <$1000/month

| Mailed tailored physical activity information | Mailed non tailored information about a low-sodium diet | SR time spent in physical activities for last 7 days, yielding an estimated caloric expenditure | 1 month assessment follow-up |

### SMOKING

#### Ahluwalia\textsuperscript{31} (Smoking) Supplemented by Okuyemi et al. 2007\textsuperscript{32} 2007 USA

- **RCT**
- 173 smokers in a low-income public housing development
  - 52 m, 121 f
  - Mean age = 48 (13.1)
  - 72.9-74.2% had individual income ≤$800/month

| Motivational interviewing counselling for smoking and nicotine replacement therapy (NRT) | Motivational interviewing counselling, provision of fruit and vegetables, a cookbook and educational videos (see Ahluwalia, diet, above) | Biochemically confirmed smoking abstinence 7 days | 6 month assessment |

#### Andrews\textsuperscript{56} Supplemented by Andrews et al.

- **RCT**
- 103 African American women from a subsidised housing development.

| Counselling, NRT and community health worker | Smoking print materials, group education on | Biochemically confirmed smoking abstinence 7 days | 6 month assessment |
| Study | Design | Country | Age and Income Information | Intervention | Outcome | Follow-Up |
|-------|--------|---------|-----------------------------|-------------|---------|-----------|
| Bullock<sup>35</sup> 2007 USA | RCT | 695 women attending Women Infant and Children Nutritional Supplement (WIC) clinic  
Mean age = 22 (4.6)  
Income not reported but all women were eligible for WIC program so have household monthly gross income of ≤185% of the federal poverty level (see also Chang participant description) | Social Support (SS) intervention: Telephone calls from a nurse and 24 access through a pager  
Social Support plus booklets (SS+B) intervention: Same with eight mailed booklets on stopping smoking in pregnancy  
Booklets alone (B) control intervention: Eight mailed booklets on stopping smoking in pregnancy  
Control (C) intervention: no intervention | Biochemically confirmed smoking abstinence for previous 7 days  
End of pregnancy (T2)  
Post-delivery follow up (T3) |  

| Dornelas<sup>39</sup> 2006 USA | RCT | 105 pregnant smokers from a non-profit tertiary care community hospital  
Mean age = 26.1 (5.8), 18-42  
49% household income of ≤$15,000/year.  
Counselling session and telephone follow-up | Usual care: standard smoking cessation advice  
Biochemically confirmed smoking abstinence for previous 7 days  
End of pregnancy assessment  
Six months post-partum follow- |
| Author | Year | Country | Study Design | Participants | Intervention | Outcome Measure | Follow-up |
|--------|------|---------|--------------|--------------|--------------|-----------------|-----------|
| Fang   | 2006 | USA     | RCT          | 66 low-income Chinese and Korean smokers  
63 m, 3 f  
Mean age ranged from 43.97 (17.21) to 48.35 (16.47)  
68% had individual income ≤$15,000/year | Motivational interviewing style session + NRT  
General health counselling, an educational booklet + NRT | SR smoking abstinence, last 7 days | 1 week assessment  
1 month and 3 month follow-up |
| Froelicher | 2010 | USA     | cRCT         | 60 African Americans from a low-income neighbourhood with high health disparities  
17 m, 43 f  
Mean age = 46 (10.8)  
55.9-61.5% individual income <$15,000/year | Smoking cessation program and tobacco industry and media messages hand-outs  
Standard smoking cessation program and written hand-outs | Biochemically confirmed abstinence | 6 month assessment  
12 months follow-up |
| Gordon | 2010 | USA     | cRCT         | 2549 smokers visiting public dental clinics serving people of low-income  
1241 m, 1508 f  
Mean age = 40.5 (12.6)  
Income not reported but participants at or below 200% of the federal poverty threshold as | Brief smoking advice  
Usual care | SR smoking abstinence for last 6 months | 7.5 months end point |
defined by the US Census Bureau 2006-8. This equates to an individual income ≤ $19,600/year.*

