Supporting lifestyle change for adults at risk of type 2 diabetes

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Policy implications

- Supporting lifestyle change is a key aim of diabetes prevention policy /practice

Diabetes UK

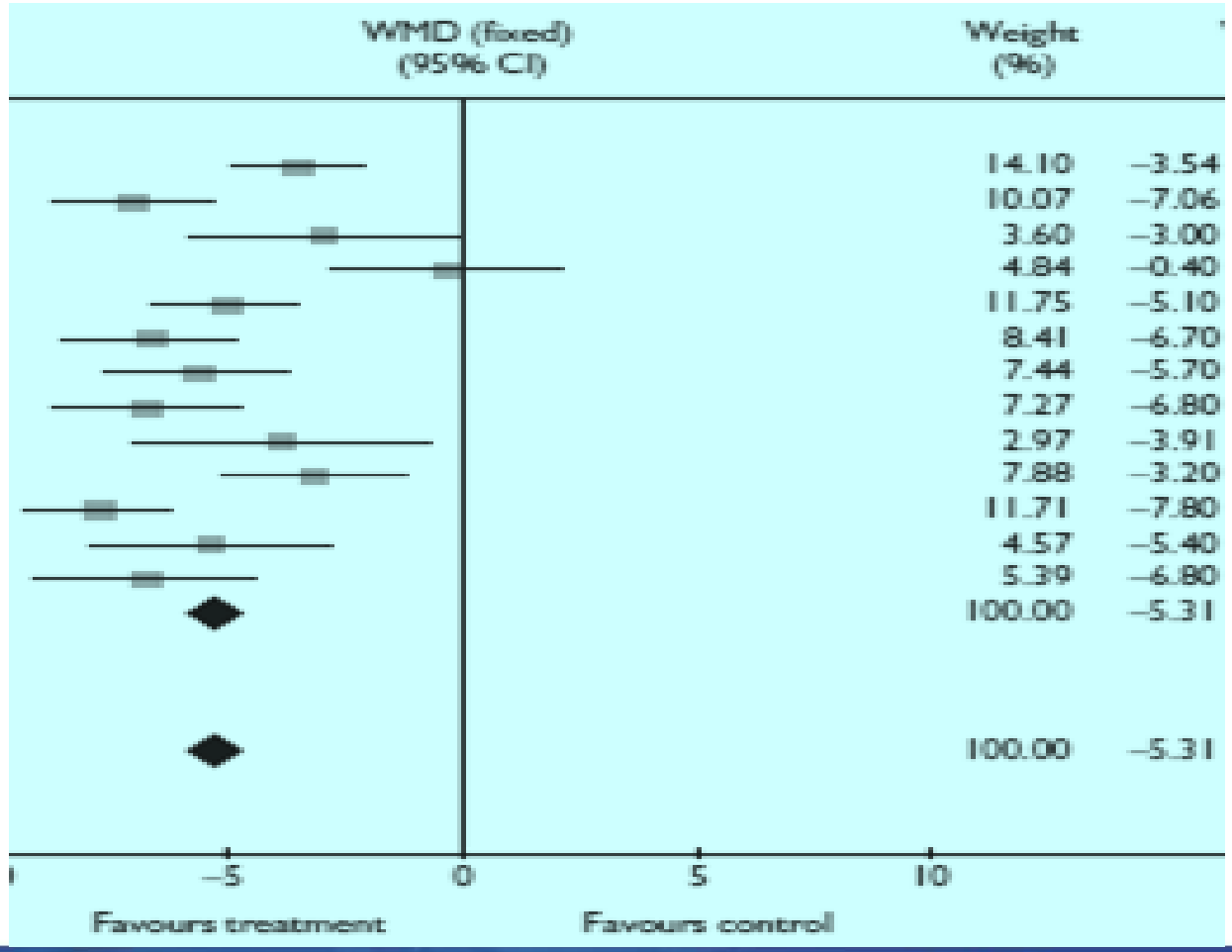
American Diabetes Association.
Cure • Care • Commitment

International Diabetes Federation

Image

NICE

But, there are huge variations in intervention effectiveness

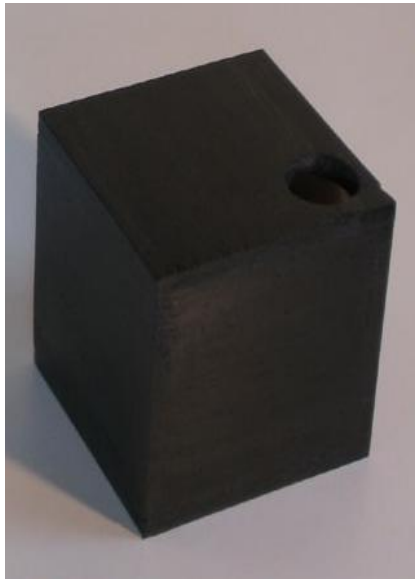


Avenell et al, 2004

DP Implementation studies

	Time (mths)	Wt loss (Kg)	PA change	Drop-out
DEPLOY	12	**5.7**	-	37%
PRE-DIAS	12	**3.8**	+47 min	9%
GGT	12	**2.5**	-	17%
GOAL	12	**0.8**	-	11%

So what works?



Supporting change in diet and physical activity behaviour for adults at risk of type 2 diabetes: A systematic review of reviews

Colin Greaves, Kate Sheppard, Charles Abraham, Wendy Hardeman, Michael Roden, IMAGE Study Group, Peter Schwarz

Greaves et al, BMC Public Health, 2011

Aims of review

To identify intervention components which are associated with **a)** increased physical activity **b)** dietary change in populations at risk of type 2 diabetes

NB: Review 3 has a similar question, but focused on diabetes prevention outcome

Method

- Systematic review of reviews

Inclusion criteria

- Any group at increased risk for diabetes (including overweight /obese, PD etc)
- Interventions to increase PA, change diet or lose weight (not surgical or pharmaceutical)
- Only high quality reviews (OQAQ >=14)

Data extraction /Intervention components examined

- Theoretical basis
- Behaviour change techniques
- Intensity
- Delivery provider,
- Mode (e.g. group/individual)
- Setting
- Population characteristics (e.g. ethnicity, age)

Synthesis

- Every piece of evidence (i.e. every relevant analysis reported in a review) was graded in terms of a) type and b) methodological quality.
- SIGN evidence grading criteria

  1 or 2 (causal or associative), then ++, +, or – (high, medium, low quality)

Results

- 3856 possible articles
- 30 met both selection and quality criteria

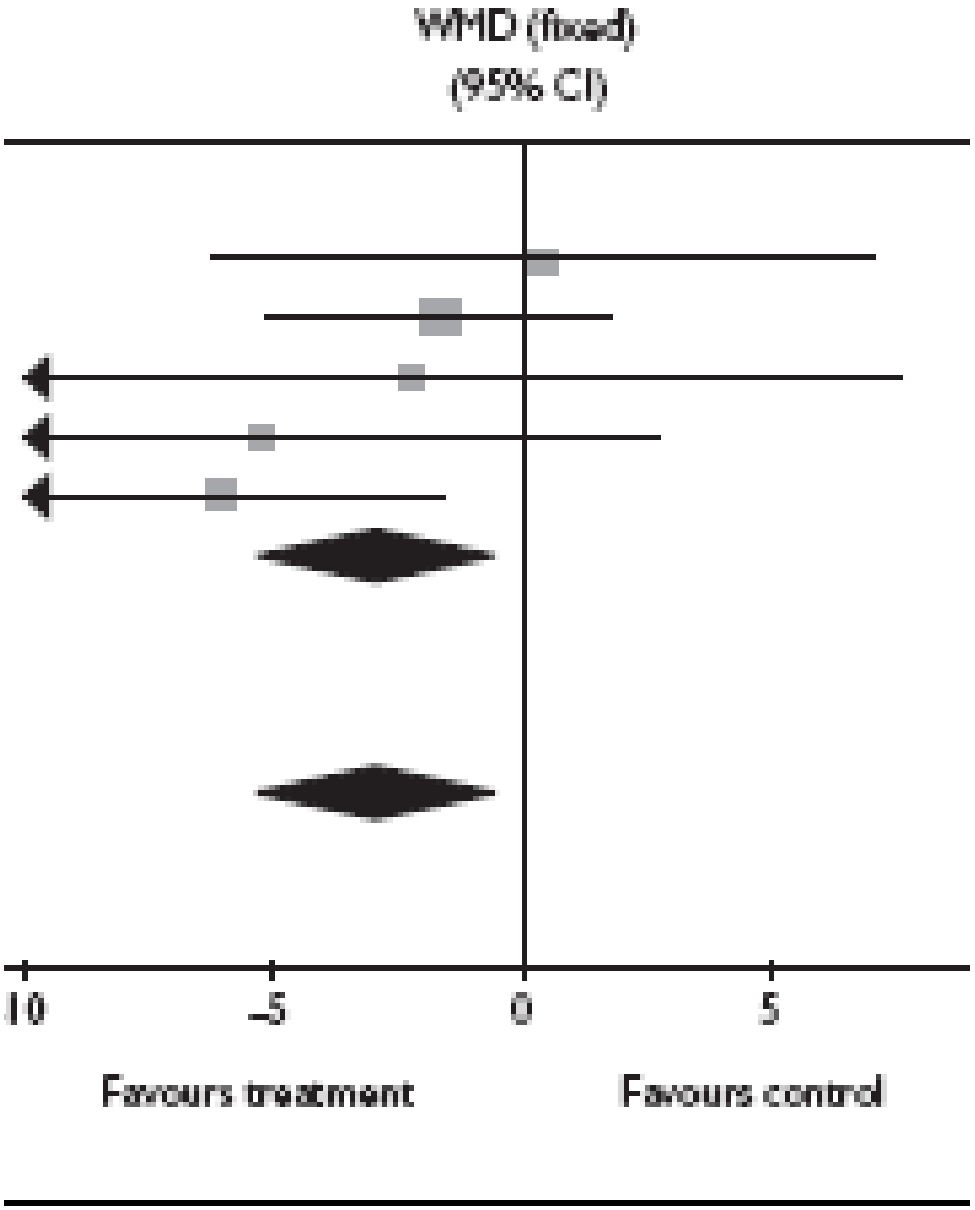
1: Theories

Interventions* using a theoretical model showed no greater weight loss	2-
Prompting self-monitoring alongside other **self-regulation** or 'learning from experience' techniques (e.g. Feedback; Review of goals; Relapse management) doubled effect size*	2+

* Both diet & physical activity

2: Behaviour change techniques

Adding **social support** (usually family) increases weight loss at 12 months (+3Kg)	1+
The planned use of established behaviour change techniques (e.g. relapse prevention, goal setting) significantly increases weight loss (+ 4.5 Kg) at 6 months	1+



Social support

Avenell et al, 2004

Behaviour change techniques

Motivational interviewing is effective for short-term weight reduction (<= 6 mths)	1++
Using **pedometers** to promote walking produce modest weight loss and moderate increases in PA (<= 12 mths)	1+

Behaviour change techniques

Self-monitoring, encouraging self-talk were associated with **both** weight loss and increased physical activity	2+

Behaviour change techniques

For dietary change: Providing instruction and the use of **relapse prevention** techniques.	2+
For physical activity: Prompting practice, individual tailoring, setting goals and **time management** were associated with increased effectiveness.	2+

Behavioural targets

Interventions which promote PA as well as dietary change produce greater weight loss than those which promote diet change only at up to 24 mths	1+

Intensity

A **greater frequency** or number of meetings was associated with greater effectiveness in dietary and /or physical activity interventions at up to 15 months	2++

Other intervention components

- **Intervention provider**: *No clear difference* between health professionals, other professionals, or lay people (2+)
- **Delivery mode**: *No clear difference* between individual & group (2-)
- **Population characteristics**: GENDER: no substantial difference (2++) . SEDENTARY: **Targeting sedentary populations** may increase physical activity (2-)
- **Intervention setting**: *No clear differences*

What does this add to Reviews 2,3,4?

- Increased strength of evidence
  - Use a planned, coherent set of **established behaviour change techniques** **1+** (+4.5 Kg)
  - Engage **social support** (esp. family) **1+** (+3 Kg)
  - Target **both diet and physical activity** **1+** (+2-3 Kg)
- Reinforces other statements
  - Can use clinical or community settings
  - Can use group or individual mode

What does this add to Reviews 2,3,4?

- Extends or adds new evidence
  - Evidence on specific behaviour change techniques /intervention content
  - Can extend the range of intervention providers
  - Number of contacts /increased frequency of sessions is associated with greater weight loss
  - Population characteristics and effectiveness
- Increased generalisability
  - Much more UK based evidence.

Example 1

- **Review 3, ES 8:** Information and advice alone is not as effective as "theoretically-based" detailed lifestyle interventions.
  - Basis: descriptions of successful trials (NB: most trials here drew on multiple theories)
- **Additional:** No one theory is preferred, but the inclusion of a coherent set of established behaviour change techniques and including self-regulatory techniques may increase effectiveness
  - Basis: Meta-regression. **Includes UK data**

Example 2

- **Review 3, ES 8:** Successful interventions have included tailored information provision, self-monitoring of diet, PA and weight, building up in small steps, problem-solving, family support ...
  - Basis: descriptions of successful trials
- **Additional:** Causal and associative analyses in nine well-conducted systematic reviews. The evidence shows that **inclusion of specific techniques (see ES4) may increase levels of behaviour change and /or weight loss**

Optimal intervention content

- Coherent set of established behaviour change techniques, including individually tailored techniques designed to provide information, increase motivation, goal-setting, identification of barriers, problem-solving (developing strategies to addressing emotional, social, environmental, financial barriers, as well as ‘automatic’ or impulsive behaviours), encouraging self-talk, self-monitoring of weight, PA and other self-regulatory techniques to encourage learning from experience (e.g. review of progress and motivations, goal review)

Optimal intervention content

- Engaging support from a family member, friend or carer
- Target both diet and PA (targets to be specified)
- Core programme of 10-16 sessions, followed by 6-monthly review /reinforcement sessions and further reinforcement during contacts with primary care
- Delivered in group, individual or mixed modes of delivery, by well-trained providers with relevant backgrounds. Group mode should be used where possible for reasons of economy.
- Adaptations may be necessary for some ethnic or cultural groups or for people with mental health problems or other physical or mental limitations.

Summary: what works?

- Use a planned, coherent set of **established behaviour change techniques**[2] (e.g. motivational interviewing, self-regulatory techniques, prompting self-talk) **1+**
- Engage **social support** (esp. family) **1+**
- Target **both diet and physical activity** **1+**

2. Abraham & Michie. Taxonomy of behavior change techniques .... *Psychology & Health* 2008

What might also work?

- Maximise **intensity** (number or frequency of contacts) **2++**
- Prompt self-monitoring alongside other **self-regulatory techniques** (goal-setting, providing feedback, review goals, relapse management) **2+**

Implementation programmes

	Wt loss (Kg)	D+PA; S-R, BCTs	N contact	Social support
DEPLOY	5.7	3/3	**16**	Y
PRE-DIAS	3.8	3/3	**12**	Y
GGT	2.5	3/3	**6**	N
GOAL	0.8	3/3	**6**	N

* once screened, but screening uptake “low”
** 67% agreed to screening

Evidence Grading

- 1++, 1+, 1- CAUSAL: Meta-analysis of randomised between group comparisons, where individual trials designed to report the relevant contrast.

- 2++, 2+, 2- ASSOCIATIONS: e.g. counting numbers of studies (high vs. low intensity) with significant differences; Descriptive summaries of successful vs. unsuccessful trials

Intervention components associated with increased effectiveness in dietary and physical activity intervention: A systematic review of reviews

(Originally prepared for the IMAGE Study Group 5/1/2009. Adapted for NICE Programme Development Group on Prevention of progression to type 2 diabetes 28/07/2011)

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Glossary

Terminology used in this paper may vary. Because this is a review of reviews, we have often used the language employed by the individual review authors. However, we have adopted the terminology stated below wherever possible.

- **Behavioural intervention /Behaviour change techniques**: Authors have used different terminology when discussing behavioural interventions and where appropriate we have provided their definition. Where we have used the term "behaviour change techniques" (BCTs) or "established behaviour change techniques", we are referring to established, well-defined techniques, as included for example in Michie and Abraham's taxonomy of behaviour change techniques.[1] These are usually used as part of a coherent, planned strategy for behaviour change (as opposed to simply providing information or instructions on what to do, as may be the case with some dietary interventions or structured physical activity sessions).

- **Cognitive-behavioural therapy**: A form of psychotherapy that emphasises the important effect of automatic thoughts on how a person feels and what he /she does.[2] In the context of weight loss, cognitive-behavioural therapy can be used to identify and modify aversive thinking patterns and mood states related to unhealthy eating.

- **Counselling (Dietary/Physical Activity)**: A generic, usually poorly defined term used in a number of reviews. This may involve anything from providing simple instructions through to the use of established behaviour change techniques or specified styles of patient interaction (such as cognitive behavioural therapy or motivational interviewing).

- **Exercise***: Planned bouts of physical activity usually pursued for personal health and fitness goals. Exercise is a subset of physical activity, which is volitional, planned, structured, repetitive and aimed at improvement or maintenance of any aspect of fitness or health.

- **Exercise referral scheme**: Referral by a primary care clinician to a programme that encourages increased physical activity or exercise, involving initial assessment, a programme tailored to individual needs, as well as monitoring and supervision throughout the programme.[4]

- **Motivational Interviewing**: A distinct intervention approach with an accredited training network, defined in detail by Miller and Rollnick.[5] It is a client-centred yet directive method for enhancing intrinsic motivation to change by exploring and resolving client ambivalence (e.g. by exploring the pros and cons of change) and barriers to confidence about making a change.

- **Physical activity (PA)***: Any force exerted by skeletal muscle that results in energy expenditure above resting level. This includes the full range of human movement, from competitive sport and exercise to active hobbies, walking, cycling, or activities of daily living.