| Study | Design | Country | Sample Size | Participant Characteristics | Intervention Details | Outcome Measures | Follow-up | Notes |
|-------|--------|---------|-------------|-----------------------------|----------------------|-----------------|----------|-------|
| Liles* | RCT    | USA     | 150         | 150 low-income mothers who smoke from WIC programme  
Mean age 30.1 (7.1)  
Income not reported but all eligible for WIC program so have household monthly gross income of ≤185% of the federal poverty level (see also Chang participant description) | Counselling to decrease second-hand smoke exposure | Not specified | Biochemically confirmed quit for at least 7 days over study period | 18 month assessment |
| Miller* | RCT    | Australia | 1377       | 1377 disadvantaged smokers  
Age not specified  
Income not reported but all participants were eligible for an Australian Government concession card, which currently requires an individual income of <$2,072AUS/month ($1948 US dollars)** | Availability of a quitline and NRT | Availability of a quitline without NRT | SR smoking abstinence: previous day | 3 month assessment  
6 months and 12 months follow-up |
| Okuyemi* | RCT   |         | 430        | 430 homeless adult smokers | Multi session | Standard care of | Biochemically | 8 weeks (post- |
| Year | Location | Study Design | Participants | Intervention | Follow-up | Outcome |
|------|----------|--------------|--------------|--------------|-----------|---------|
| 2013 | USA      |              | 63.5% had a monthly family income <$400 | motivational interviewing intervention and NRT | 26 weeks (follow-up) | confirmed smoking abstinence: previous seven days |
| 2010 | USA      | RCT          | 251 low-income pregnant ex-smokers | Motivation and problem solving intervention | Biochemically confirmed smoking abstinence following delivery of baby | Follow-up week 26 post-partum |
| 2000 | USA      | RCT          | 214 medicaid-eligible female smokers of childbearing age | 3 months of telephone support and NRT | Biochemically confirmed smoking abstinence: previous seven days | 3 months |
| 2005 | USA      | RCT          | 330 low-income women smokers | 3 months of telephone support for psychosocial issues surrounding quitting and NRT | NRT only | 3 months |

Note: NRT stands for Nicotine Replacement Therapy.
| Study | Year | Country | RCT Type | Description | Intervention Details | Outcome Measures | Follow-up Details |
|-------|------|---------|----------|-------------|----------------------|------------------|------------------|
| Sykes | 2001 | UK      | RCT      | 260 adult smokers from a deprived area, 94 m, 166 f, Age not specified, Income not reported, 42% in manual occupation or unemployed and therefore defined as ‘low-income’ | Quit for life self-help cognitive behavioural programme, Usual care ‘stopping smoking made easier’ booklet | Biochemically confirmed smoking abstinence: previous seven days | Follow-up outcome point |
| Volpp | 2006 | USA     | RCT      | 179 low-income veteran smokers, 168 m, 10 f, Mean age ranged from 52.7 to 53.1, 49.7% household income <$15,000/year | Free smoking cessation program +financial incentives for attending class and quitting smoking, The same program without incentives | Biochemically confirmed smoking abstinence: previous seven days | 30 day assessment, 6 months follow-up |
| Wu    | 2009 | USA     | RCT      | 139 low-income Chinese American smokers, 107 m, 15 f, Mean age ranged from 43.9 (12.1) – 45 (12.8), 72%-77% individual income <$20,000/year | Motivational interviewing counselling for smoking, General health counselling | Biochemically confirmed quit at follow-up | 6 month assessment |

Note: RCT=randomised controlled trial. cRCT=cluster randomised controlled trial. SR=self-reported. If a study had multiple arms testing interventions for one behaviour, they are listed under one section in the table. If the study included interventions with the same participants for more than one behaviour, the characteristics for each
intervention are reported separately for the relevant behavioural target *Source: [http://familiesusa.org/product/federal-poverty-guidelines](http://familiesusa.org/product/federal-poverty-guidelines) retrieved 14.06.14 ** Source: [http://www.humanservices.gov.au/customer/enablers/centrelink/low-income-health-care-card/income-test](http://www.humanservices.gov.au/customer/enablers/centrelink/low-income-health-care-card/income-test), retrieved 14.06.14
Table 2: Risk of bias for individual studies, in alphabetical order (following Avenell et al. 2004).

| Lead study author | Quality of random allocation concealment | Description of withdrawals and drop outs | Intention to treat analysis? | Participants blinded to treatment status? | Intervention facilitators blinded to treatment status? | Outcome assessors blinded to treatment status? |
|-------------------|-----------------------------------------|------------------------------------------|----------------------------|----------------------------------------|------------------------------------------------|----------------------------------|
| 1 Ahluwalia<sup>31,32</sup> | A | Numbers and reasons | Yes | Bi | C | C |
| 2 Andrews<sup>56,57</sup> | C | Numbers stated only | Yes | Bi | Bi | Bi |
| 3 Armitage<sup>25</sup> | C | Numbers stated only | Yes | Ai | Ai | C |
| 4 Auslander<sup>33</sup> | C | Numbers stated only | No | Bi | Bi | Bi |
| 5 Bullock<sup>58</sup> | Bi | Numbers and reasons | Yes | Ai | C | Ai |
| 6 Chang<sup>34,35</sup> | Bi | Numbers and reasons | No | Ai | Ai | Bi |
| 7 Dangour<sup>48,49</sup> | Bi | No numbers given | Yes | C | C | Ai |
| 8 Dornelas<sup>59</sup> | Bi | Numbers and reasons | Yes | Bi | Bi | Bi |
| 9 Dutton<sup>50</sup> | Bi | Numbers and reasons | Not clear | C | C | C |
| 10 Elder<sup>56</sup> | Bi | Numbers and reasons | No | C | C | C |
| 11 Emmons<sup>37</sup> | Bi | Numbers stated only | Yes | Bi | Bi | Bi |
| 12 Fang<sup>60</sup> | C | Not mentioned | Yes | C | C | C |
| 13 Froelicher<sup>61</sup> | Bi | Numbers stated only | Yes | C | C | Bii |
| 14 Gans<sup>48</sup> | A | Numbers and reasons | Yes | Bi | Bi | Aii |
| 15 Gordon<sup>62</sup> | Bi | Numbers stated only | No | Bi | Bi | Bi |
| 16 Jackson<sup>59</sup> | A | Numbers and reasons | Yes | C | Ai | C |
| 17 Keyserling<sup>40,41</sup> | A | Numbers and reasons | Yes | Bi | Bi | Bi |
| 18 Liles<sup>64</sup> | Bi | Numbers stated only | Yes | Bi | Bi | Ai |
| 19 Marcus<sup>51</sup> | Bi | Numbers and reasons | Yes | Bi | Bi | Aii |
| No. | Study | Quality of random allocation concealment | Blinding |
|-----|-------|-----------------------------------------|----------|
| 20  | Miller | Numbers stated only                      | Yes      |
| 21  | Nitzke | Numbers stated only                      | Yes      |
| 22  | Okuyemi| Numbers and reasons                      | Yes      |
| 23  | Olvera | Numbers and reasons                      | No       |
| 24  | Parra-Medina |  | Yes      |
| 25  | Pekmezi| Numbers and reasons                      | Yes      |
| 26  | Reitzel| Numbers stated only                      | Yes      |
| 27  | Sanchez-Johnsen | NA | No       |
| 28  | Steptoe| Numbers stated only                      | Yes      |
| 29  | Tessaro| Numbers stated only                      | No       |
| 30  | Solomon| Numbers stated only                      | Yes      |
| 31  | Solomon| Numbers stated only                      | Yes      |
| 32  | Sykes  | Numbers stated only                      | Yes      |
| 33  | Volpp  | Numbers stated only                      | Yes      |
| 34  | Whitehead |  | Yes      |
| 35  | Wu     | Numbers and reasons                      | No       |

**Note.** NA = not applicable

*Quality of random allocation concealment:*
A = good attempt at concealment
Bi = states random allocation but no description given
Bii = attempt at concealment but real chance of disclosure of assignment prior to formal trial entry
C = definitely not concealed