Supporting change in diet and physical activity behaviour for adults at risk of type 2 diabetes: A systematic review of reviews

CJ Greaves[1], K Sheppard[1], C Abraham[2], W Hardeman[3], M Roden[4], PH Evans[1], P Schwarz[5], The IMAGE Study Group[6]

Institutes: [1]Peninsula Medical School, UK. [2]University of Sussex, UK. [3]University of Cambridge, UK. [4] Heinrich-Heine-Universität Düsseldorf, Germany. [5]Technical University of Dresden, Germany (Carl Gustav Carus Medical Faculty). [6]International collaboration group, led from Technical University of Dresden, Germany

Brief overview: Achieving behaviour change is a complex problem. Changing an existing habit requires people to establish a motivation or intention to change, make decisions and action plans, recognise and overcome barriers (both practical and psychological), initiate the new routine, and then to maintain the new routine, resisting temptations to relapse back to former habits. Many approaches are possible for supporting changes to diet and physical activity. These vary from simple information-giving to more intensive individual counselling approaches. Approaches range from the use of specific behaviour change techniques in isolation (e.g. self-monitoring, action planning) to more comprehensive programmes which may or may not be based on theoretical or empirical models of behaviour change[2;5-8] Supportive environments and social, societal and cultural contexts may also be highly relevant in mediating behaviour change. In the context of diabetes prevention, a multi-level approach is probably needed (i.e. including individual and community level as well as environmental and government /policy level interventions). However, this review will focus primarily on assessing the evidence base for interventions to support change at the individual level.

The aim is to consider the evidence about which types of individual-level intervention are more or less effective for supporting the changes in dietary behaviour and physical activity required for type 2 diabetes prevention in at-risk adult populations.

1 Evidence Summary

The following evidence statements are based on the available review-level evidence on how the content or components of interventions relate to effectiveness for weight loss, change in diet or changes in physical activity.

The quality of the reviews in the statements below was medium-to-high (+ or ++) in all cases (i.e. only well-conducted systematic reviews were included in this review). The quality assessment system used (OQAQ) to grade the reviews and the specific risks of bias and OQAQ scores for each review are provided in Appendix I. The quality of each piece of evidence (i.e. each analysis) was graded separately using modified SIGN guidelines for evidence grading (Appendix I) and these are the quality ratings provided in the evidence statements below. The graded evidence tables are presented in Appendix II.

Evidence statement 1:
The relationship between underlying behavioural models and effectiveness

Summary: Evidence was extracted from meta-regression analyses in two well-conducted systematic reviews of RCTs of interventions to promote changes in diet and /or physical activity. The evidence suggests that, although having a theory of behaviour change did not influence weight loss, using a specific cluster of self-regulatory techniques was associated with a doubling of effect size for weight loss, change in diet, and increased physical activity.

Specific details:

Medium quality associative evidence from one meta-regression analysis (one +) suggested that interventions to promote changes in diet and /or physical activity which stated a theoretical model as their foundation delivered no greater weight loss than interventions that did not state their theoretical underpinnings.[38]

However, medium quality associative evidence from four meta-regression analyses (four +) in two reviews found a strong association between the use of a theoretically specified cluster of 'self-regulatory' intervention techniques (specific goal-setting, prompting self-monitoring, providing feedback on performance, goal review) and increased effectiveness in terms of a) weight loss, b) change in dietary outcomes, c) change in physical activity and d) combined (standardised mean difference for either dietary change or physical activity) outcomes. Studies that used these techniques generated around twice the effect size of other interventions (SMD = 0.60 (95%CI: 0.39 to 0.81) & 0.26 (95%CI: 0.20 to 0.31), respectively across all types of

intervention (with similar patterns for diet-only and physical-activity-only studies).[38,48]

This evidence derives from studies based in a) the USA, Australia, UK, Canada, Finland, and Netherlands [38] and b) in the USA, Australia, UK, 'other European countries' and Japan [48].

Evidence statement 2:

The relationship between using established behaviour change techniques and effectiveness

Summary: Evidence was extracted from meta-analyses of RCTs and descriptive summaries of RCTs and cohort studies in three well-conducted systematic reviews. The evidence shows that using well-described, established behaviour change techniques, as opposed to providing instructions or having no formal plan for supporting behaviour change substantially increased weight loss in interventions to support changes in diet and /or physical activity.

Specific details:

Medium quality causal evidence from one meta-analysis of RCTs (one +) found that adding a coherent set of established behaviour change techniques (see Glossary for definition) to dietary and /or physical activity interventions (as opposed to providing instructions or not having any formal plans about how to support behaviour change) significantly increased the amount of weight loss and physical activity initially produced at a median 6 months of follow up by an estimated 4.5Kg (95%CI: 4.34 to 4.57).[54] The studies underlying this evidence were conducted in the USA, UK, Spain, South America, Canada, Sweden, Netherlands, and Switzerland (predominantly US).

This was supported by two associative analyses (one +, one -) which descriptively compared the results of different groups of studies. Using established behaviour change techniques was associated with increased weight loss at 12 months (2.5 to 5.5kg) compared with non-behavioural interventions (0.1 to 0.9kg).[46,47] The geographical origins of this evidence were not well described, but the reviews included 'mostly US based' studies.

Evidence statement 3:
Choosing multiple or individual behavioural targets

Summary: Evidence was extracted from meta-analyses of RCTs and descriptive summaries of RCTs in 4 well-conducted systematic reviews. The evidence shows that targeting both diet and physical activity is more effective than targeting diet alone in interventions to support changes in diet and /or physical activity.

Specific details:

High and medium quality causal evidence from eight meta-analyses (one ++, four +, three -) in three reviews and one descriptive summary of trials that compared diet vs. diet plus exercise (one -) showed that interventions which targeted both physical activity and diet, rather than only one of these behaviours, delivered an additional 2-3 Kg of weight loss at up to 24 months of follow up.[31,36,37,54] The studies underlying this evidence were conducted in a wide range of countries including the USA, UK, other European countries, Australia and Canada.

Evidence statement 4:
The relationship between using specific behaviour change techniques and effectiveness

Summary: Evidence was extracted from a range of causal and associative analyses in nine well-conducted systematic reviews. The evidence shows that a range of specific techniques (as described below) may increase levels of behaviour change and /or weight loss in interventions to support changes in diet and /or physical activity.

Specific details (in order of evidence quality):

i) High to medium quality causal evidence from two meta-analyses of RCTs (one ++, one +) showed that interventions to change diet and /or physical activity based on **motivational interviewing** were more effective than traditional advice-giving for *initial* weight loss at 3 to 6 months of follow up with an estimated effect on weight of 0.72 BMI units (95% CI: 0.33 to 1.11) and a SMD of 0.53 (95%CI: 0.32 to 0.74) on combined physical activity and dietary outcomes.[53,35] The countries in which the studies underlying this evidence were conducted are not reported in the reviews, but include at least one UK study and several in USA.

ii) Medium quality causal evidence from one meta-analysis of RCTs (one +) was found that adding **social support** to interventions (usually from family members)

provided an additional weight loss of 3.0kg (95%CI: 0.6 to 5.3 Kg) at up to 12 months (compared with the same intervention with no social support element).[31] The studies underlying this evidence were all conducted in the USA.

iii) Medium quality causal evidence from one descriptive summary of individual RCT findings (one +) showed that **brief advice**, usually delivered alongside **goal-setting**, led to a median increase in walking activity of 27 mins /week at 12 months of follow up.[51] The studies underlying this evidence were conducted in USA and Australia.

iv) Medium quality causal evidence from one meta-analysis (+) and one descriptive summary of individual RCTs (+) from two reviews showed that **pedometer based interventions** (i.e. self-monitoring of physical activity, usually alongside step-goals or step diaries or both) increased walking activity by a) 2004 steps per day (95%CI: 878 to 3129) at a median 11 weeks of follow up or b) a median time spent walking of 54 min per week (Range: -11 to +181 min/wk) at a median 13 weeks of follow up.[33,51] The studies underlying this evidence were conducted in USA, UK, other European countries, Australia, Canada and Japan.

Medium to high quality associative evidence based on meta-analysis of only the intervention arms of studies (one ++, one +) from two reviews suggested that small changes in weight might also be achievable with pedometer based interventions (e.g. change in BMI of 0.38kg/m2 (95% CI: 0.05 to 0.72) at 11 weeks).[33,52] The studies underlying this evidence were not well reported in one study, but include studies conducted in the USA, Canada, Europe, Japan and Australia.

v) Medium to low quality associative evidence from three meta-regression analyses (three +) and two 'vote-counting' analyses (two -) in three reviews suggested that effectiveness for initial behaviour change was associated with using the following techniques* A) *For dietary change:* **providing instruction, encouraging self-monitoring** of behaviour, **relapse prevention** techniques.[38,48] B) *For physical activity change:* **prompting practice**, **encouraging self-monitoring** of behaviour, **individual tailoring** (e.g. of information or counselling content).[38,40,48] The studies underlying this evidence were conducted in a wide range of countries, including the USA, Australia, UK, Canada, other European countries and Japan.

Further medium quality associative evidence from two meta-regression analyses (two +) in one review suggested that increased maintenance of behaviour change was associated with the use of **time management techniques** (for physical activity) and **encouraging self-talk** (for both dietary change and physical activity).[38] The studies underlying this evidence were conducted in USA, Australia, UK, Canada,

Finland, and Netherlands.

* Definitions of these techniques can be found in a recent taxonomy of behaviour change techniques.[62]

Evidence statement 5:

The relationship between mode of intervention delivery and effectiveness

Summary: Evidence was extracted from descriptions of individual RCTs in the evidence tables of a number of reviews and from meta-regression and other associative analyses in four well-conducted systematic reviews. This showed that effective interventions can be delivered using group, individual or combined (individual and group) modes of delivery. No strong evidence was found for any difference in any outcomes of physical activity and /or dietary interventions between individual, group and combined modes of intervention delivery.

Specific details

High quality evidence (++) from descriptions of individual RCTs in the evidence tables of a number of reviews shows that it is possible to deliver successful physical activity and /or dietary interventions using group, individual or combined (individual and group) modes of delivery. The studies underlying this evidence were conducted in a wide range of countries, including the USA, Australia, the UK, and other European countries.

Medium to low quality associative evidence from three meta-regression analyses (three +) and 2 descriptive reviews of the characteristics of successful studies (two -) provided no strong evidence of any difference in any outcome of physical activity and /or dietary interventions between individual, group and combined modes of intervention delivery at up to 12 months of follow up.[31,38,46,48,51] The studies underlying this evidence were conducted in a wide range of countries including the USA, Australia, the UK, and other European countries.

Evidence statement 6:

The relationship between type of intervention provider and effectiveness

Summary: Evidence was extracted from descriptions of individual RCTs in the evidence tables of a number of reviews and from meta-regression and other associative analyses in four well-conducted systematic reviews. This showed that effective interventions can be delivered by doctors, nurses, dieticians /nutritionists,

exercise specialists and lay people. No strong evidence was found for any difference in any outcomes of physical activity and /or dietary interventions between different intervention providers.

Specific details:

High quality evidence (++) from descriptions of individual RCTs in the evidence tables of a number of reviews shows that it is possible to deliver successful physical activity and /or dietary interventions using doctors, nurses, dieticians /nutritionists, exercise specialists and lay people. It should be noted however that these providers were often working within a multi-disciplinary team. The studies underlying this evidence were conducted in a wide range of countries, including the USA, UK and other European countries

Medium to low quality associative evidence from two meta-regression analyses (two +) and 2 descriptive reviews of the characteristics of successful studies (two -) provided no strong evidence of any difference in any outcome of physical activity and /or dietary interventions delivered by either medically trained health professionals (doctors, nurses), other professionals (psychologists, counsellors, dieticians, health educators), public health students, or lay people at up to 12 months of follow up.[38,40,48,51] The studies underlying this evidence were conducted in a wide range of countries including USA, Australia, the UK, and other European countries.

Evidence statement 7:

The relationship between intervention intensity and effectiveness

Summary: Evidence was extracted from one meta-analyses of RCTs and several meta-regression and other associative analyses in ten well-conducted systematic reviews. This was a complex area as definitions of intervention intensity reported in the reviews varied considerably. The evidence suggests that in interventions to support changes in diet and /or physical activity: a) A greater total number of personal contacts /intervention sessions is associated with greater weight loss at up to 36 months of follow up and changes in diet at 12 months. b) A greater frequency of meetings, particularly in the active phase of the intervention is associated with greater weight loss at up to 15 months of follow up. c) When intensity is considered in terms of intervention duration or total contact time, there is insufficient evidence to draw any clear conclusions about its impact on the effectiveness of dietary and /or physical activity interventions.

Specific details:

i.) Weight Loss: Overall, 7 out of 9 analyses of intervention intensity favoured higher intensity interventions.

Medium to low quality associative evidence from one meta-regression analysis (+) and two descriptive analyses (two -) in three reviews showed a positive association between the *total number of contacts* and weight loss at 12 to 38 months.[46,50,57] The studies underlying this evidence were conducted in a wide range of countries including the USA, the UK, France, Netherlands, Sweden, Finland and China.

High and low quality associative evidence from one meta-regression (++) and one descriptive analysis (-) in two reviews found a relationship between *increased frequency of contacts* and weight loss at 6 to 15 months of follow up.[37,47] However, high and medium quality evidence from two meta-regression analyses (one ++, one +) in two reviews[37,38] found no such relationship at 6 to 60 months. The studies underlying this evidence were conducted in a wide range of countries including the USA, Australia, UK, Canada, Finland and other European countries.

Medium quality associative evidence from three meta-regression analyses (two +, one -) found mixed evidence (one positive, one negative, one trend only) on the association between intervention *duration* (the time period over which the intervention was delivered) and weight loss.[33,50,52] The studies underlying this evidence were conducted in a wide range of countries including the USA, Australia, UK, Canada, Japan, China, Finland and other European countries.

Medium quality causal evidence from one meta-analysis (+) of RCTs comparing different intervention intensities[54] found that more intensive interventions (those including more behaviour change techniques, more contact time or a longer duration of intervention) generated 2.3kg (95% CI: 1.4 to 3.3) more weight loss than less intensive interventions at a median 7 months of follow up. This was supported by associative evidence from a descriptive summary of RCTs with different intervention intensities (+) from the same review. However, it was not possible to deduce from the available data which component of intensity drives this relationship. The studies underlying this evidence were conducted in the USA, UK, Spain, South America, Canada, Sweden, Netherlands, and Switzerland (predominantly US).

Dietary Change: Low quality associative evidence from two stratified meta-analyses (two -) within the same review found a positive relationship between number of contacts and self-reported dietary change at 12 months of follow up.[34] The studies underlying this evidence were conducted in USA, UK, Netherlands, Sweden, New Zealand, Italy and Japan.

Physical Activity: There was a lack of evidence on the relationship between intervention intensity and physical activity outcomes. Low quality associative evidence from one meta-regression analysis (-) and one descriptive analysis (-) in two reviews[33,40] found no clear relationship between intervention intensity (duration) and physical activity outcomes. The studies underlying this evidence were conducted in the USA, Canada, Europe, Japan and Australia.

Evidence statement 8:

The relationship between population characteristics and effectiveness

Summary: Evidence was extracted from descriptive and associative analyses in *** well-conducted systematic reviews. The evidence shows that, in interventions to support changes in diet and /or physical activity, changes in weight, diet and physical activity were shown to be possible in a range of age, gender, ethnic and high-risk populations. There was very little (or only mixed) review-level evidence on the relationships between any intervention outcomes and gender, having increased ethnicity, high cardiovascular risk, being sedentary, or increased weight. However, people with a higher starting weight achieved better reductions in incidence of type 2 diabetes at 24 to 55 months.

Specific details:

Gender: Medium and low quality associative evidence from five meta-regression or stratified meta-analyses (three +, two -) and three descriptive analyses (three -) from six reviews found no consistent association between gender and changes in weight or physical activity at 10 weeks to 16 months of follow up.[33,38,41,48,55,58] The studies underlying this evidence were conducted in in a wide range of countries, including the USA, UK and other European countries.

Ethnicity: High quality evidence (++) from individual trials described in the data tables of the reviews examined showed that interventions can be effective for a number of ethnic groups.[4] Low quality associative evidence from one meta-regression analysis (-) suggested that intervention studies with a higher percentage of white Caucasian participants achieved larger decreases in BMI at a median of 12 weeks of follow up.[33] Another meta-regression analysis (-) in the same review reported no association between ethnicity and increased walking. The studies underlying this evidence were conducted in the USA, Canada, Europe, Japan and Australia.

Age: Medium to low quality associative evidence from two meta-regression or stratified meta-analyses (one +, one -) from two reviews[33,55] suggested that older

people lost around 0.7Kg more weight than younger people at 10 to 16 weeks of follow up. Low quality associative evidence from on meta-regression analysis (-) and one descriptive summary of within-trial sub-group analyses (-) from two reviews found no significant relationship between age and physical activity at 3 to 6 months of follow up.[33,41] The studies underlying this evidence were conducted in a wide range of countries, including the USA, UK, Canada, other European countries, Japan and Australia

At risk populations: A range of evidence, including strong causal evidence from two meta-analyses of sub-groups of studies (two ++) found that changes in weight and (at least short-term) physical activity are possible in high risk as well as lower risk populations, including high and low weight, high cardiovascular risk groups and sedentary and non-sedentary groups, at between 3 and 36 months of follow up.[33,37,38,41,42,43,48,51] Medium to low quality associative evidence from two meta-regression (one +, one -) and two descriptive analyses (one +, one -) from four reviews provided mixed evidence as to whether targeting of interventions at people who are more sedentary was associated with larger increases in the amount of physical activity (two medium quality analyses (one positive, one negative), two low quality analyses (one negative, one positive trend).[33,41,48,51] The studies underlying this evidence were conducted in a wide range of countries, including the USA, UK and other European countries.