*Blinding:*
$A_i$ = action taken at blinding likely to be effective
$A_{ii}$ = blinding stated but no description given
$B_i$ = no mention of blinding
$B_{ii}$ = attempt at blinding but reason to think it may not have been successful
$C$ = not blinded
### Table 3: Intervention outcomes: organised by behavioural target and then by alphabetical order of lead study author

| Study reference and follow-up point | Outcome measure                                                                 | Control group baseline mean (SD/SE) | Intervention group baseline mean (SD/SE) | Control group endpoint mean (SD/SE) or proportion abstinent from smoking | Intervention group endpoint mean (SD/SE) or proportion abstinent from smoking | Follow-up outcome mean (SD/SE) or proportion abstinent from smoking | Intervention effect as reported in the paper |
|-----------------------------------|---------------------------------------------------------------------------------|-------------------------------------|-----------------------------------------|--------------------------------------------------------------------------|-----------------------------------------------------------------------------|-----------------------------------------------|-----------------------------------------------|
| **DIET**                          |                                                                                 |                                     |                                         |                                                                          |                                                                            |                                               |                                               |
| Ahluwalia31,32                      | SR Portions of fruit and vegetables per day, last 7 days                        | 2.17 (1.63)                         | 2.06 (1.73)                             | 2.44 (2.42)                                                             | 3.10 (2.48)                                                               | Mixed linear model found significant difference between groups (p=.04)  |
| Auslander33                        | SR mean % of calories from fat                                                   | 36%                                 | 35.9%                                  | 35.6%                                                                   | 32.1%                                                                     | ANCOVA test and post-hoc tests revealed significant difference between intervention and control group at 3 month post test [t=-4.01 p<.01] and 6 month follow-up [2.50 p<.05] |
| Chang34,35                          | SR cups of fruit and vegetables per day                                         | 4.25 (2.91)                         | 4.87 (4.41)                            | 4.73 (3.41)                                                            | 6.33 (3.42)                                                              | General linear mixed model found no significant intervention effect at either time point p>.05   |
| Study | Participants | Time Point | Endpoint | Mean (SE) | Significance |
|-------|---------------|------------|----------|-----------|--------------|
| Elder | M2 time point 12 weeks | SR Mean grams of fat per day | 56.8 (SD25.2) | 49.1 (SE1.9) | Tailored IV group 49.8 (SE2) Promotora IV group 43.1 (SE1.9) |
| Emmons | (diet) Endpoint | SR Fruit and veg servings per day | 3.19 (SE0.062) | 3.13 (SE0.064) | 3.57 (SE 0.064) |
| Gans | (3 arms) | SR Fruit and veg servings per day | NS | Change from baseline 0.42 (2.51) | Change from baseline 0.24 (2.52) |

- Significant differences between groups reported at M2: $F(2.309)=3.73, p=0.025$
- Group differences were not maintained at M3 or M4 (not further specified).