Weight: Medium and low quality associative evidence from two meta-regression or stratified meta-analyses (one +, one -) and two descriptive analyses (one +, one -) in four reviews[33,41,42,48] provided mixed findings from a wide range of countries (two + (one positive, one negative), two - (one positive, one negative)) as to whether targeting more overweight people was associated with larger increases in the amount of weight loss achieved. However, high quality associative evidence from one meta-regression analysis (++) of studies conducted in China, Japan, USA, Finland and Australia showed that people with a higher starting weight achieve better reductions in the incidence of type 2 diabetes at 2 to 4.6 years, such that each unit increase in BMI at baseline was associated with a decrease in hazard ratio of −7.3% (95% CI: −13.6 to −0.9).[43]

Evidence statement 9:

The relationship between intervention setting and effectiveness

Summary: Evidence was extracted from descriptions of individual RCTs in the

evidence tables of a number of reviews and from one meta-regression and one stratified meta-analysis. This showed that effective interventions can be delivered in healthcare settings, the workplace, the home, and in the community. No strong evidence was found for any difference in any outcomes of physical activity and /or dietary interventions between different intervention settings.

Specific details:

High quality evidence (++) from descriptions of individual RCTs in the evidence tables of a number of reviews shows that it is possible to deliver effective interventions in a wide range of settings, including healthcare settings, the workplace, the home, and in the community.[e.g. 30,34] Few reviews formally examined the impact of intervention setting on effectiveness. The studies underlying this evidence were conducted in a wide range of countries, including the USA, UK and other European countries.

Medium quality associative evidence from one meta-regression analysis (+) found no significant differences in outcomes (either dietary or physical activity change) between interventions in primary care, community and workplace settings at 6 months of follow up.[48] However, low quality associative evidence from one stratified meta-analysis (-) of RCTs in different settings found numerically greater reductions in dietary fat (-5.22%, vs. -3.15%) and numerically greater increases in fruit and vegetable consumption (1.88 vs. 0.83 servings/day) in healthcare compared with workplace /community settings.[34] The studies underlying this evidence were conducted in USA, UK, Netherlands, Sweden, New Zealand, Italy, Japan, Australia, Canada and Finland

Evidence statement 10:
Effectiveness of diet and /or physical activity interventions on weight loss

Summary: Evidence was extracted from meta-analyses in ten well-conducted systematic reviews of RCTs. The evidence shows that interventions to promote changes in diet and/or physical activity can produce a net average weight loss of 2-5 Kg that is sustained for up to 7 years. However, a wide range of effect sizes was observed as well as a tendency for initial weight loss to be reversed over time in the majority of studies.

Specific details:

High quality causal evidence (++) from eight meta-analyses of RCTs from four

systematic reviews showed that interventions to promote changes in diet (or both diet and physical activity) produced moderate and clinically meaningful effects on weight loss (typically 3-5 kg at 12 months, 2-3 kg at 36 months)[a].[37,38,42,50] A further fourteen analyses (eight +, six -) from six systematic reviews provided data that is consistent with this statement. [31,39,49,54,57,59]

Medium to low quality causal evidence from 2 meta-analyses of RCTs (one +, one -) from 2 systematic reviews showed that weight loss of 2-3 kg from dietary or combined (diet and physical activity) interventions can be sustained for 36 months and for as much as 7 years. [31,39]

Medium to low quality causal evidence from two meta-analyses (one +, one -) of RCTs from two systematic reviews showed that interventions aiming only to increase physical activity can have small effects (1-2 kg) on weight for up to 12 months.[49,54]

It is worth noting that, in the tables of the systematic reviews examined, a wide range of weight loss can be observed for interventions that promote dietary change and /or physical activity. This may reflect a strong impact of intervention content, delivery characteristics and /or fidelity of delivery on intervention effectiveness.

High quality evidence from one meta-analysis of RCTs (one ++) in one systematic review showed that during the 'maintenance phase' of interventions (from 6-60 months), patients regained weight at an average rate of 0.03 BMI units /month ($p<0.001$). This implies that, to achieve longer-term weight loss, interventions need to do more to address behaviour maintenance. [37]

The studies underlying this evidence were conducted in a wide range of countries including the US, UK, other European countries, Canada, and Australia.

[a] NB: Confidence intervals cannot be presented where the figures represent a range of results from several different reviews, or if the review does not report them. In some cases, CIs can be found in the evidence tables in Appendix II.

Evidence statement 11:

Effectiveness of interventions on diet and /or physical activity

Summary: Evidence was extracted from meta-analyses and descriptive summaries of findings in 8 well-conducted systematic reviews of RCTs. The evidence suggests that interventions to promote increased physical activity can produce a net change of around 30-60 mins of moderate physical activity per week that is sustained for up to

19 months. The evidence also suggests that interventions to promote dietary change can produce significant, positive changes in calories, fat, fibre, fruit and vegetable intake that are sustained for up to 19 months.

Specific details:-

Physical activity: High quality causal evidence (++) was found from four meta-analyses of RCTs in two reviews that physical activity interventions can produce moderate changes in self-reported physical activity (standardised mean difference around 0.3)[a] and cardio-respiratory fitness (standardised mean difference around 0.5)[a] at a minimum 6 months of follow up.[41,59]

Medium to low quality causal evidence from six meta-analyses of RCTs and summaries of RCTs and other studies (three +, three -) from three systematic reviews showed that interventions to increase physical activity can have moderate effects (30-60 minutes of moderate physical activity per week[a]) at 6 weeks to 19 months of follow up.38,40,51

Dietary Intake: Medium and lower quality causal evidence from nine meta-analyses and descriptive summaries of RCTs (six +, three -) from three systematic reviews found positive changes in self-reported diet (calorie, fat, fibre, fruit and vegetable intake) at 6 to 19 months of follow up for dietary interventions.[38,34,44]

Evidence at the level of high quality systematic reviews for the longer-term benefits (beyond 19 months) on physical activity or diet is lacking. Furthermore, within the data tables of the reviews examined, there were few examples of individual trials where physical activity significantly increased at more than 12 months.

The studies underlying this evidence were conducted in a wide range of countries including the US, UK, other European countries, Canada, and Australia.

[a] Confidence intervals cannot be presented where the figures represent a range of results from several different reviews, or if the review does not report them. In some cases, CIs can be found in the evidence tables in Appendix II.

2 Abstract

Background
To develop more efficient programmes for promoting dietary and/or physical activity change (in order to prevent type 2 diabetes) it is critical to ensure that the intervention components and characteristics most strongly associated with effectiveness are included. The aim of this systematic review of reviews was to identify intervention components that are associated with increased change in diet and/or physical activity in individuals at risk of type 2 diabetes.

Methods
MEDLINE, EMBASE, CINAHL, PsycInfo, and the Cochrane Library were searched for systematic reviews of interventions targeting diet and/or physical activity in adults at risk of developing type 2 diabetes from 1998 to 2008. Two reviewers independently selected reviews and rated methodological quality. Individual analyses from reviews relating effectiveness to intervention components were extracted, graded for evidence quality and summarised.

Results
Of 3856 identified articles, 30 met the inclusion criteria and 129 analyses related intervention components to effectiveness. These included causal analyses (based on randomisation of participants to different intervention conditions) and associative analyses (e.g. meta-regression). Overall, interventions produced clinically meaningful weight loss (3-5kg at 12 months; 2-3kg at 36 months) and increased physical activity (30-60 mins/week of moderate activity at 12-18 months). Based on causal analyses, intervention effectiveness was increased by engaging social support, targeting both diet and physical activity, and using well-defined /established behaviour change techniques. Increased effectiveness was also *associated with* increased contact frequency and using a specific cluster of "self-regulatory" behaviour change techniques (e.g. goal-setting, self-monitoring). No clear relationships were found between effectiveness and intervention setting, delivery mode, study population or delivery provider. Evidence on long-term effectiveness suggested the need for greater consideration of behaviour maintenance strategies.

Conclusions
This comprehensive review of reviews identifies specific components which are associated with increased effectiveness in interventions to promote change in diet and/or physical activity. To maximise the efficiency of programmes for diabetes prevention, practitioners and commissioning organisations should consider including these components.

3 Background

The development of type 2 diabetes is strongly associated with being overweight, obese or physically inactive.[1,2] Large randomised controlled trials (RCTs) have shown that relatively modest changes in lifestyle (increasing fibre (≥15g/ 1000 kcal), reducing total fat (<30% of energy consumed) and saturated fat (<10% of energy consumed), engaging in moderate physical activity (≥30mins/day), weight reduction (5%)) can reduce the risk of progression to type 2 diabetes in adults with impaired glucose regulation (also known as pre-diabetes) by around 50%.[3-7] In one study, achieving four or more of the above targets led to zero incidence of type 2 diabetes up to seven years later.[8] Consequently, promoting changes in physical activity and dietary intake is now recommended in national and international guidelines as a first line therapy for preventing type 2 diabetes.[9-12]

A number of diabetes prevention programmes have been developed internationally (e.g. in Finland,[13] Germany,[14,15] the US,[16,17] Australia[18] and China[19]). However, national diabetes prevention strategies are still lacking in many countries. The cost-effectiveness of lifestyle intervention approaches for diabetes prevention is already well established and is favourable in comparison to pharmacological approaches.[20-22] However, most interventions used to date in a research setting are considered to be too intensive for widespread implementation in health services[23]. For example, the US Diabetes Prevention Programme[4] involved 16 individual counselling sessions plus individual coaching and a maintenance programme with further individual and group sessions. A major challenge for healthcare providers therefore is how to achieve the lifestyle changes needed to prevent type 2 diabetes (and its associated cardiovascular risk) without overstretching existing budgets and available resources.[24,25]

In translating the research evidence into practical programmes it is critical to ensure that the intervention components (i.e. behaviour change techniques and strategies) and characteristics

(e.g. setting, delivery mode, intervention provider) most strongly associated with effectiveness are included.

We therefore aimed to systematically review existing systematic reviews to summarise the evidence relating the content of interventions for promoting dietary and /or physical activity change to their effectiveness in producing weight and behaviour change. The review focused on evidence relating to individuals at risk of type 2 diabetes due to lifestyle (e.g. inactivity) or clinical risk factors (e.g. overweight, elevated blood pressure).

4 Methods

Data Sources and Search Strategy

One author (KS) searched MEDLINE, EMBASE, CINAHL, PsycInfo, and the Cochrane Library for systematic reviews in the English language, published between January 1998 and May 2008 (the search terms were reviewed by several authors (CG, CA, WH) and are provided in Appendix I, Table S1). Reference lists of selected reviews and relevant clinical guidelines were also searched and experts in the area were contacted in order to identify unpublished reviews.

Review selection

Two reviewers (KS, CG) independently examined titles and abstracts. Relevant review articles were obtained in full, and assessed against the inclusion and study quality criteria described below. Inter-reviewer agreement on inclusion was assessed using kappa statistics and any disagreements were resolved through discussion.

Inclusion criteria: 1) Type of study: Systematic reviews and meta-analyses including RCTs, observational studies, case-controlled or other quasi-experimental studies. Comparison groups could include usual care, no intervention or other interventions. 2) Type of intervention: Interventions promoting physical activity and/or dietary change at the individual-level (i.e. interventions delivered to individuals either singly or in group sessions, but not whole-community or whole-population level interventions such as media campaigns or changes in

the local environment). 3) Study populations: Adults (18 years and over) at risk of developing type 2 diabetes, selected because they were obese, overweight, sedentary, had hypertension, impaired fasting glucose, impaired glucose tolerance, hyperlipidaemia, metabolic syndrome, polycystic ovarian syndrome, gestational diabetes, a family history of type 2 diabetes or cardiovascular disease, or had been identified as having a high cardiovascular disease risk score (e.g. using a validated risk score such as Q-RISK or Framingham).

Exclusion criteria: 1) Reviews not meeting pre-defined criteria for methodological quality (Appendix I, Table S2). 2) Reviews which focused on people with existing diabetes, cardiovascular disease, or solely on healthy adults, or which were confined to groups with significant co-morbidities (e.g. arthritis, mental health).

Outcomes: We selected reviews where the primary outcome measure was weight, weight loss (kg or Body Mass Index (BMI), proportions of people achieving a target weight loss), changes in physical activity (e.g. frequency, met-hrs per week) or dietary behaviour. Behaviours could be measured objectively (e.g. with accelerometers) or by self-report (e.g. dietary intake questionnaires). Cardio-respiratory fitness was considered as a proxy for change in physical activity. As self-report increases the risk of measurement bias,[26,27] we have highlighted findings based on self-report in the data tables (Appendix II, Tables S7-S14). We also examined papers for other outcomes which might be of interest in relation to change in weight, diet, or physical activity behaviour or in relation to the progression to type 2 diabetes.

Study quality assessment

Review quality was rated independently by two authors (KS, CG) for a sub-sample (35 out of 107) of the articles identified as potentially relevant, using the Overview Quality Assessment Questionnaire (OQAQ;[28] Appendix I, Table S2). Thereafter, review quality was rated by one researcher (KS) and verified by another (CG). Reviews were included if their OQAQ score was 14 or more (possible range 0-18) and if they scored at least one point for either of the two OQAQ criteria about assessing quality /taking quality into account in analyses (this

was intended to maximise the likely quality of evidence underlying the review-level analyses). A percentage score was calculated for inter-rater agreement (defined as ≤1 point of variation on OQAQ scores) and any disagreements were resolved by discussion.

Data extraction

We extracted data on the effectiveness of interventions and on the relationship of effectiveness to seven pre-defined intervention components. These were: Theoretical basis (i.e. we extracted analyses relating effectiveness to the use of any stated theory of behaviour or behaviour change); Behaviour change techniques used (e.g. the use of specific techniques such as goal-setting, problem-solving or the planned use of some clearly defined set of behaviour change techniques: See Table 1 for examples); Mode of delivery (e.g. group-based, individual, self-delivery, mixed-mode); Intervention provider (e.g. general practitioner, counsellor); Intensity (e.g. number of sessions, total contact time); Characteristics of the target population (e.g. age, ethnicity, risk state); and Setting (e.g. primary care, workplace). Data were extracted against a data extraction template by one author (KS) and checked by another (CG) with reference to the full text of the article. Extracted data also included inclusion and exclusion criteria, reported analyses and analysis type.

Grading of evidence

An evidence grade was given to each reported analysis, based on the Scottish Intercollegiate Guidelines Network (SIGN) evidence grading system.[29] This system grades the risk of bias associated with a particular piece of evidence on a hierarchy from meta-analysis and RCT evidence (grade 1) down to expert opinion (grade 4), with additional indicators (++, + or -) to indicate methodological quality. The SIGN system was modified, as our review aimed to identify the relative effectiveness of intervention components, rather than effectiveness *per se* (see Appendix I, Table S3 for full details). Although the SIGN evidence grading uses an alpha-numeric system (1++, 1+, 1-, 2++, 2+, 2-), for ease of reading we have converted this to a text-based format. For each analysis the quality of the evidence (the degree of confidence

that the risk of bias is low) is described as either “high (++), medium (+) or low (-)”. Each analysis is also categorised as being either “causal” evidence (SIGN grade 1; evidence from meta-analyses or summaries of RCTs where the component or characteristic of interest was experimentally manipulated) or “associative” evidence (SIGN grade 2; evidence from correlational or observational analyses). We also applied a category of ”very low quality” for analyses with very low apparent power (total N < 100). The reporting that follows excludes this very low quality evidence, although it is included in the supplementary data tables for completeness.

Analysis

No statistical analyses or meta-analyses were conducted. Instead, the existing analyses reported in the articles reviewed were extracted and reported in a systematic format (Appendix II Tables S7 to S14). Each analysis was graded using the adapted SIGN criteria as described above and a narrative synthesis is presented below, indicating both the quality of the evidence (low, medium, high) and whether it is causal or associative in nature.

In accordance with reporting guidelines for systematic reviews, a PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) checklist is available for this review (Appendix III).

5 Results

Searches identified 3856 potentially relevant articles. Following review of titles and abstracts, 96 articles were retrieved and quality-assessed. An additional 11 articles were identified through reference lists and grey literature. Of these 107 articles, 30 met both the selection and quality criteria (Figure 1) and these are identified by an asterisk in the reference list.[30-59] The inter-rater reliability (Kappa) for applying review selection criteria was 0.71 (95%CI: 0.61 to 0.80), and the proportion for inter-reviewer agreement on review quality was 0.70 (95%CI: 0.55 to 0.85).

Review characteristics

The characteristics of the included and excluded reviews are summarised in Appendix I, Tables S4 and S5. Ten reviews examined physical activity interventions, three examined dietary interventions and seventeen examined both. Reviews included data from a range of populations (e.g. sedentary, overweight, obese, impaired glucose tolerance) and delivery settings (e.g. home based, leisure centre based, primary care, workplace) and used a variety of descriptive, meta-analytic and meta-regression analyses to investigate the association of intervention components with effectiveness. We identified 129 analyses of relationships between intervention components and effectiveness, and 55 analyses of intervention effectiveness (Appendix II, Tables S7 to S14). The dates of published studies included in the reviews examined ranged from 1966 to 2008.

Study quality

The methodological quality of included reviews (Appendix I, Tables S4, S6) was generally good (median OQAQ score = 15.6). The most common methodological weaknesses were the lack of use of study quality data to inform analyses (e.g. by sensitivity analysis, or by constructing separate analyses which excluded low quality trials) and potential bias in the selection of articles (e.g. not using independent assessors).

Evidence synthesis

The extracted analyses and evidence grades for each analysis are presented in Appendix II, Tables S7 to S14. The findings can be summarised as follows:-

Theoretical basis (Appendix II, Table S7)

One meta-regression analysis provided medium quality associative evidence (grade 2+) suggesting that interventions with an explicitly stated theoretical basis (e.g. Social Cognitive Theory,[60] Theory of Planned Behaviour[61]) were no more effective in producing changes in either weight or in combined dietary and physical activity outcomes than interventions with

no stated theoretical basis.[38] However, four meta-regression analyses (all medium quality associative analyses) in two reviews[38,48] did find an association between the use of a theoretically specified cluster of 'self-regulatory' intervention techniques (specific goal-setting, prompting self-monitoring, providing feedback on performance, goal review) and increased effectiveness in terms of a) weight loss, b) change in dietary outcomes, c) change in physical activity and d) combined (standardised mean difference for either dietary change or physical activity) outcomes.

Behaviour change techniques (Appendix II, Table S8)

Categorisation of interventions varied greatly between reviews, with categories often conceptually overlapping and vaguely defined (e.g. diet vs. exercise vs. behavioural intervention). Despite this, we have summarised evidence on the use of what we have called "established, well defined behaviour change techniques", based on those reviews where clear and specific definitions were provided (see Table 1 for definitions). Further definition of the specific behaviour change techniques cited in Table 1 and those mentioned in the text below can be found in a recent taxonomy of behaviour change techniques.[62]

Causal evidence from one medium quality meta-analysis indicated that change in weight was greater when established, well defined behaviour change techniques were added to interventions (e.g. when dietary advice plus a well-defined behavioural intervention using established behaviour change techniques was compared with dietary advice alone). The weight loss achieved by adding established behaviour change techniques to interventions was 4.5kg at a median 6 months of follow up.[54] This was supported by two associative analyses (one medium and one low quality) which compared the results of different groups of studies in which the interventions either did or did not use established, well-defined behaviour change techniques. Using established behaviour change techniques was associated with increased weight loss (2.5 to 5.5kg) compared with non-behavioural interventions (0.1 to 0.9kg).[46,47]

Evidence from five low to medium quality associative analyses in two reviews attempted to relate the number of behaviour change techniques used to effectiveness in terms of weight loss or changes in diet or physical activity. The evidence was equivocal with the pattern of data suggesting a possible association, but only one analysis approached significance.[38,48]

Use of specific behaviour change techniques: High quality causal evidence was found that adding social support to interventions (usually from family members) provided an additional weight loss of 3.0kg at up to 12 months (compared with the same intervention with no social support element).[31]

Medium to low quality associative evidence (from three meta-regression analyses and two associative analyses in three reviews) suggested that effectiveness for initial behaviour change (i.e. change in weight, diet or physical activity was associated with using the following techniques (NB: definitions of these can be found in a recent taxonomy of behaviour change techniques[62]): 1) For dietary change: providing instruction, establishing self-monitoring of behaviour, use of relapse prevention techniques.[38,48] 2) For physical activity change: prompting practice, establishing self-monitoring of behaviour, individual tailoring (e.g. of information or counselling content).[38,40,48] One review also provided medium quality causal evidence (a descriptive summary of individual RCT findings) that brief advice, which usually included goal-setting, led to an increase in walking activity (27 mins/week walking at 12 months of follow up).[51] Goal-setting alongside the use of pedometers was also associated with increased walking (see below).

Further medium quality associative evidence suggested that increased *maintenance* of behaviour change was associated with the use of time management techniques (for physical activity) and encouraging self-talk (for both dietary change and physical activity).[38]

Three reviews examined interventions that used pedometers (i.e. self-monitoring of physical activity) to promote walking: Medium quality causal evidence (two analyses from two reviews) supported the effectiveness of pedometer based interventions for increasing walking activity[33,51] (mean increase of 2004 steps per day at a median 11 weeks; median increase in time walking of +54 min per week at a median 13 weeks). It must be noted that the vast majority of the interventions included in these meta-analyses included either step-goals or step diaries (or both) alongside the use of pedometers, so the evidence does not support the use of pedometers in isolation from these additional techniques. Indeed, associative analyses from one review[33] suggested that the use of a) a step diary (one low quality analysis) and b) goal-setting (one low and one medium quality analysis) in combination with use of a pedometer was associated with increased walking. Medium to high quality associative evidence (based on meta-analysis of only the intervention arms of studies) from two reviews[33,52] suggested that small changes in weight might also be achievable with pedometer based interventions (e.g. change in BMI of 0.38kg/m2 at 11 weeks).

Motivational interviewing: Motivational interviewing is a distinct combination of behaviour change techniques (including decisional balance and relapse prevention techniques) delivered in a specific style (using patient centred empathy building techniques, such as rolling with resistance; affirmation and reflective listening).[63] High quality causal evidence from one meta-analysis of RCTs[53] found that motivational interviewing was significantly more effective than traditional advice-giving for initiating changes in weight (producing a net difference of 0.72 BMI units compared with traditional advice-giving) at 3 to 24 months of follow up (mostly under 6 months). A further meta-analysis of RCTs[35] provided medium quality causal evidence of the effectiveness of motivational interviewing for a combined physical activity and dietary outcome, at up to 4 months of follow up (Standardised Mean Difference 0.53).

Targeting multiple behaviours: Causal evidence from nine analyses in four reviews (one high, four medium and four low quality) showed that interventions which targeted *both* physical activity and diet rather than only one of these behaviours produced higher weight change (additional weight loss around 2-3kg at up to 12 months).[31,36,37,54]

Mode of delivery (Appendix II, Table S9)

The evidence from five reviews of dietary and /or physical activity intervention was mixed. Five associative analyses (three medium and two low quality) from four reviews failed to find a clear association between effectiveness and mode of intervention delivery for weight loss, dietary change or physical activity change.[38,46,48,51] One review found medium quality associative evidence that 'mixed mode' (individual and group) delivery was significantly related to greater effectiveness, compared with individual delivery, for initial weight loss (up to 6 months), but not for weight loss maintenance (at a mean 19 months).[38] However, it is worth noting that there is evidence from individual high quality RCTs (based on data in the evidence tables of the included reviews) that individual, group, and mixed mode interventions can all be effective in changing diet and/or physical activity.[31,38,51]

Intervention provider (Appendix II, Table S10)

There was a lack of high quality evidence in this area for comparisons between specific types of intervention provider. Four associative analyses (two medium, two low) from four reviews provided no consistent or significant relationship between intervention provider and weight, physical activity or dietary outcomes at up to 12 months of follow up.[38,40,48,51] However, strong evidence from individual RCTs (based on data in the evidence tables of the included reviews) showed that a wide range of providers (with appropriate training) including doctors, nurses, dieticians/ nutritionists, exercise specialists and lay people, can deliver effective interventions for changing diet and/ or physical activity.[38,40,43,48,51,52]

Intervention intensity (Appendix II, Table S11)

Definitions of intervention intensity reported in the reviews varied considerably, incorporating frequency and total number of contacts, total contact time, duration of the intervention (number of months or years over which the intervention was delivered) and the number of behaviour change techniques used. The frequency and duration of clinical contact varied widely, ranging from 1 to around 80 sessions, delivered daily to monthly and lasting anything from 15 to 150 minutes, over periods ranging from 1 day to 2 years. For instance, one review of 17 weight loss interventions that compared different intervention intensities, reported that the median contact frequency was weekly, the median session time 60 minutes, and the median delivery period 10 weeks.[54] Physical activity interventions are often much more intensive due to a focus on practising the target behaviour (e.g. Shaw et al.[55] report interventions lasting 3 to 12 months with 3 to 5 sessions per week lasting a median 45 minutes each).

Weight Loss: Overall, 7 out of 9 analyses of intervention intensity favoured higher intensity interventions. One meta-analysis of ten small RCTs (N=306) comparing different intervention intensities[54] found medium quality causal evidence that more intensive interventions (those including more behaviour change techniques, more contact time or a longer duration of intervention) generated significantly more weight loss than less intensive interventions (an additional 2.3kg at a median seven months follow up). This was supported by a medium quality associative analysis from the same review. However, it was not possible to deduce from the available data which component of intensity drives this relationship.

Medium to low quality evidence from three analyses in three reviews (one medium quality, two low quality) showed a positive association between the *total number of contacts* and weight loss at 12 to 38 months.[46,50,57] Associative evidence from two analyses in two reviews (one high quality, one low quality) found a relationship between *increased frequency*

of contacts and weight loss at 6 to 15 months of follow up.[37,47] However, two associative analyses (one high and one medium quality) in two reviews[37,38] found no such relationship at 6 to 60 months. Two medium quality associative analyses found mixed evidence (one positive one negative) on the association between intervention *duration* and weight loss.

Dietary Change: Two low quality associative analyses within the same review found a positive relationship between number of contacts and self-reported dietary change at 12 months of follow up.[34]

Physical Activity: There was a lack of evidence on the relationship between intervention intensity and physical activity outcomes. Two low quality associative analyses in two reviews[33,40] found no clear relationship between intervention intensity (duration) and physical activity outcomes.

Characteristics of the target population (Appendix II, Table S12)

Gender: Eight associative analyses (three medium quality, five low quality) from six reviews found no consistent association between gender and changes in weight or physical activity at 10 weeks to 16 months of follow up.[33,38,41,48,55,58]

Ethnicity: Although there is evidence (within some of the component trials in the reviews examined) that interventions can be effective for a number of ethnic groups[4] there was very little review-level evidence on the relationship between ethnicity and intervention effectiveness. One associative analysis (low quality) suggested that intervention studies with a higher percentage of white Caucasian participants achieved larger decreases in BMI at a median of 12 weeks of follow up.[33] Another (low quality) associative analysis in the same review reported no association between ethnicity and increased walking.

Age: Associative analyses (one medium quality, one low quality) from two reviews[33,55] suggested that older people lost more weight than younger people at 10.5 to 16 weeks of

follow up.[33] Two further (low quality) analyses from two reviews found no relationship between age and physical activity at 3 and 6 months of follow up.[33,41]

At risk populations: A range of evidence, including strong causal evidence from two meta-analyses of sub-groups of studies and associative evidence from meta-regression analyses from several further reviews found that changes in weight and (at least short-term) physical activity are possible in high risk as well as lower risk populations, including high and low weight, high cardiovascular risk groups and sedentary and non-sedentary groups, at between 3 and 36 months of follow up.[33,37,38,41,42,43,48,51] Five analyses from four reviews provided mixed evidence as to whether targeting of interventions at people who are more sedentary was associated with larger increases in the amount of physical activity (two medium analyses (one positive, one negative), three low quality analyses (two negative, one trend).[33,41,48,51]

Diabetes: In two associative analyses (one high quality, one medium quality), effectiveness for weight loss (at 3 to 60 months) was found to be considerably lower for people with type 2 diabetes than for people without type 2 diabetes.[37,38]

Weight: Four analyses in four reviews[33,41,42,48] provided mixed associative evidence (two medium (one positive, one negative), two low quality analyses (one positive, one negative)) as to whether targeting more overweight people was associated with larger increases in the amount of weight loss achieved. However, one high quality associative analysis showed that people with a higher starting weight achieve better *health* improvements at 2 to 4.6 years, in terms of a reduced incidence of type 2 diabetes.[43]

Setting (Appendix II, Table S13)

Examples were found (based on data in the evidence tables of included reviews) of effective interventions delivered in a wide range of settings, including healthcare settings, the workplace, the home, and in the community.[30,34] Few reviews formally examined the

impact of intervention setting on effectiveness. However, one medium quality associative analysis revealed no significant differences in outcomes (either dietary or physical activity change) at six months between interventions in primary care, community and workplace settings.[48]

Overall effectiveness (Appendix II, Table S14)

Weight Loss: High quality causal evidence (grade 1++) from eight meta-analyses of RCTs from four reviews showed that interventions to promote changes in diet (or both diet and physical activity) produced moderate and clinically meaningful effects on weight loss (typically 3-5 kg at 12 months, 2-3 kg at 36 months).[37,38,42,50] The effectiveness of such interventions (as well as physical activity only interventions) in producing weight loss was further supported by medium and low quality causal evidence (grade 1+ and 1-) from 14 meta-analyses and summaries of RCTs from six reviews (eight medium, six low quality analyses).[31,39,49,54,57,59]

Physical Activity: High quality causal evidence was found from four meta-analyses of RCTs in two reviews that physical activity interventions can produce moderate changes in self-reported physical activity (standardised mean difference around 0.3; Odds Ratio for achieving healthy activity targets around 1.2 to 1.3) and cardio-respiratory fitness (standardised mean difference around 0.5) at a minimum 6 months of follow up.[41,59] This was supported by lower quality causal evidence from six meta-analyses of RCTs and summaries of RCTs and other studies (three medium and three low quality analyses) from three systematic reviews that interventions to increase physical activity increased self-reported physical activity (typically equivalent to 30-60 minutes of walking per week) at a median of 6 weeks to 19 months of follow up.[38,40,51] However, it is worth noting that there were few examples of trials with successful outcomes at more than 12 months.

Dietary Intake: Medium and lower quality causal evidence from meta-analyses and descriptive summaries of RCTs (nine analyses from three separate reviews: six medium, three low) that found positive changes in self-reported diet (calorie, fat, fibre, fruit and vegetable intake) at 6 to 19 months of follow up for dietary interventions.[38,34,44]

Other Outcomes: High quality causal evidence (grade 1++) from one meta-analysis of RCTs[43] showed that interventions to promote changes in diet or physical activity (or both) produced moderate and clinically meaningful effects on the risk of progression to type 2 diabetes (relative risk reduction of 49% at 3.4 years) in people with impaired glucose regulation.

One review which examined variations in effectiveness over time[37] showed that weight loss tended to reverse once interventions ceased or moved from an active to a maintenance phase (net weight loss during active phase 0.08 BMI units per month; net weight *gain* during maintenance phase 0.03 BMI units per month).

6 Discussion

This review has, for the first time, systematically identified, synthesised *and graded* a wide range of evidence about the relationship of intervention content to effectiveness in individual-level interventions for promoting changes in diet and /or physical activity in adults at risk of type 2 diabetes.

Interventions produced significant and clinically meaningful changes in physical activity (typically equivalent to 30-60 minutes of walking per week, for up to 18 months) and in weight (typically 3-5 kg at 12 months, 2-3 kg at 36 months). Greater effectiveness of interventions was causally linked (in meta-analyses and randomised trials which experimentally manipulated the use of these elements) with targeting both diet and physical

activity, mobilising social support and the use of well-described /established behaviour change techniques. Greater effectiveness was also associated (in correlational analyses and non-randomised comparisons) with using a cluster of self-regulatory techniques (goal-setting, prompting self-monitoring, providing feedback on performance, goal review[62,64]), and providing a higher contact time or frequency of contacts. However, with regard to intensity, the amount of clinical contact in interventions varied widely (see ranges reported above) and the evidence does not support the recommendation of any particular minimum threshold. The evidence on patterns of effectiveness over time[37] also suggested that there is a need for an increased focus on the use of techniques to support behaviour maintenance.

There were no clear associations between provider, setting, delivery mode, ethnicity and age of the target group and effectiveness. This (and evidence from a range of individual RCTs cited in the reviews examined) suggests that interventions can be delivered successfully by a wide range of providers in a wide range of settings, in group or individual or combined modes, and can be effective for a wide range of ethnic and age groups.

While the use of "established, well-defined behaviour change techniques" was associated with increased effectiveness, it is worth emphasising that individual techniques are rarely applied in isolation and should form part of a coherent intervention model. Therefore, a planned approach to intervention design may be appropriate, such as "intervention mapping",[65] or other systematic intervention development processes[66] which select intervention techniques to address targeted behaviour change processes (and that are tailored for the target population and setting).

Taken together, the findings suggest a number of indications about how practice can be optimised practice in the development and delivery of interventions to promote changes in diet and /or physical activity. These findings have been previously used to inform the

development of a European guideline for preventing type 2 diabetes, resulting in the recommendations in Table 2.[12] It is hoped that these and other guidelines will help to meet the growing need for less costly, but nonetheless effective, type 2 diabetes prevention programmes.

Although providing a greater degree of depth with regard to intervention components, these findings are consistent with UK guidance for the prevention and treatment of obesity (which recommends engaging social (especially family based) support, and targeting both diet and exercise).[67] The findings are also consistent with recent guidance from the American Heart Association[68] on the prevention of heart disease in adults aged over 18, which recommend the use of motivational interviewing as well as goal-setting, self-monitoring and a high contact frequency. Recent evidence-based guidance from the US Association of Diabetes Educators also recommends goal-setting, problem-solving (relapse prevention) and self-monitoring of plans (self-regulation) for supporting healthy eating and increased physical activity in people with type 2 diabetes.[69] Our findings may also be more widely generalisable to adults with diagnosed chronic disease (e.g. type 2 diabetes, heart disease) or to apparently healthy adults.

Strengths and limitations

Our review focused only on higher quality systematic reviews. We identified a substantial number of reviews which synthesised data from a large number of RCTs and other studies, in a wide range of age groups, clinical /risk groups and settings. Drawing together these findings in one place has generated a comprehensive, evidence-based overview of which intervention components are most likely to facilitate effectiveness.

However, several challenges affecting the synthesis and interpretation of the available evidence were encountered. One of the limitations most commonly cited by review authors

was an inadequate description of behavioural interventions in the individual study reports. This causes difficulties for the reviewer in categorising intervention content and conducting subsequent analyses to relate content to effectiveness. We therefore suggest that future intervention study reports (and reviews of individual studies) use an appropriate taxonomy to describe (and categorise) behaviour change techniques.[62] A major limitation in assessing the utility of specific theories and techniques underpinning interventions is that techniques may not be implemented rigorously or may not faithfully represent the specified theories.[62,70] Notably, none of the 30 reviews that we examined took intervention fidelity into account. Hence, the lack of an association between the use of a stated theory and effectiveness may reflect a lack of good theories or it may reflect poor implementation of theories. Other potentially important sources of bias include measurement issues (especially in relation to the use of self-report data); self-selection of intervention participants; and a failure to consider potential biases due to study quality in some reviews. Furthermore, it is worth noting that with associative evidence, other covariates than those analysed may account for the stated relationships (e.g. the association between intensity and effectiveness might be explained to some extent by lower quality of intervention being associated with lower intensity).