- Significantly greater changes in IV group than C group $p=.005$
- At 4 months significant differences between C and ST
| 4 months | MT IV group | MTI IV group | ST IV group | MTIV 0.68 (2.63), MTI IV 0.49 (2.58) ST 0.58 (2.69) |
|----------|-------------|--------------|-------------|---------------------------------------------|
| 0.72 (2.55) | 0.36 (2.58) | 0.92 (2.92) |             | (p=.01), ST and MTI (p=.01), MT and MTI (p=.01), C and MT (p=.05) |
| **Jackson** | **SR fruit and vegetable intake per day** | 3.3 (1.7) | 3.0 (1.6) | 3.1 (1.5) |
| 4 weeks | change of -0.2 (1.5) | 3.44 (1.6) | change of +0.44 (1.6) | - |
| **Keyserling** | **End point data: objectively measured fruit and veg intake, via median serum carotenoids (ug/dL)** | 3.8(SE0.05) | 3.8(0.06) | 3.9 (SE0.03) |
| (diet) | Follow-up data: fruit and vegetable consumption via Dietary Risk Assessment (score range 0-103, | | | 4.0 (SE0.03) |
| 6 month assessment | | | | | 12 month assessment: C 32.8(SE0.7) IV 29.2 (SE0.7) |
| | | | | | Marginally significant difference between adjusted mean objective measures at 6 month assessment (p=.05) |
| | | | | | Significant difference at follow-up12 month assessment for Dietary Risk Scores (p<.001) |
| Study                  | Intervention | Outcome Measure                                      | Baseline Mean (SD) | Post-intervention Mean (SD) | P-value | Findings                                                                 |
|------------------------|--------------|--------------------------------------------------------|--------------------|----------------------------|---------|--------------------------------------------------------------------------|
| Nitzke 12 months       | Daily fruit and vegetable intake, servings             | 4.72 (2.61)        | 4.75 (2.86)          | 4.60 (2.45)                | 4.90 (2.35) | -                                                                        |
|                        |              |                                                        |                    |                            |         | • Significant intervention effect from ANOVA [F=3.49, p<.05]               |
| Parra-Medina 12 months | Dietary risk assessment score (rated between 0 and 104, where lower scores equal a lower intake of saturated fat and cholesterol) | 32.1 (8.5)         | 32.0 (9.1)           | 26.8 (7.3)                  | 21.3 (6.9) | -                                                                        |
|                        |              |                                                        |                    |                            |         | • Mean reductions in dietary risk assessment score were significantly greater amongst intervention participants (p<.001) |
| Sanchez-Johnsen 6 weeks | SR fruit and veg servings per day                      | 6.11 (3.11)        | 5.66 (3.80)          | 4.63 (2.51)                | 5.33 (3.40) | -                                                                        |
|                        |              |                                                        |                    |                            |         | • ANOVA test suggested significant intervention effect [F=4.716, p=.04]    |
| Steptoe 12 months      | SR fruit and veg servings per day                      | 3.67 (2.0)         | 3.6 (1.81)           | 0.87 (2.22)                | 1.49 (2.2) | -                                                                        |
|                        |              |                                                        |                    |                            |         | • Significant difference in change =0.62 servings, [p=.021, 95% CI 0.09 to 1.13] |
| Tessaro 67             | SR fruit and veg                                      | 3.87 (1.90)        | 3.90 (1.89)          | 3.55 (2.24)                | 3.74 (2.11) | -                                                                        |
|                        |              |                                                        |                    |                            |         | • Paired t test indicated no                                             |
| 3 months | servings per day | | | | | significant difference between 3 month follow-up scores ($p=.32$) |
|---|---|---|---|---|---|---|

**PHYSICAL ACTIVITY**

| **Armitage**<sup>25</sup> | **1 month** | **SR metabolic equivalent minutes exercise per week (MET mins)** | 896.89 (1657.94) | 733.12 (945.15) | 868.33 (1659.01) | 1080.62 (1317.70) | - |
|---|---|---|---|---|---|---|---|
| **Chang**<sup>34,35</sup> | **(Physical activity) 2 months** | **SR metabolic equivalent minutes exercise per week (MET mins)** | 27.28 (29.85) | 29.76 (26.74) | 33.51 (29.34) | 41.09 (29.87) | 8 month follow-up C 36.02 (29.3) IV 53.20 (30.24) |
|---|---|---|---|---|---|---|---|
| **Dangour**<sup>38,49</sup> | **24 month assessment** | **Objectively measured walking capacity: metres walked in six minutes** | 452.8 (78.4) | 447.9 (72.4) | 432.8 (77.8) | 466.5 (86.7) | |
|---|---|---|---|---|---|---|---|
| **Dutton**<sup>50</sup> | **Post-treatment** | **SR hours exercise per week** | NS | NS | Mean change from baseline: 0.59 (10.99) | Mean change from baseline: 0.75 (7.58) | |
|---|---|---|---|---|---|---|---|

- Significant intervention effect according to ANCOVA analysis [$F(1,66)=7.28$, $p=.009$]

- General linear mixed model, no significant effect at 2 months (effect size $d=0.25$, CI -0.24 to 0.74) or at 8 months (effect size $d=0.57$, CI -0.04 to 1.18)

- Significant difference between groups ($p=.001$)