A further potential source of bias which no review accounted for was the low sample size contributing to some of the analyses examined. In particular, it is worth noting that, whilst the evidence on the usefulness of social support is graded as level 1+ evidence from a meta-analysis of randomised controlled trials, the total number of participants contributing to the meta-analysis was only 127. If the grading system had taken sample size into account, we may have given this a lower grade. In interpreting the findings in this review, it should also be noted that the analyses considered were in many cases based on overlapping sets of trials (and other studies). It should also be noted, as this is a review of reviews we were not able to synthesise or meta-analyse data from individual studies, which may have yielded valuable

evidence. It is also worth noting that at the time of the literature search there were no high quality reviews on the use of internet-based interventions, so no evidence is presented in this area.

Implications for practice and policy

Our review has generated clear evidence which is suitable for developing guidelines on how interventions for promoting lifestyle change within diabetes prevention programmes could be developed or refined to maximise effectiveness. This evidence goes considerably beyond the data on basic effectiveness presented in trials and systematic reviews of diabetes prevention programmes to date.[3-8] It can be useful, for example, in guiding the translation of effective, high-intensity /high resource-use interventions in research contexts into lower-cost (yet still effective) interventions for implementation in clinical practice.

Directions for future research

More rigorous evaluations of the effectiveness and cost-effectiveness of specific intervention components and clusters of techniques for promoting and maintaining change in diet and physical activity are needed. This will require experimental and theoretically driven manipulation of intervention components in well-powered and high-quality trials. Intervention studies need to provide careful descriptions of the hypothesised causal processes for achieving behaviour change and the specific techniques used to modify these processes. Trials should include process analyses to establish the validity or otherwise of the causal models proposed. Research is urgently needed to compare the cost-effectiveness of interventions with different providers, intervention modes and intensities (using clear and consistent conceptualisations of intensity and attempting to disentangle the different elements of intensity such as contact time, number of contacts and contact frequency). This should include the evaluation of remotely delivered and/or self-delivered (e.g. internet-based) approaches and other approaches that

might provide high effectiveness for lower cost. Research is also needed to establish the impact of the intervention setting on effectiveness; to optimise intervention procedures for different ethnic, age and gender groups; to establish effective techniques for improving recruitment to interventions (and to address gender imbalances); and to assess the possible adverse affects of dietary and physical activity interventions.

7 Conclusions

Interventions to promote changes in diet and /or physical activity in adults with increased risk of diabetes or cardiovascular disease are more likely to be effective if they a) target both diet and physical activity, b) involve the planned use of established behaviour change techniques, c) mobilise social support, and d) have a clear plan for supporting maintenance of behaviour change. They may also benefit from providing a higher frequency or total number of contacts. To maximise the effectiveness of intervention programmes to promote changes in diet and/or physical activity for diabetes prevention, practitioners and commissioning organisations should carefully consider the inclusion of the above components.

8 Competing interests

The authors declare that they have no competing interests.

Authors' contributions

CG conceived and coordinated the study. KS and CG conducted literature searches, data extraction, review selection, quality rating and evidence grading and drafted the manuscript. CA, WH, MR, PE and PS contributed to the design of the study and interpretation of the results. All authors read and approved the final manuscript.

Acknowledgements

Funding: European Commission Community Action Programme for Public Health (Project 2006309); South West General Practice Trust; National Institute for Health Research. The views expressed in this publication are those of the authors and not necessarily those of the funding bodies. We would also like to thank Rod Taylor, Tiffany Moxham, members of the Society for Academic Primary Care (SAPC), the Psychosocial Aspects of Diabetes (PSAD)

Study Group, Denise de Ridder, Stanton Newman and Robert M Kaplan, who provided useful commentary.

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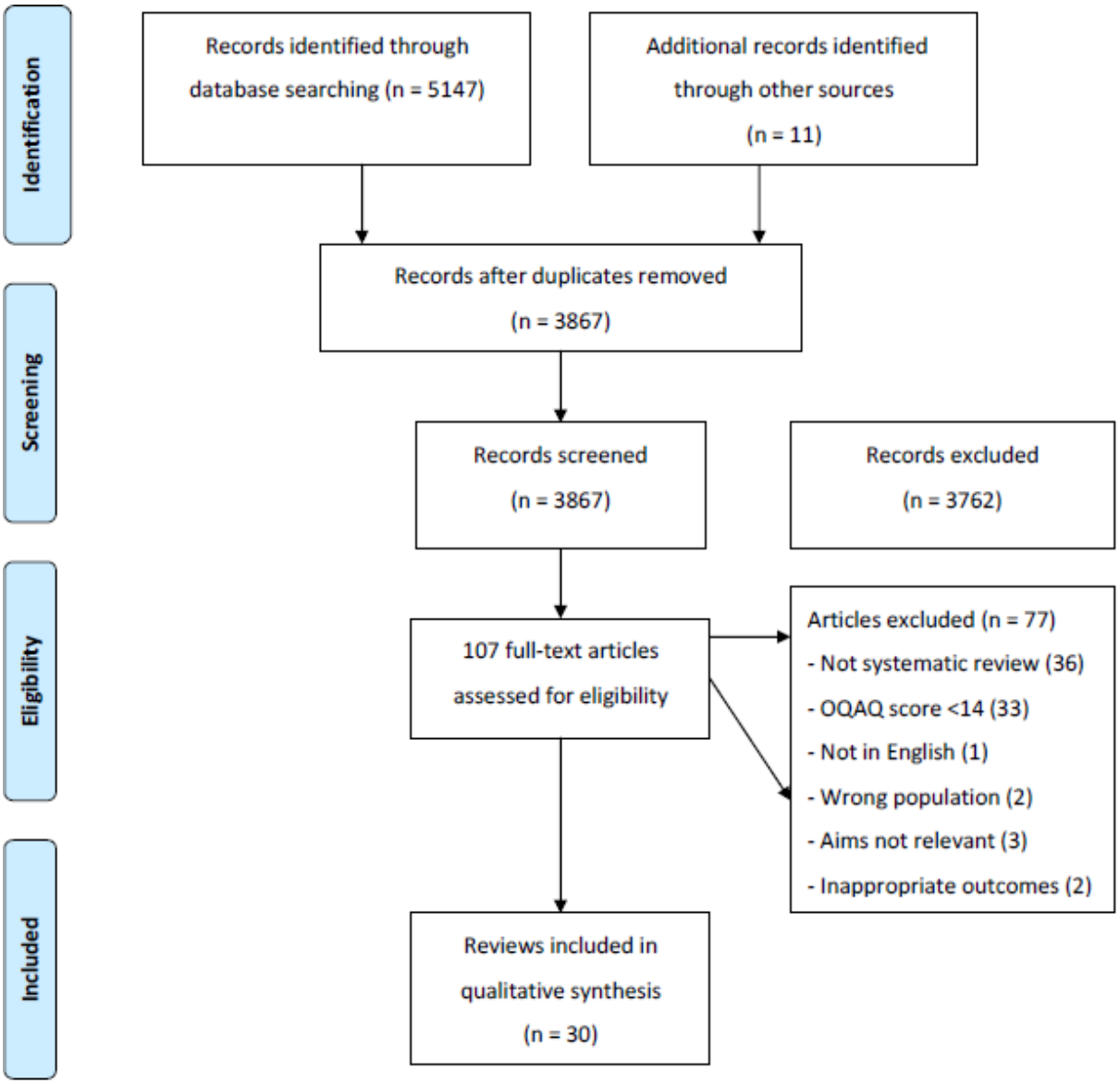
Figure 1 - Flow diagram of study selection



10 Tables

Table 1 - Definitions of 'established behaviour change techniques'

Source	Basis for categorisation
Avenell et al. 2004 [31]	Definitions of behaviour therapy varied by study but include self-monitoring, stimulus control, problem solving, relapse prevention management, cognitive restructuring, self-assertion, social support, goal setting, self-reinforcement.
McTigue et al. 2003 [46]	Behavioural interventions are strategies to help patients acquire the skills, motivations, and support to change diet and exercise patterns. These include barrier identification, problem solving, self-monitoring, social support, goal-setting, developing action plans, relapse prevention, stimulus control and cognitive restructuring.
Shaw et al. 2005 [54]	Behavioural therapy aims to provide the individual with coping skills to handle various cues to overeat and to manage lapses in diet and physical activity when they occur and to provide motivation essential to maintain adherence to a healthier lifestyle once the initial enthusiasm for the programme has waned. Therapeutic techniques in studies relating to the benefit of using "established behaviour change techniques" include stimulus control, self-control and therapist-controlled contingencies, self-monitoring, problem solving, goal setting, behaviour modification, reinforcement.
NICE Obesity guidance [67]	This guidance document comprises a summary (and expansion) of reviews by Shaw et al.[54], McTigue et al.[46], Avenell et al.[31] and Smith et al.[71]. Definitions vary by analysis but typically include cue avoidance, self-monitoring, stimulus control, social support, planning problem solving, cognitive restructuring, modifying thoughts, relapse prevention, reinforcement of change, coping strategies, coping imagery, goal setting, social assertion, reinforcement techniques for enhancing motivation.

Table 2 - Recommendations for practice from the IMAGE European guideline for diabetes prevention

A[1]	Interventions should aim to promote changes in both diet and physical activity
A	Interventions should use established, well defined behaviour change techniques (e.g. Specific goal-setting, relapse prevention, self-monitoring, see Table 1)
A	Interventions should encourage participants to engage social support in planned behaviour change (i.e. engage others who are important such as family, friends, and colleagues)
A	Interventions may be delivered by a wide range of people /professions, subject to appropriate training. There are examples of successful physical activity and /or dietary interventions delivered by doctors, nurses, dieticians /nutritionists, exercise specialists and lay people, often working within a multi-disciplinary team
A	Interventions may be delivered in a wide range of settings. There are examples of successful physical activity and /or dietary interventions delivered in healthcare settings, the workplace, the home, and in the community
A	Interventions may be delivered using group, individual or mixed modes (individual and group). There are examples of successful physical activity and /or dietary interventions using each of these delivery modes
A	Interventions should include a strong focus on maintenance. It is not clear how best to achieve behaviour maintenance but behaviour change techniques designed to address maintenance include: self-monitoring of progress, providing feedback, reviewing of goals, engaging social support, use of relapse management techniques and providing follow-up prompts
B	Interventions should maximise the frequency or number of contacts with participants
C	Interventions may consider building on a coherent set of "self-regulation" techniques, which have been associated with increased effectiveness (Specific goal setting; Prompting self-monitoring; Providing feedback on performance; Review of behavioural goals) as a starting point for intervention design. However, this is not the only approach available
C	No specific intervention adaptations are recommended for men or women, although it may be important to take steps to increase engagement and recruitment of men
D	If using established behaviour change techniques, a clear plan of intervention should be developed, based on a systematic analysis of factors preceding, enabling and supporting behaviour change in the social /organisational context in which the intervention is to be delivered. The plan should identify the processes of change and the specific techniques and method of delivery designed to achieve these processes. Such planning should ensure that the behaviour change techniques and strategies used are mutually compatible and well-adapted to the local delivery context. Following the procedures of the

	PRECEDE-PROCEED model [62], Intervention Mapping [61], or a similar intervention-design procedure is recommended
D	People planning and delivering interventions should consider whether adaptations are needed for different ethnic groups (particularly with regard to culturally-specific dietary advice), people with physical limitations and people with mental health problems

[1]**Key to grades of recommendations:**
A: At least one meta-analysis, systematic review, or RCT rated as 1++ and directly applicable to the target population*; or* A body of evidence consisting principally of studies rated as 1+, directly applicable to the target population, and demonstrating overall consistency of results
B: A body of evidence including studies rated as 2++, directly applicable to the target population, and demonstrating overall consistency of results*; or* Extrapolated evidence from studies rated as 1++ or 1+
C: A body of evidence including studies rated as 2+, directly applicable to the target population and demonstrating overall consistency of results*; or* Extrapolated evidence from studies rated as 2++
D: Evidence level 3 or 4 (non-analytic studies or expert opinion)*; or E*xtrapolated evidence from studies rated as 2+

11 Appendices

Appendix I – Table S1: Search Strategy. Table S2 (and explanatory text): OQAQ: Quality assessment tool for systematic reviews and meta-analyses. Table S3 (and explanatory text): Evidence Grading System. Table S4: Characteristics of Included Reviews. Table S5: Excluded papers. Table S6: OQAQ scores.

Appendix II – Tables S7-14: Data from analyses of: S7) Theoretical basis; S8) Behaviour change techniques; S9) Mode of delivery; S10) Intervention provider; S11) Intervention intensity; S12) Intervention population; S13) Intervention setting; S14) Intervention Effectiveness.

Appendix III – PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) 2009 Checklist.

Appendix 1: Supplementary Tables S1 to S6

Table S1: Search Strategy. Table S2 (and explanatory text): OQAQ: Quality assessment tool for systematic reviews and meta-analyses. Table S3 (and explanatory text): Evidence Grading System. Table S4: Characteristics of Included Reviews. Table S5: Excluded papers. Table S6: OQAQ scores.

Table S1: Search strategy

Unless otherwise stated, search terms were free text terms; MeSH terms: Medical subject heading (MEDLINE medical index term); the dollar sign ($) stands for any character and a number directly after a dollar sign denotes the maximum number of additional letters after the word-stem. The search strategy for MEDLINE is presented below. This strategy was adapted for each database used.

1.	(RISK NEAR DIABETES).TI,AB.
2.	(RISK NEAR HEART).TI,AB.
3.	(RISK NEAR CARDIOVASCULAR).TI,AB.
4.	(RISK NEAR CVD).TI,AB.
5.	(CARDIOVASCULAR ADJ RISK).TI,AB.
6.	(RISK ADJ CARDIOVASCULAR).TI,AB.
7.	SEDENTARY.TI,AB.
8.	OBESITY.W.DE. OR DIABETES-MELLITUS-TYPE-2.DE. OR HYPERTENSION.W.DE. OR OVERWEIGHT.W.DE.
9.	INACTIVE.TI,AB.
10.	OVERWEIGHT.TI,AB.
11.	(OVER ADJ WEIGHT).TI,AB.
12.	OBES$3.TI,AB.
13.	OBESITY-MORBID.DE.
14.	DIABET$2.TI,AB.
15.	HYPERTENS$3.TI,AB.
16.	(HIGH ADJ BLOOD ADJ PRESSURE).TI,AB.
17.	(GLUCOSE ADJ INTOLERANC$3).TI,AB.
18.	(IMPAIRED ADJ GLUCOSE ADJ TOLERANC$3).TI,AB.
19.	(IMPAIRED ADJ FASTING ADJ GLUCOSE).TI,AB.
20.	HYPERLIPID$5.TI,AB.
21.	HYPERGLYC$5.TI,AB.
22.	(METABOLIC ADJ SYNDROME).TI,AB.
23.	(HIGH ADJ CHOLESTEROL).TI,AB.
24.	HYPERCHOLESTEROL$5.TI,AB.
25.	(FAMILIAL ADJ HYPERLIPID$5).TI,AB.
26.	PREDIABETES.TI,AB.
27.	(PRE ADJ DIABETES).TI,AB.
28.	(POLYCYSTIC ADJ OVARIAN ADJ SYNDROME).TI,AB.
29.	(FAMILY ADJ HISTORY).TI,AB.
30.	(GESTATIONAL ADJ DIABETES).TI,AB.
31.	(METABOLIC ADJ SYNDROME).TI,AB.
32.	METABOLIC-SYNDROME-X.DE. OR POLYCYSTIC-OVARY- SYNDROME.DE.
33.	PREDIABETIC-STATE.DE. OR GLUCOSE-INTOLERANCE.DE.
34.	HYPERCHOLESTEROLEMIA.W.DE. OR HYPERLIPIDEMIAS.W.DE.

35.	DIABETES-GESTATIONAL.DE. OR HYPERGLYCEMIA.W.DE.
36.	HYPERLIPIDEMIA-FAMILIAL-COMBINED.DE.
37.	1 OR 2 OR 3 OR 4 OR 5 OR 6 OR 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 OR 24 OR 25 OR 26 OR 27 OR 28 OR 29 OR 30 OR 31 OR 32 OR 33 OR 34 OR 35 OR 36
38.	OBESITY.W.DE. OR HYPERTENSION.W.DE. OR OVERWEIGHT.W.DE.
39.	1 OR 2 OR 3 OR 4 OR 5 OR 6 OR 7 OR 9 OR 10 OR 11 OR 12 OR 13 OR 15 OR 16 OR 17 OR 18 OR 19 OR 20 OR 21 OR 22 OR 23 OR24 OR 25 OR 26 OR 27 OR 28 OR 29 OR 30 OR 31 OR 32 OR33 OR34 OR 35 OR 36 OR 38
40.	PREVENT$5.TI,AB.
41.	(PATIENT ADJ EDUCATION).TI,AB.
42.	PATIENT-EDUCATION-AS-TOPIC.DE. OR SELF-CARE.DE.
43.	(PRIMARY ADJ PREVENTION).TI,AB.
44.	HEALTH-PROMOTION.DE. OR DIET.W.DE. OR FOOD-HABITS.DE.
45.	(HEALTH$3 ADJ BEHAV$6).TI,AB.
46.	HEALTH-BEHAVIOR.DE. OR LIFE-STYLE.DE. OR WALKING.W.DE. OR HEALTH-EDUCATION.DE. OR RISK-REDUCTION-BEHAVIOR.DE.
47.	(HEALTH$3 ADJ EDUCAT$5).TI,AB.
48.	COUNSELING.W.DE.
49.	(HEALTH$3 ADJ PROMOT$5).TI,AB.
50.	EXERCISE.W.DE. OR PHYSICAL-FITNESS.DE. OR SPORTS.W.DE.
51.	MOTIVAT$5.TI,AB.
52.	(SELF ADJ MANAGEMENT).TI,AB.
53.	PATIENT-CENTERED-CARE.DE.
54.	(SELF ADJ CARE).TI,AB.
55.	(SELF ADJ REGULATION).TI,AB.
56.	(PROBLEM ADJ SOLVING).TI,AB.
57.	PROBLEM-SOLVING.DE.
58.	(PERSON ADJ CENTRED).TI,AB.
59.	(PERSON ADJ CENTERED).TI,AB.
60.	(CLIENT ADJ CENTERED).TI,AB.
61.	(CLIENT ADJ CENTRED).TI,AB.
62.	(PATIENT ADJ CENTERED).TI,AB.
63.	(PATIENT ADJ CENTRED).TI,AB.
64.	DIET.TI,AB.
65.	(BEHAV$5 ADJ THEOR$3).TI,AB.
66.	(BEHAV$5 ADJ THEOR$3).TI,AB.
67.	PSYCHOLOGICAL-THEORY.DE. OR BEHAVIOR-THERAPY.DE. OR COGNITIVE-THERAPY.DE.
68.	(AEROBIC ADJ TRAIN$3).TI,AB.
69.	EXERCISE-THERAPY.DE. OR PHYSICAL-ENDURANCE.DE. OR PHYSICAL-EDUCATION-AND-TRAINING.DE. OR SWIMMING.W.DE. OR BICYCLING.W.DE.
70.	(STRENGTH ADJ TRAIN$3).TI,AB.
71.	WEIGHT-LOSS.DE.
72.	(RESISTANCE ADJ TRAIN$3).TI,AB.
73.	WALK$3.TI,AB.
74.	BICYCL$3.TI,AB.
75.	SWIM$4.TI,AB.
76.	SPORT$1.TI,AB.
77.	FITNESS.TI,AB.
78.	EXERCIS$3.TI,AB.
79.	WEIGHT.TI,AB.
80.	LIFESTYLE.TI,AB.