- ANOVA test found no significant difference between conditions ($p=.65$)
| Study            | Measure Description                                                                 | Baseline Mean (SD or SE) | Follow-up Mean (SD or SE) | Change (SD or SE) | Significance Notes |
|------------------|--------------------------------------------------------------------------------------|--------------------------|---------------------------|-------------------|--------------------|
| Emmons et al.    | SR Mean hours per week                                                               | 4.93 (SE0.16)            | 4.8 (SE0.16)              | 4.91 (SE0.16)     | 4.77 (0.17).       |
|                  | No significant differences between groups at follow-up                               |                          |                           |                   | [p=.51]            |
| Jackson et al.   | SR minutes per week of physical activity                                            | 122 (SD not reported)    | 127 (SD not reported)     | 136 (135)         | [change of 14]     |
|                  | Means not significantly different at 4 week follow-up according to an unpaired Student’s t-test [p=.42] |
| Keyserling et al.| Objectively measured PA; accelerometer moderate minutes per day                     | 13(SE1.2)                | 11.6 (SE1.3)              | 11.7(SE1.1)       | 12.2(SE1.1)        |
|                  | Not significantly different according to ANCOVA, at 6 months [p=.74] or 12 month follow-up [p=.33] |
| Marcus et al.    | SR moderate to vigorous minutes of physical activity per week                        | 3.02 (10.3)              | 1.87 (6.86)               | 32.98 (82.82)     | 73.36 (89.73)      |
|                  | Intervention group significantly more active than control group at 6 months, according to a longitudinal regression controlling for baseline differences (p<.001) |
| Olvera et al.    | SR activity level on a scale from 0 (sedentary) to 7 (vigorous)                      | 1.2 (1.5)                | 1.4 (0.9)                 | 1.2 (0.9)         | 2.1 (1.6)          |
|                  | No significant effect according to ANCOVA [F 1.35, p=2.57, d=.4]                    |
| Pekmezci et al.  | SR minutes of                                                                        | 11.88                    | 16.56                     | 96.79 (118.49)    | 147.27 (241.55)    |
|                  | No significant between group                                                         |                          |                           |                   |                    |
|                |                                                                 |                                                                 |                                                                 |                                                                 |                                                                 |                                                                 |
|----------------|-----------------------------------------------------------------|-----------------------------------------------------------------|-----------------------------------------------------------------|-----------------------------------------------------------------|-----------------------------------------------------------------|-----------------------------------------------------------------|
| **Sanchez-Johnsen**<sup>45</sup> | (Physical activity) 6 week assessment | SR times engaged in activity designed to improve fitness on a scale from 1 (0 times) to 9 (more than 7 times) | 2.11 (2.18) | 2.11 (1.75) | 2.98 (2.48) | 3.66 (1.78) | • No significant difference according to ANCOVA \[F=0.634, p=.434\] |
| **Whitehead**<sup>35</sup> | 1 month assessment | SR time spent in physical activities for last 7 days, yielding an estimated caloric expenditure | 2507.82 (SE 2.64) | 2507.35 (2.55 SE) | 2506.72 (2.65) | 2511.76 (2.56) | • A doubly multivariate ANOVA with planned comparisons showed significant differential group changes at 1 month \[F(1,205)=17.98, p<.001\] and 6 months \[F(1,205)=4.07, p<.05\] |
| **SMOKING** |                                                                 |                                                                 |                                                                 |                                                                 |                                                                 |                                                                 |
| **Ahluwalia**<sup>31,32</sup> | (Smoking) 6 month | Biochemically confirmed smoking | All smoked at baseline | All smoked at baseline | 9 of 93 abstinent | 4 of 57 abstinent | • Adjusted Mantel-Haenszel chi-square statistic revealed no significant difference between |
| Study | Time Point | Methodology | Abstinence | p Value |
|-------|------------|-------------|------------|---------|
| Andrews | 6 month assessment | Biochemically confirmed smoking abstinence 7 days | 3 of 52 abstinent | p=.73 |
| Bullock | 2 arms | Biochemically confirmed smoking abstinence last 7 days | B control group: 27 of 141 (12%); C control group: 22 of 128 (17%) | - |
| Dornelas | End of pregnancy assessment | Biochemically confirmed smoking abstinence for previous 7 days | - | - |
| Fang | 1 week | SR smoking abstinence, last 7 days | - | - |