81.	(LIFE ADJ STYLE).TI,AB.
82.	BEHAV$6.TI,AB.
83.	NUTRITION.TI,AB.
84.	COUNSEL$5.TI,AB.
85.	(PHYSICAL ADJ FITNESS).TI,AB.
86.	(PHYSICAL$2 ADJ ACTIV$5).TI,AB.
87.	BODY-WEIGHT.DE. OR WEIGHT-GAIN.DE. OR DIET- REDUCING.DE.
88.	(PHYSICAL ADJ ENDURANCE).TI,AB.
89.	ENERGY-INTAKE.DE.
90.	(HEALTH$3 ADJ BEHAV$6).TI,AB.
91.	HEALTH-BEHAVIOR.DE. OR FOOD-HABITS.DE.
92.	(PSYCHOLOGICAL ADJ THEORY).TI,AB.
93.	(AEROBIC ADJ TRAIN$3).TI,AB.
94.	INTERVENTION.TI,AB.
95.	WALKING.W.DE.
96.	40 OR 41 OR 42 OR 43 OR 44 OR 45 OR 46 OR 47 OR 48 OR 49 OR 50 OR 51 OR 52 OR 53 OR 54 OR 55 OR 56 OR 57 OR 58 OR 59 OR 60 OR 61 OR 62 OR 63 OR 64 OR 65 OR 66 OR 67 OR 68 OR 69 OR 70 OR 71 OR 72 OR 73 OR 75 OR 76 OR 77 OR 78 OR 79 OR 80 OR 81 OR 82 OR 83 OR 84 OR 85 OR 86 OR 87 OR 88 OR 89 OR 90 OR 91 OR 92 OR 93 OR 94 OR 95
97.	WEIGHT.TI,AB.
98.	(PHYSICAL$2 ADJ ACTIV$5).TI,AB.
99.	EXERCIS$3.TI,AB.
100.	WALK$3.TI,AB.
101.	EXERTION$2.TI,AB.
102.	(ENERGY ADJ EXPENDITURE).TI,AB.
103.	BMI.TI,AB.
104.	(BODY ADJ MASS ADJ INDEX).TI,AB.
105.	(WAIST ADJ CIRCUMFERENCE).TI,AB.
106.	(WAIST ADJ TO ADJ HIP).TI,AB.
107.	97 OR 98 OR 99 OR 100 OR 101 OR 102 OR 103 OR 104 OR 105 OR 106
108.	(SYSTEMATIC ADJ REVIEW).TI,AB.
109.	REVIEW.TI,AB.
110.	(META ADJ ANALYSIS).TI,AB.
111.	META-ANALYSIS.TI,AB.
112.	GUIDELINE$1.TI,AB.
113.	REVIEW=YES
114.	PT=META-ANALYSIS
115.	METAANALYSIS.TI,AB.
116.	(SYSTEMATIC NEAR (REVIEW$3 OR OVERVIEW)).TI,AB.
117.	(QUANTITATIV$2 NEAR (REVIEW$3 OR OVERVIEW$2 OR SYNTHESIS$2)).TI,AB.
118.	108 OR 109 OR 110 OR 111 OR 112 OR 113 OR 114 OR 115 OR 116 OR 117
119.	OBSERVATIONAL.TI,AB.
120.	RCT.TI,AB.
121.	INTERVENTION$1.TI,AB.
122.	(RANDOMI$4 ADJ CONTROL ADJ TRIAL$1).TI,AB.
123.	(QUASI ADJ EXPERIMENTAL).TI,AB.
124.	TRIAL$1.TI,AB.
125.	119 OR 120 OR 121 OR 122 OR 123 OR 124
126.	37 AND 96 AND 118 AND 125
127.	39 AND 96 AND 118 AND 125
128.	126 AND 107

129.	127 AND 107
130.	128 NOT 129
131.	129 AND (CHILD# OR ADOLESCENT.DE. OR INFANT#)
132.	129 AND ANIMAL=YES
133.	129 NOT 131
134.	133 NOT 132

Table S2: OQAQ: Quality assessment tool for systematic reviews and meta-analyses

A modified version of the OQAQ was used to assess the quality of reviews. This consists of the following nine questions each answerable as 'yes', 'no' or 'partially/can't tell', carrying scores of 2, 0 and 1, respectively.

Quality Criteria: Reviews were included if their OQAQ score was 14 or more (possible range: 0-18) and if they met at least one of the two OQAQ criteria (scored minimum 1 point on either question 5 &/or 6) about assessing study quality and taking quality into account in analyses (this emphasis on study quality was intended to maximise the likely quality of evidence underlying the review-level analyses).

1.	**Were the search methods used to find evidence on the primary question(s) stated?**
(a)	**Yes**, description of databases searched, search strategy, and years reviewed. **2 points**.
(b)	**Partially**, descriptions of methods not complete. **1 point**.
(c)	**No**, no description of search methods. **0 points**.
2.	**Was the search for evidence reasonably comprehensive?**
(a)	**Yes**, at least one computerised database searched and also a search of unpublished or non-indexed literature. **2 points**.
(b)	**Can't tell**, search strategy partially comprehensive, at least one of the strategies performed. **1 point**.
(c)	**No**, search not comprehensive or not described well. **0 points**.
3.	**Were the criteria used for deciding which studies to include in the review reported?**
(a)	**Yes**, inclusion and exclusion criteria clearly defined. **2 points**.
(b)	**Partially**, reference to inclusion and exclusion criteria can be found but are not defined clearly enough. **1 point**.
(c)	**No**, no criteria defined. **0 points**
4.	**Was bias in the selection of articles avoided?**
(a)	**Yes**, issues influencing selection bias were covered. Both of the following bias-avoiding strategies were used: (1) two or more assessors independently judged study relevance, (2) assessors selected studies using predetermined criteria. **2 points**.
(b)	**Can't tell**, only one of the strategies used. **1 point**.
(c)	**No**, selection bias was not avoided or was not discussed. **0 points**.
5.	**Were the criteria used for assessing the methodological quality of studies reviewed reported?**
(a)	**Yes**, criteria defined and used addressed the major factors influencing bias. **2 points**.
(b)	**Partially**, some discussion or reference to criteria. **1 point**.
(c)	**No**, validity or methodological quality criteria not used or not described. **0 points**.
6.	**Were study quality assessment criteria used to inform the review analysis?**
(a)	**Yes**, criteria were used to inform the analysis, either by exclusion from the analysis if low quality or through sensitivity analysis. **2 points**.
(b)	**Partially**, some discussion but not clearly described application of criteria. **1 point**.
(c)	**No**, criteria not used or not described. **0 points**.
7.	**Were the methods used to combine the findings of the relevant studies (to reach a conclusion) reported?**

(a) **Yes**, qualitative and quantitative methods are acceptable. **2 points.**
(b) **Partially**, partial description of methods to combine and tabulate; not sufficient to duplicate. **1 point**.
(c) **No**, methods not stated or described. **0 points**.

8. Were findings of the relevant studies combined appropriately relative to the primary question of the overview?

(a) **Yes**, combining of studies appears acceptable. **2 points**.
(b) **Can't tell**, should be marked if in doubt. **1 point**.
(c) **No**, no attempt was made to combine findings, and no statement was made regarding the inappropriateness of combining findings. **0 points**.

9. Were the conclusions made by the author(s) supported by the data and/or analysis reported in the overview?

(a) **Yes**, data were reported that support the main conclusions regarding the primary question(s) that the overview addresses. **2 points**.
(b) **Partially**. **1 point**.
(c) **No**, conclusions not supported or unclear. **0 points**.

Table S3: Evidence Grading System (Source: SIGN 50. A guideline developer's handbook, 2008)

LEVELS OF EVIDENCE QUALITY
1++ High quality meta-analyses, systematic reviews of randomised control trials, or randomised control trials with a very low risk of bias
1+ Well-conducted meta-analyses, systematic reviews, or randomised control trials with a low risk of bias
1- Meta-analyses, systematic reviews, or randomised control trials with a high risk of bias
2++ High quality systematic reviews of case control or cohort studies High quality case control or cohort studies with a very low risk of confounding or bias and a high probability that the relationship is causal
2+ Well-conducted case control or cohort studies with a low risk of confounding or bias and a moderate probability that the relationship is causal
2- Case control or cohort studies with a high risk of confounding or bias and a significant risk that the relationship is not causal
3 Non-analytic studies, e.g. case reports, case series
4 Expert opinion

CRITERIA FOR GRADING EVIDENCE QUALITY IN THIS REVIEW

The evidence grading system applied to each analysis was based on the Scottish Intercollegiate Guidelines Network (SIGN) evidence grading system (as above), which is also used by the UK's National Institute for Health and Clinical Excellence (NICE). However, we were looking at analyses which identified intervention characteristics associated with effectiveness, rather than effectiveness per se. We therefore refined the system as follows:-

1. Evidence Grade 1 (causal evidence) was assigned to randomised, between-group comparisons of individual-level data. Where reviews have assessed the quality of their component trials and taken this into account in analyses, this will tend to reduce the risks of

bias in that analysis due to differences in population, intervention type, measurement and attrition. However, further risk may still arise from bias in the selection of trials to enter into the meta-analysis (e.g. poor categorisation of the component being analyzed) or other sources of possible error (e.g. low overall N). Based on these considerations, the overall risk of bias for each analysis was assessed by two reviewers (KS, CG) to assign levels of '++', '+' or '-' to the evidence grade.

2. Evidence Grade 2 (associative evidence) was applied to observational comparisons or contrasts of study-level data (of types i to iv described below). The risks of bias due to study level factors (i.e. whether effects might be explained by differences in or covariance with study population, intervention type, study quality, measurement methods), as well as other factors (e.g. overall statistical power) was assessed by two reviewers (KS, CG) to assign levels of '++', '+' or '-'. Hence, Evidence Grade 2++ was applied to balanced observational comparisons where clear evidence was presented that the groups compared are well-matched such that there was a low risk of bias due to differences in population, intervention type, measurement and study quality, and there were no other likely sources of bias or unreliability. A grade of 2- was applied if there was clearly a high risk of bias for the particular comparison (e.g. comparison based on low numbers of participants/trials or there was clear bias in the selection of trials for the sub-group analysis, or clear imbalances between the groups compared).

3. An assignment of 'ungraded' was applied to any analysis (causal or associative) where there was a clear indication of serious methodological weakness (e.g. severe risk of bias), or if the total number of participants contributing to the analysis was less than 100.

APPLICATION OF THE GRADING SYSTEM IN THIS REVIEW:

The reviews which we selected used five different approaches to identify intervention characteristics associated with increased effect size:-

i) 'Vote counting'. This involves dividing individual studies into groups according to the inclusion of particular characteristics (e.g. high vs. low intensity) and counting the number or proportions of studies which found statistically significant differences (i.e. the number of significant results for groups of trials with different intervention components were counted and compared numerically without statistical analysis).

ii) Stratified meta-analysis: Stratified meta-analysis was used to compare the effect sizes of trials which were grouped according to the inclusion of particular characteristics (e.g. high vs. low intensity) (i.e. the results for sub-groups of trials with different intervention components were statistically pooled and then compared numerically without further statistical analysis).

iii) Meta-regression: Meta-regression analysis was used to compare the effect sizes of trials which were grouped according to the inclusion of particular characteristics (e.g. high vs. low intensity) (i.e. the results for sub-groups of trials with different intervention components were statistically pooled and then statistically contrasted).

iv) Qualitative (descriptive) summaries: This typically involved looking at the intervention descriptions of successful and unsuccessful trials and qualitatively extracting themes which seem more common in the successful studies (e.g. the studies which found a significant difference were more likely to be intensive). This has some advantages in terms of the ability to identify more subtle patterns in the data, but also disadvantages in terms of not being able to produce any estimation of the likely size or statistical reliability of the effect implied.

v) Within study experimental comparison with randomisation: In these analyses, statistical comparisons had been made (in individual RCTs) between groups, which were randomised according to particular contrast characteristics (e.g. high intensity vs. low intensity). The results of such studies had then been summarised either descriptively, or, more usually, by meta-analysis.

The first four approaches are essentially observational, associative analyses (indirect post hoc observations of study-level results) and were therefore graded at level 2. The fifth approach derives from randomised, between group comparisons of the relevant factor and this type of analysis was graded at level 1.

Table S4 - Characteristics of Included Reviews

Study	Type of review	Aim	Inclusion/exclusion criteria	Key outcomes	OQAQ Score (see table S6)	Period searched
Ashworth et al. 2005 (30)	Descriptive	To assess the effectiveness of 'home-based' versus 'centre-based' physical activity interventions on the health of older adults	*Design*: Randomised or quasi-randomised controlled trials, comparing home-based and centre-based physical activity programmes *Participants*: Adults (50yrs+) with cardiovascular risk factors	Physical activity	17	1966 to Sept 2002
Avenell et al. 2004 (31)	Meta-analysis	To review the long-term effects of obesity treatments (inc. diet & physical activity interventions) on body weight, risk factors for disease, and disease	*Design*: RCTs with detailed descriptions of an intervention programme; minimum 2 yr follow-up *Participants*: Adults (18-70yrs) with BMI of 28 kg/m^2 or more	Weight	16	1966 to May 2001
Bosch et al. 2007 (32)	Descriptive	To assess the effects of contracts between patients and healthcare practitioners on patients' adherence to treatment, prevention and promotion of healthy diet & physical activity	*Design*: RCTs *Participants*: Patients or their carers, any age or gender, with any health condition in any health setting. Practitioners, and any worker or service providing screening, diagnosis, therapeutics, rehabilitation, prevention or health promotion activities	Weight	17	1966 to May 2004
Bravata et al. 2007 (33)	Meta-analysis	To evaluate the association of pedometer use with physical activity and health outcomes	*Design*: RCTs or observational studies, with more than 5 participants, reporting change in the number of steps / day. *Participants*: Adult outpatients	Physical activity	14	1966 to February 2007
Brunner et al. 2007 (34)	Meta-analysis	To assess the effects of providing dietary advice to achieve sustained dietary changes or improved cardiovascular risk profile among healthy adults	*Design*: RCTs involving parallel group design *Participants*: Healthy community dwelling adults (18yrs +) including 13 RCTs in people with cardiovascular risk factors	Dietary change	15	Jan 1966 to Nov 2006

Study	Type of review	Aim	Inclusion/exclusion criteria	Key outcomes	OQAQ Score (see table S6)	Period searched
Burke et al. 2003 (35)	Meta-analysis	Evaluate the efficacy & sustained efficacy of adaptations of motivational interviewing (AMI) compared with control procedures and other active treatments	*Design*: Controlled clinical trials *Participants*: Not reported	Physical activity & weight	14	nr
Curioni & Lourenco 2005 (36)	Meta-analysis	To assess the effectiveness of dietary interventions and exercise in long-term weight loss in overweight and obese people	*Design*: RCTs of diet, exercise or both, follow-up period after intervention of at least 1yr *Participants*: Overweight and obese adults 18 years old or older with BMI of >25	Weight	14	Inception to March 2003
Dansinger et al. 2007 (37)	Meta-analysis	To perform a meta-analysis of the effect of dietary counselling compared with usual care on body mass index (BMI) over time in adults	*Design*: RCTs (≥16 weeks in duration) with min. observation period, including treatment & follow-up, of at least 1 year *Participants*: Overweight or obese adults (18yrs+)	Weight	17	Jan 1997 to July 2006
Dombrowski et al. 2008 (38)	Meta-analysis & descriptive	To identify intervention and programme features which are linked to more effective interventions in terms of behaviour (diet & physical activity) and weight change	*Design*: Published RCTs providing ≥12 wks follow-up data after the point of randomisation *Participants*: Adults with BMI of ≥ 30, age of ≥ 40yr and one additional risk factor for morbidity	Physical activity, dietary change & weight loss	15	Studies published between 1985 and 2008
Douketis et al. 2005 (39)	Descriptive	To investigate lifestyle (diet & physical activity), pharmacologic, and surgical methods of weight loss to assess (1) weight loss efficacy (2) effects of weight loss on cardiovascular risk factors (3) applicability of findings from studies to everyday clinical practice	*Design*: RCTs or non-RCTs *Participants*: Overweight or obese adults with BMI ≥25kg/m²	Weight	15	1966 to September 2003

Study	Type of review	Aim	Inclusion/exclusion criteria	Key outcomes	OQAQ Score (see table S6)	Period searched
Eakin et al. 2000 (40)	Meta-analysis & descriptive	To find out what strategies are practical and effective to use in primary care settings to enhance levels of patient physical activity	*Design*: RCTs or quasi-experimental study with a comparison group, intervention delivered or initiated in a primary care setting *Participants*: Not reported	Physical activity	14	1980 to 1998
Foster et al. 2005 (41)	Meta-analysis	To assess the effects of interventions for promoting physical activity	*Design*: RCTs comparing different interventions to encourage sedentary adults not living in an institution to become physically active *Participants*: Sedentary adults (16 yrs+), not living in an institution	Physical activity, cardio-respiratory fitness	17	January 1966 to December 2001
Galani & Schneider 2007 (42)	Meta-analysis	To assess the mid- to long-term effectiveness of lifestyle interventions in the prevention and treatment of obesity	*Design*: RCTs with min. observation period, including treatment & follow-up, of at least 1 year *Participants*: Overweight or obese adults (18yrs+)	Weight	16	1995 to 2005
Gillies et al. 2007 (43)	Meta-analysis	To quantify the effectiveness of pharmacological and lifestyle interventions to prevent or delay type 2 diabetes in people with IGT	*Design*: RCTs, studies had to have an intervention to delay or prevent type 2 diabetes *Participants*: Individuals with IGT	Progression to type 2 diabetes	17	1966 to July 2006
Halcomb et al. 2007 (44)	Descriptive	To investigate the efficacy of general practice nurse interventions for cardiac risk factor reduction	*Design*: RCTs that investigated the effectiveness of interventions for cardiovascular disease management or risk factor reduction undertaken by general practice nurses *Participants*: Adults (18yrs+)	Physical activity & weight	14	1966 to 2005
Kahn et al. 2002 (45)	Descriptive	To evaluate effectiveness of various interventions to increasing physical activity	*Design*: Intervention studies, RCTs or non-RCTs, multiple measurement before-and-after designs with concurrent comparison groups, prospective cohort studies *Participants*: Not reported	Physical activity, aerobic capacity	15	1980 to 2000

Study	Type of review	Aim	Inclusion/exclusion criteria	Key outcomes	OQAQ Score (see table S6)	Period searched
McTigue et al. 2003 (46)	Descriptive	To assess the benefits and harms of screening and earlier treatment in reducing morbidity and mortality from overweight and obesity	*Design*: RCTs of good or fair quality of counselling and behavioural interventions, promoting change in diet or exercise or both *Participants*: Overweight or obese (BMI ≥25) adults (18yrs+)	Weight	16	Jan 1994 to Feb 2003
McTigue et al. 2006 (47)	Descriptive	To examine evidence concerning obesity's health-related risks, diagnostic methods, and treatment outcomes in older individuals	*Design*: RCTs with a follow-up of at least 1 year *Participants*: Adults ≥ 60yrs	Weight	16	Jan 1st 1980 to Nov 2005
Michie et al. 2008 (48)	Meta-analysis	To identify effective individual techniques and theoretically derived combinations of techniques which are linked to more effective interventions in terms of behaviour and weight change	*Design*: Experimental or quasi-experimental *Participants*: Adults (18yrs+)	Physical activity & dietary change	15	1990 to 2007
Murphy et al. 2007 (49)	Meta-analysis	To quantify changes due to walking interventions, that may alter cardiovascular risk factors	*Design*: RCTs with walking as the only intervention *Participants*: Sedentary but apparently healthy adults (18yrs+)	Cardiovascular fitness & weight	15	1971 to Sept 2004
Norris et al. 2007 (50)	Meta-analysis	To assess the effectiveness of dietary, physical activity, and behavioural weight loss, and weight control intervention in adults with pre-diabetes	*Design*: RCTs with weight loss or weight control as their primary stated goal *Participants*: Adults (18yrs +) with pre-diabetes, of any weight	Weight	17	1966 to May 2004
Ogilvie et al. 2007 (51)	Descriptive	To assess the effects of interventions to promote walking in individuals and populations.	*Design*: Any design *Participants*: No limits imposed	Physical activity	16	1990 onwards

Study	Type of review	Aim	Inclusion/exclusion criteria	Key outcomes	OQAQ Score (see table S6)	Period searched
Richardson et al. 2008 (52)	Meta-analysis	To examine the effects of pedometer-based walking interventions on weight loss	*Design*: RCTs or other controlled trials or pre-intervention and post-intervention prospective cohort study, studies using pedometers as motivational tool to increase walking *Participants*: Sedentary, overweight or obese (>25kg/m²) adults	Weight	15	Search conducted July 2005 (period searched not reported)
Rubak et al. 2005 (53)	Meta-analysis	To evaluate the effectiveness of motivational interviewing (MI) in different areas of disease and to identify factors shaping outcomes	*Design*: RCTs using MI as the intervention *Participants*: Not reported	Weight	16	1963 to Jan 2004
Shaw et al. 2005 (54)	Meta-analysis	To assess the effects of psychological interventions for overweight or obesity as a means of achieving sustained weight loss	*Design*: RCTs *Participants*: Overweight or obese (BMI >25kg/m²) adults (18yrs+)	Weight	17	Inception to June 2003
Shaw et al. 2006 (55)	Meta-analysis	To assess regular exercise as a means of achieving weight loss, using RCTs and focused on overweight and obese populations	*Design*: RCTs and quasi-RCTs only *Participants*: Adults (18yrs+)	Weight	16	Inception to 2003
Thompson et al. 2003 (56)	Meta-analysis	To assess effects of dietary advice given by a dietician compared with another health professional, or use of self-help resources, in reducing blood cholesterol in adults	*Design*: RCTs of at least 6-wks intervention. All interventions had to include dietary advice to reduce blood cholesterol *Participants*: Adults (18yrs+), participants with or without existing heart disease or previous MI	Weight	18	1966 to Sept 2002
Tsai & Wadden 2005 (57)	Descriptive	To describe the components, costs, and efficacy of the major commercial and organised self-help weight-loss programmes in the United States	*Design*: Any design conducted in the US *Participants*: Adults	Weight	14	1966 to 2003

Study	Type of review	Aim	Inclusion/exclusion criteria	Key outcomes	OQAQ Score (see table S6)	Period searched
Whitlock et al. 2003 (58)	Descriptive review of reviews	To examine whether: (1) changing individual health behaviour improves health outcomes, and (2) interventions in the clinical setting influence people to change their behaviour	*Design*: RCTs or non-RCTs of primary care based interventions or primary care-feasible interventions conducted in clinical settings *Participants*: Adult women	Physical activity & dietary change	14	1996 to 2003
Williams et al. 2007 (59)	Meta-analysis & descriptive	To assess whether exercise-referral schemes are effective in improving exercise participation in sedentary adults	*Design*: RCTs, non-RCTs, observational studies, process evaluations and qualitative studies *Participants*: Adults referred to exercise-referral schemes from primary care	Physical activity	17	Inception to March 2007

Table S5: Excluded papers

Papers excluded	Reason(s) for exclusion*
Obesity: weight loss without drugs: a balanced diet avoiding high- calorie foods, plus exercise. Prescrire International 2007; 16:162-167.	B
Adams J, White M. Are activity promotion interventions based on the trans-theoretical model effective? A critical review. Br J Sports Med 2003;37:106-114.	B
Allen NA. Social cognitive theory in diabetes exercise research: an integrative literature review. Diabetes Educator 2004;30:805-819	D
Anderson J, Luan J, H°ie L. Structured weight-loss programs: meta-analysis of weight loss at 24 weeks and assessment of effects of intervention intensity. Advances in Therapy 2004;21(2):61-75.	B
Angelo JB, Huang J, Carden D. Diabetes prevention: a review of current literature. Adv Stud Med 2005; 5(5):250-259.	A
Astrup A, Grunwald GK, Melanson EL, Saris WH, Hill JO. The role of low-fat diets in body weight control: a meta-analysis of ad libitum dietary intervention studies. International Journal of Obesity and Related Metabolic Disorders: Journal of the International Association for the Study of Obesity 2000;24:1545-1552.	B
Ayyad C, Andersen T. Long-term efficacy of dietary treatment of obesity: a systematic review of studies published between 1931 and 1999. Obesity reviews 2000;1:113-119.	B
Bronner Y, Boyington J. Developing weight loss interventions for African-American women: elements of successful models. J Natl Med Assoc 2002;94:224-235.	B
Case J, Willoughby D, Haley Z, V, Maybee P. Today's educator. Preventing type 2 diabetes after gestational diabetes. Diabetes Educator 2006;32:877-878.	A
Catenacci V, Wyatt H. The role of physical activity in producing and maintaining weight loss. Nature clinical practice Endocrinology & metabolism 2007;3:518-529.	B
Curtis J, Wilson C. Preventing type 2 diabetes mellitus. J Am Board Fam Pract 2005;18:37-43.	B
Dachs R. Exercise is an effective intervention in overweight and obese patients. Am Fam Phys 2007;75:1333-1336.	A
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Key: A: Not a systematic review (36); B: OQAQ score <14 (33); C: Not in English (1); D: Inappropriate population (2) ; E: Review aims or intervention type not relevant (3); F: Inappropriate outcomes (2).

Table S6: OQAQ scores

Study	OQAQ Score									
	Qu 1	Qu 2	Qu 3	Qu 4	Qu 5	Qu 6	Qu 7	Qu 8	Qu 9	**Total**
Ashworth et al. 2005	2	2	2	2	2	1	2	2	2	17
Avenell et al. 2004	2	2	2	1	2	1	2	2	2	16
Bosch et al. 2007	2	2	2	2	2	1	2	2	2	17
Bravata et al. 2007	2	2	2	0	2	1	2	2	1	14
Brunner et al. 2007	2	2	2	2	1	0	2	2	2	15
Burke et al. 2003	1	2	2	1	1	2	2	1	2	14
Curioni & Lourenco 2005	2	1	1	2	2	0	2	2	2	14
Dansinger et al. 2007	2	1	2	2	2	2	2	2	2	17
Dombrowski et al. 2008	2	1	2	2	2	0	2	2	2	15
Douketis et al. 2005	2	2	2	2	2	1	1	1	2	15
Eakin et al. 2000	2	2	2	1	1	1	2	1	2	14
Foster et al. 2005	2	2	2	2	2	1	2	2	2	17
Galani & Schneider 2007	2	2	2	0	2	2	2	2	2	16
Gillies et al. 2007	2	2	1	2	2	2	2	2	2	17
Halcomb et al. 2007	2	2	2	2	2	0	2	1	1	14
Kahn et al. 2002	2	2	1	2	2	2	2	1	1	15
McTigue et al. 2003	2	1	2	2	2	2	1	2	2	16
McTigue et al. 2006	2	2	1	2	2	1	2	2	2	16
Michie et al. 2008	2	2	2	2	1	0	2	2	2	15
Murphy et al. 2007	2	2	2	1	1	1	2	2	2	15
Norris et al. 2007	2	2	2	2	2	1	2	2	2	17
Ogilvie et al. 2007	2	2	2	1	2	1	2	2	2	16
Richardson et al. 2008	2	2	2	1	1	1	2	2	2	15
Rubak et al. 2005	2	2	2	1	2	1	2	2	2	16
Shaw et al. 2005	2	2	2	1	2	2	2	2	2	17
Shaw et al. 2006	2	2	2	2	2	0	2	2	2	16
Thompson et al. 2003	2	2	2	2	2	2	2	2	2	18

Tsai & Wadden 2005	2	2	2	2	0	1	2	2	2	15
Whitlock & Williams 2003	2	2	2	1	2	2	1	1	1	14
Williams et al. 2007	2	1	2	2	2	2	2	2	2	17

Appendix II: Evidence tables

Supplementary Tables S7-14: Data from analyses of: S7) Theoretical basis; S8) Behaviour change techniques; S9) Mode of delivery; S10) Intervention provider; S11) Intervention intensity; S12) Intervention population; S13) Intervention setting; S14) Intervention effectiveness.

Table S7: Theoretical Basis

Study	Comparisons	Method of comparison	N studies (N participants)	Outcome	Follow-up time	Results	Evidence Grade	OQAQ Review Quality (out of 18)
Dombrowski et al. 2008	Theory-based intervention versus intervention with no stated theory base	Uni-variate meta-regression	44 (10,560)	Weight (kg)	Active intervention phase (mean 6.2 mths)	Those studies which stated a theoretical model as the foundation of the intervention showed no trend in inducing greater weight losses compared to studies that did not state theoretical underpinnings	2+	15
Dombrowski et al. 2008	Interventions congruent with different theoretical bases	A series of uni-variate meta-regression analyses (studies grouped according to no. of theory congruent techniques used)	44 (10,560)	Weight (kg)	Active intervention phase (mean 6.2 mths)	Only Control Theory showed an increase in weight loss with the inclusion of more theory congruent techniques. This was marginally significant between studies using 3 Control Theory techniques (WMD = -4.7kg, 95%CI: -7.0 to -2.4) and those using none (WMD = -2.9kg, 95%CI: -4.6 to -1.2). All other theories showed no significance or marginal trends across studies	2+	15
Michie et al. 2008	Interventions using behaviour change techniques congruent with Control Theory[28] versus other	Multi-variate meta-regression of RCT data	71 (28,838) with 28 'congruent' interventions	Standardised mean difference (Cohen's d) for combined dietary and	1 wk to 24 mths (mean 6 mths)	Results showed that interventions which prompted self-monitoring and used at least one other technique congruent with Control Theory generated around twice the effect size of other interventions (SMD = 0.60 (95%CI: 0.39 to 0.81) &	2+	15

Table S7: Theoretical Basis

Study	Comparisons	Method of comparison	N studies (N participants)	Outcome	Follow-up time	Results	Evidence Grade	OQAQ Review Quality (out of 18)
	interventions			physical activity outcomes		0.26 (95%CI: 0.20 to 0.31), respectively). Similar analyses restricted to only dietary and PA interventions found a similar pattern of results (SMD = 0.72 vs 0.24 and SMD = 0.50 vs 0.28 respectively). Sensitivity analyses excluding outliers and controlling for the number of non Control Theory related techniques suggested that the results were robust	2+ 2+	

Abbreviations: RCT = Randomised Controlled Trial. SMD = Standardised Mean Difference. WMD = Weighted Mean Difference. OQAQ = Oxman Quality Assessment Questionnaire, Mths = months

Table S8: Behaviour Change Techniques

Study	Comparisons	Method of comparison	N studies (N participants)	Outcome	Follow-up time	Results	Evidence Grade	OQAQ Review Quality (out of 18)
1. Use of established behaviour change techniques (non specific)								
Shaw et al. 2005	Adding behaviour therapy to diet & exercise	Descriptive summary and meta-analysis of RCTs making this comparison	6 (467)	Weight (kg)	6 to 16 mths (median 6mths)	5 out of 6 studies (N=431) favoured adding behaviour therapy to diet & exercise, one (N=36) favoured diet and exercise alone. Meta-analysis found a benefit of adding behaviour therapy of -4.46kg (95%CI: -4.57 to -4.34) with significant heterogeneity between studies	1+	17
McTigue et al. 2003	Adding behaviour therapy to diet & exercise	Descriptive summary of groups of RCTs and cohort studies with different intervention content	14 (7776)	Weight (kg)	12 to 54 mths (median 12 mths)	Having a behavioural component in the intervention was associated with increased effectiveness, but this was almost perfectly confounded with increased contact frequency. The mean net weight change for the 11 (N=6097) behavioural (and higher intensity) interventions ranged from -3 to -5 kg, compared with an overall net weight change of -2.0 kg Focusing on RCTs, of the 6 with a behavioural component, 4 achieved -2.5 to -5.5 kg net weight change (N=5482) and 2 achieved only borderline weight reduction (N=184). For non-behavioural interventions, net weight change ranged from -0.1 to -0.9 kg (3 studies, N=1759)	2-	16

Table S8: Behaviour Change Techniques

Study	Comparisons	Method of comparison	N studies (N participants)	Outcome	Follow-up time	Results	Evidence Grade	OQAQ Review Quality (out of 18)
McTigue et al. 2006	Adding behaviour therapy to diet and /or exercise for older people	Descriptive 'vote-counting' of significant RCT results	11 (nr)	Weight (kg)	12 to 48 mths (median 15 mths)	Of 7 RCTs that included a behavioural component, 5 showed a significant or borderline significant weight loss. The four studies without a clear behavioural component showed no significant treatment effect on weight loss	2+	16
Avenell et al. 2004	Adding behaviour therapy to diet	Meta-analysis of RCTs making this comparison	1) 2 (50) 2) 1 (31) 3) 1 (34) 4) 1 (40)	Weight (kg)	1) 12mths 2) 18ths 3) 36mths 4) 60mths	Adding behaviour therapy to diet improved weight loss (95%CI) by:- 1) -7.67 kg (-11.97 to -3.36) 2) -4.18 kg (-8.32 to -0.04) 3) -2.91 kg (-8.60 to 2.78) 4) 1.90 kg (-3.75 to 7.55)	Ungraded	16
Avenell et al. 2004	Adding behaviour therapy to diet & exercise	Meta-analysis of RCTs making this comparison	1 (105)	Weight (kg)	12mths	The addition of behaviour therapy to diet & exercise did not significantly improve weight loss. NB: There were many groups in this study with N = ~13 per group, so this finding is not robust	Ungraded	16
Shaw et al. 2005	Adding cognitive behavioural therapy to diet & exercise	Meta-analysis of RCTs making this comparison	2 (63)	Weight (kg)	4.5 and 6 mths	Adding CBT to exercise & diet resulted in significantly more weight loss (-4.9 kg, 95% CI: -7.3 to -2.4)	Ungraded	17
Michie et al. 2008	Number of behaviour change techniques (BCTs) included in intervention	Uni-variate & multi-variate regression of RCT data	71 (28,838)	Standardised effect size for dietary and physical activity outcomes (mix of objective and self-reported)	1 wk to 24 mths (mean 6 mths)	The number of BCTs had no significant association with effect size ($p > 0.05$)	2+	15