Notes:
- Odds ratio 4.9, CI -1.51 to 15.89
- Main effect of intervention group variable in multiple regression, p=.001.
- Likelihood ratio chi-square not significantly different X²=1.33, p=.72 at T2 end of pregnancy X²=1.39, p=.71 at T3 post-delivery follow-up
- Significant difference at end of pregnancy assessment only, according to chi-squared test X²=5.94(1), p=.015.
| Study          | Assessment                  | Days   | Follow-up                  | Chi-square Test | p Value | Finding                                      |
|---------------|-----------------------------|--------|----------------------------|-----------------|---------|----------------------------------------------|
| Froelicher    | 6 month assessment          | -      | 3 of 26                    | X^2(1)=2.51     | .11     | Not significantly different – not further specified. |
| Gordon        | 7.5 months endpoint         | -      | 8 of 439                   | F(1,12)=14.62   | <.01    | Significant between groups effect            |
| Liles         | 18 month assessment         | -      | 5 of 74                    | Fisher’s exact test: difference statistically significant p=.029 |
| Miller        | 3 month assessment          | -      | 97 of 377                  | Chi squared test: significant difference reported at 3 and 6 month assessment [p≤.001] but not at 12 months [p value not specified] |
| Okuyemi       | Biochemically confirmed abstinence | - | 19 of 214                  | No significant group |
| Study | Follow-up | Subject | Outcome | Description | Difference | Note |
|-------|-----------|---------|---------|-------------|------------|------|
| Reitzel 2006 | 8 weeks (post-intervention) | confirmed smoking abstinence: previous seven days | 12 of 214 IV 20 of 216 | difference according to chi squared test at week 8 ($p=0.89$) or week 26 ($p=0.15$) | 19 of 115 31 of 136 | • Main effect of treatment approached significance according to a continuation ratio logit model [$X^2(1)=3.10$, $p=.08$] |
| Solomon 2000 | 3 months | Biochemically confirmed smoking abstinence following delivery of baby | 58 of 159 | Significant difference at 3 months [$p=.035$] according to Chi square test but not at 6 month follow-up [$p$ value not specified] | 30 of 108 44 of 106 | • Experimental condition strongest predictor in logistic regression at 3 months: OR 2, CI 1.09 TO 3.68. Not a significant predictor at 6 month follow-up (not further specified) |
| Solomon 2005 | 3 months | SR smoking abstinence, last 7 days | 48 of 159 IV 65 of 171 | | 58 of 159 82 of 171 | • |
| Study  | Follow-up/Assessment | Smoking Abstinence: Previous Seven Days | Follow-up/Assessment | Smoking Abstinence: Previous Seven Days | 6 months | Significance |
|--------|----------------------|----------------------------------------|----------------------|----------------------------------------|----------|--------------|
| Sykes  | Follow-up            | Biochemically confirmed smoking        | -                    | -                                      | 6 of 107 | 21 of 122    |
|        |                      | abstinence: previous seven days         |                      |                                        |          | Significant difference compared to controls [X^2(2)=22.339, p<.001] |
| Volpp  | 30 day assessment    | Biochemically confirmed smoking        | -                    | -                                      | 4 of 87  | 15 of 92     |
|        |                      | abstinence: previous seven days         |                      |                                        |          | 6 months     |
|        |                      |                                        |                      |                                        |          | Significant difference at 30 day assessment according to Chi squared test [X^2=6.46, p=.01], but not at 6 month assessment [X^2 = 0.31, p=0.57] |
| Wu     | 6 month assessment   | Biochemically confirmed quit at follow- | -                    | -                                      | 20 of 62 | 40 of 60     |
|        |                      | up                                     |                      |                                        |          | Significant difference according to logistic regression, OR 4.32, CI: 2.01 to 9.27, p<.001 |

Note. SR=self-reported NS=not specified, C=control group IV=intervention group SE=standard error, OR=odds ratio, CI=confidence interval. p<.05 was considered statistically significant. Unless otherwise specified, in smoking interventions no participants were abstinent from smoking at baseline.