Table S8: Behaviour Change Techniques

Study	Comparisons	Method of comparison	N studies (N participants)	Outcome	Follow-up time	Results	Evidence Grade	OQAQ Review Quality (out of 18)
Dombrowski et al. 2008	Number of BCTs included in *dietary* interventions 4 sub-groups (1-3, 4-6, 7-9, ≥10)	Stratified meta-analysis and between group comparisons using uni-variate meta-regression of RCT data	A) 4(394) 6(904) 8(802) 5(2920) B) 1(54) 1(25) 2(81) 7(3529)	Weight (kg)	A) active intervention (1 to 14 mths, mean 6 mths) B) maintenance phase (6 to 36 mths, mean 19mths)	A) In dietary interventions, more BCTs were associated with more weight loss, with 1-3 BCTs (-1.1 kg, 95% CI: -2.1 to 0); 4-6 BCTs (-1.8 kg, 95% CI: -3.2 to -0.5); 7-9 BCTs (-5.0 kg, 95% CI: -7.4 to -2.6)) and 10+ BCTs (-3.0 kg, 95% CI: -5.2 to 0.9). Sub group comparisons approached significance for using 1-3 BCTs compared with 7-9 BCTs (p = 0.052) B) In the maintenance phase, weight loss was highest in studies which used 7-9 BCTs to change dietary behaviour. 1-3 BCTs (-3.3 kg, 95% CI: -5.7 to -1.0)); 4-6 BCTs (-2.6 kg, 95% CI: -7.5 to 2.3)); 7-9 BCTs (-7.9 kg, 95% CI: -11.1 to -4.7)) and 10+ BCTs (-2.9 kg, 95% CI: -4.9 to -0.8)	A) 2+ B) 2-	15

Table S8: Behaviour Change Techniques

Study	Comparisons	Method of comparison	N studies (N participants)	Outcome	Follow-up time	Results	Evidence Grade	OQAQ Review Quality (out of 18)
Dombrowski et al. 2008	Number of BCTs included in *physical activity* interventions 4 sub-groups (1-3, 4-6, 7-9, ≥10).	Stratified meta-analysis and between group comparisons using meta-regression techniques	A) 4(394); 6(904); 8(802); 5(2920) B) 0 (0); 4(607); 1(59); 6(3023)	Weight (kg)	A) active intervention (1 to 14 mths, mean 6 mths) B) maintenance phase (6 to 36 mths, mean 19mths)	A) In physical activity interventions, the highest weight loss was observed for studies that used 1-3 BCTs with 1-3 BCTs (-3.9 kg, 95% CI: -7.2 to -0.5); 4-6 BCTs (-1.8 kg, 95% CI: -2.9 to -0.7); 7-9 BCTs (-2.7 kg, 95% CI: -5.4 to 0.1)) and 10+ BCTs (-3.4 kg, 95% CI: -5.1 to -1.6). Subgroup comparisons were not significant (p > 0.3) B) In the maintenance phase, studies using 7-9 BCTs showed the greatest weight loss. 1-3 BCTs (n/a); 4-6 BCTs (-3.5 kg, 95% CI: -5.4 to -1.6); 7-9 BCTs (-7.1 kg, 95% CI: -10.9 to -3.3) and 10+ BCTs (-2.9 kg, 95% CI: -5.4 to -0.4)	A) 2+ B) 2-	15
2. Use of specific behaviour change techniques								
Avenell et al. 2004	Social support (usually from family) versus same intervention individually delivered	Meta-analysis of RCTs making this comparison	1) 4 (127) 2) 2 (209) 3) 1 (27) 4) 1 (20) 5) 1 (19)	Weight (kg)	1) 12mths 2) 18mths 3) 24mths 4) 43mths 5) 48mths	Adding social /family support to interventions improved weight loss (95%CI) by:- 1) -2.96 kg (-5.31 to -0.60) 2) -1.80 kg (-3.04 to 0.87) 3) -5.61 kg (-10.98 to -0.24) 4) -0.75 kg (-6.95 to 5.45) 5) -1.55 kg (-7.88 to 4.78)	1) 1+ 2) 1- 3, 4 & 5) Ungraded	16

Table S8: Behaviour Change Techniques

Study	Comparisons	Method of comparison	N studies (N participants)	Outcome	Follow-up time	Results	Evidence Grade	OQAQ Review Quality (out of 18)
Michie et al. 2008	Use versus non-use of specific behaviour change techniques (BCTs)	Multi-variate & uni-variate meta-regression of RCT data	71 (28,838)	Standardised effect size for dietary and physical activity outcomes (mix of objective and self-reported)	1 wk to 24 mths (mean 6 mths)	In the uni-variate analysis, only one of 26 techniques, namely '*prompt self-monitoring of behaviour'* was significantly associated with effect size ($p < 0.05$), explaining 14.6% of between study heterogeneity. The multi-variate model showed this association to be independent of setting, intensity, No. of BCTs, duration, population and delivery mode	2+	15
Dombrowski et al. 2008	Use versus non-use of specific behaviour change techniques (BCTs) aimed at changing dietary behaviour	Stratified meta-analysis and uni-variate meta-regression of RCT data	N varies by BCT; 1) 1 to 22, typically 5-10 with BCT included (N=144 to 4523) 2) 1 to 10, typically 2-5 studies with BCT included (N=25 to 3610)	Weight (kg)	1) active intervention: 1 to 14 mths, (mean 6 mths) 2) maintenance phase: 6 to 36 mths (mean 19mths)	1) Three BCTs were significantly associated with net weight loss: T8 (provide instruction, -2.8 kg), T12 (prompt self-monitoring of behaviour, -3.4 kg), and T23 (relapse prevention, -2.8 kg) explaining 26.6%, 31.1% and 19.6% of the between-study heterogeneity respectively 2) In the maintenance phase only 1 BCT was significantly associated with net weight loss (T22 prompt self talk, -3.4 kg) although only 1 study was identified as having used this BCT	1) 2+ 2) 2+	15

Table S8: Behaviour Change Techniques

Study	Comparisons	Method of comparison	N studies (N participants)	Outcome	Follow-up time	Results	Evidence Grade	OQAQ Review Quality (out of 18)
Dombrowski et al. 2008	Use versus non-use of specific behaviour change techniques (BCTs) aimed at increasing *physical activity*	Stratified meta-analysis and uni-variate meta-regression of RCT data	N varies by BCT; 1) 2 to 20, typically 5 to 10 with BCT included (N=428 to 4592) 2) 1 to 10, typically 3 to 8 studies with BCT included (N=94 to 3595)	Weight (kg)	1) active intervention: 1 to 14 mths, (mean 6 mths) 2) maintenance phase: 6 to 36 mths (mean 19mths)	1) For active intervention, one BCT aimed at changing weight behaviour was significantly associated with net weight loss: T17 (*prompt practice*, -3.6 kg), explaining 34.3% of between study heterogeneity 2) For maintenance, two BCTs were significantly associated with net weight loss (T22 *prompt self talk*, -3.4 kg and T26 *time management*, -3.4 kg). However, both of these BCTs were only associated with one intervention. A positive non-significant trend was found for T12 (*prompt self-monitoring of behaviour*, -2.8 kg, p = 0.06)	1) 2+ 2) 2+	15
Eakin et al. 2000	Individual tailoring in interventions versus those without	Descriptive 'vote-counting' of significant results for groups of RCTs & quasi-experimental studies	1) 10 (4170) 2) 7 (23,573)	Self-reported physical activity (effect size for continuous outcomes, Odds ratio for categorical outcomes)	1) < 12 mths (median 6 wks) 2) >= 12 mths (median 12 mths)	1) 6 of the 7 studies with significant short-term effects used a tailored intervention. 2) 1 of 3 studies with significant long-term effects was tailored. Overall, only 3 of 10 tailored studies had no significant effects	2- 2-	14
Ogilvie et al. 2007	Individual tailoring in interventions versus no tailoring	Descriptive summary of characteristics of successful interventions	nr (possibly 48)	Self-reported or pedometer-recorded walking (mins/week)	nr	Effective interventions typically involved content tailored to participants' requirements or circumstances	Ungraded	16

Table S8: Behaviour Change Techniques

Study	Comparisons	Method of comparison	N studies (N participants)	Outcome	Follow-up time	Results	Evidence Grade	OQAQ Review Quality (out of 18)
Ogilvie et al. 2007	Brief advice walking intervention, including goal-setting, versus no advice	Descriptive summary of individual RCT results	RCTs (1703)	Self-reported walking (mins/week)	6 wks to 12 mths (median 12 mths)	Intervention increased walking by (range) 0 to +44 min/wk (median 27min/wk), with a significant difference in 3 of 5 RCTs	1+	16
Bosch et al. 2007	Contracts versus supervised exercise versus minimal contact	Descriptive summary of individual RCT results	2 (159)	Weight (lbs)	10 wks and 12 mths	One study showed no significant differences in weight loss between contracts and controls at 10 wks. The other found that people with contracts lost 3.5lbs more than those with minimal contact ($p<0.05$) at 12 weeks, but no significant difference at 12months (0.1 lbs)	Ungraded	17
Bravata et al. 2007	Pedometer based intervention versus control	Meta-analysis 1) RCTs 2) Cohort studies	1) 8 (277) 2) 18 (2490)	Walking (pedometer-recorded steps /day)	1) 4 to 24 wks (median 10.5 wks) 2) 3 to 104 wks (median 10.5 wks)	Interventions which included pedometer use resulted in:- 1) Mean 2004 steps/day > controls (95%CI: 878 to 3129) 2) Mean 2183 steps/day > baseline (95%CI: 1571to 2796). NB: All but one small study (N=48) had follow-up of 36 weeks or less	1) 1+ 2) 2++	14
Ogilvie et al. 2007	Pedometer based intervention versus control	Descriptive summary of individual study results	7 (652) (6 RCTs)	Walking (pedometer-recorded minutes/week)	6 wks to 12 mths (median 13 weeks)	Interventions which included pedometer use resulted in (range = -11 to +181 min/wk; median 54min/wk) with a significant difference in 3 of 7 studies (2 of 6 RCTs). Studies not finding significance were considerably under-powered (N = 15 to 61)	1+	16

Table S8: Behaviour Change Techniques

Study	Comparisons	Method of comparison	N studies (N participants)	Outcome	Follow-up time	Results	Evidence Grade	OQAQ Review Quality (out of 18)
Richardson et al. 2008	Pedometer based intervention	Descriptive summary of study effects in intervention arms only	9 (307) inc. 4 RCTs	Walking (pedometer-recorded steps /day)	4 wks to 1yr (median 16 wks)	Average daily step-count increased in all studies (Range 1827 to 4556 steps/day).This equates to between 1 mile and just over 2 miles, or an additional 20 to 40mins of walking/day	2+	15
Richardson et al. 2008	Pedometer based intervention	Meta-analysis of intervention arms for RCTs and cohort studies	9 (307) inc. 4 RCTs	Weight (kg)	4 wks to 1yr (median 16 wks)	In the intervention arms, the pooled mean change from baseline was -1.27 kg (95% CI: -1.85 to -0.70). This equates to 0.05 kg/wk or 2.5 kg /year	2+	15
Bravata et al. 2007	Pedometer based intervention	Meta-analysis of intervention arms only for RCTs and cohort studies	18 (562)	BMI (kg/m^2)	3 to 104 wks (median 10.5wks)	In the intervention arms, BMI decreased by 0.38 (95% CI: 0.05-0.72; P=.03) from baseline to follow up	2++	14
Bravata et al. 2007	Use of pedometer with or without step diaries	Stratified meta-analysis of data from intervention arms and cohort studies	26 (2645) of which 3 (~950) had no step diary	Walking (pedometer-recorded steps /day)	3 to 104 wks (median 10.5 wks)	Interventions with pedometers not using a step diary did not significantly increase activity over baseline (mean 832 steps/day, 95% CI: −258 to 1922). Those using a diary significantly increased their activity over baseline (mean 2649 steps/day, 95% CI: 2032 to 3266)	2-	14
Bravata et al. 2007	Use of pedometers with or without step goals	Stratified meta-analysis of data from intervention arms and cohort studies	26 (2645); 3 (77) with no step goal	Walking (pedometer-recorded steps /day)	3 to 104 wks (median 10.5 wks)	Interventions with pedometers not using a step goal did not significantly increase activity over baseline (686 steps/day, 95%CI: -1621 to 2994). With the use of the 10 000-step-per-day goal steps-per-day increased significantly by more than 2988 (95%CI: 1646 to 4350) or 2363 (95%CI: 189 to 2936) for other step goals	2-	14

Table S8: Behaviour Change Techniques

Study	Comparisons	Method of comparison	N studies (N participants)	Outcome	Follow-up time	Results	Evidence Grade	OQAQ Review Quality (out of 18)
Bravata et al. 2007	Use of pedometers with or without step goals	Multi-variate meta-regression of data from intervention arms and cohort studies	1) 26 (2645) 2) 18 (562)	1) Walking (pedometer-recorded steps /day) 2) BMI (kg/m^2)	1) 3 to 104 wks (median 10.5 wks) 2) 3 to 104 wks (median 10.5 wks)	1) Having a step goal was the main predictor of increased physical activity (p=.001). No other covariates (inc. gender, BMI, ethnicity, baseline activity) were significant 2) BMI change was significantly associated with having a step goal (p= 0.04), independently of other covariates (inc. gender, BMI, ethnicity, baseline activity)	2+ 2+	14
Bravata et al. 2007	Use of pedometers with or without physical activity counseling	Multi-variate meta-regression of data from RCT intervention arms and cohort studies	26 (2645)	Walking (pedometer-recorded steps /day)	3 to 104 wks (median 10.5wks)	"Physical activity counseling" was not a significant predictor of increased physical activity. NB: This is poorly defined, with "some providing several weekly sessions to motivate walking and give individualised feedback, whereas others provided only a brief general physical activity lecture"	2-	14
3. Motivational interviewing								
Rubak et al. 2005	Motivational interviewing based intervention vs. traditional advice-giving /usual GP care	Generic inverse variance meta-analysis of RCTs making this comparison	6 (1140)	BMI	nr (but within range 3 to 24 mths)	The combined effect size estimate was 0.72 BMI units (95% CI: 0.33 to 1.11, p<0.0001).	1++	16

Table S8: Behaviour Change Techniques

Study	Comparisons	Method of comparison	N studies (N participants)	Outcome	Follow-up time	Results	Evidence Grade	OQAQ Review Quality (out of 18)
Burke et al. 2003	Motivational interviewing based intervention versus control	Meta-analysis of RCTs making this comparison	1) 4 (832) 2) 1 (523)	Standardised mean difference (Cohen's d) for dietary and physical activity outcomes (mix of objective and self-reported)	1) 12 to 18 wks 2) 12 mths	1) The interventions produced moderate-to-strong effects (SMD= 0.53, 95%CI: 0.32 to 0.74), compared with standard treatment or placebo controls 2) In this single study, the increase in physical activity was not significant (SMD = 0.17, 95%CI: -0.12 to 0.46)	1) 1+ 2) 1-	14
4. Targeting multiple behaviours								
Shaw et al. 2006	Adding exercise to diet	Meta-analysis of RCTs making this comparison	1) 15 (1079) 2) 6 (482)	1) Weight (kg) 2) BMI (kg/m^2)	1) 3 to 12mths (median 16 wks) 2) 3 to 12 mths (median 6 mths)	1) Adding exercise to diet produced additional weight loss of -0.65 kg (95%CI: -0.97 to -0.33) 2) Adding exercise to diet produced additional change in BMI of -0.31 kg/m^2 (95%CI: -0.55 to -0.07)	1) 1++ 2) 1+	16
Curioni & Lourenco 2005	Adding exercise to diet	Meta-analysis of RCTs making this comparison	1) 6 (407) 2) 6 (407)	Weight (kg)	1) after intervention 2) 1yr after the end of the intervention	1) Weight loss (±SD) for diet & exercise was approx 30% greater than for diet: -13.0 ±10.4 kg vs -9.9 ±9.6 kg, SMD = -0.20 (95%CI: -0.41 to 0.01, p=0.06) 2) Sustained weight loss (±SD) for diet & exercise was 50% greater: -6.7±8.3 kg vs. -4.5±11.3 kg SMD = -0.20 (95%CI: -0.42 to 0.01, p = 0.06)	1- 1-	14
Avenell et al. 2004	Adding exercise to diet	Meta-analysis of RCTs making this comparison	1) 2 (269) 2) 2 (131) 3) 1 (21)	Weight (kg)	1) 12mths 2) 18mths 3) 36mths	Adding exercise to diet produced additional weight loss (95%CI) of:- 1) -1.95 kg (-3.22 to -0.68), 2) -7.63 kg (-10.33 to -4.92) 3) -8.22 kg (-15.27 to -1.16)	1) 1+ 2) 1- 3) Ungraded	16

Table S8: Behaviour Change Techniques

Study	Comparisons	Method of comparison	N studies (N participants)	Outcome	Follow-up time	Results	Evidence Grade	OQAQ Review Quality (out of 18)
Dansinger et al. 2007	Adding exercise to diet	1) Multi-variate meta-regression 2) Description of individual RCTs with this comparison 3) T-tests of intervention arm means at different times 4) T-tests of BMI slopes in intervention arms at different times	1) 46+ (6386) 2) 7 (1016) 3) N varies by time point (nr) 4) N varies by time point (nr)	Weight (kg)	6-60 mths (median varies by analysis /nr)	1) Adding exercise to dietary intervention made no significant difference at the end of the active or maintenance phases (p= 0.50, p=0.62) 2) Weight loss was generally greater among participants in combined diet & exercise programs than for diet alone. However, most differences were not significant 3) Active phase: At 12 mths, diet and exercise produced significantly greater weight loss than diet alone, but weight changes were similar in both groups at 3 and 6 mths. Maintenance phase: Changes in weight were not significantly different across studies 4) At 3-12 mths, the 3 diet & exercise interventions led to significantly greater weight loss than diet alone (Mean Diff: -0.23 kg/m^2/mth, p=0.009). For other time periods slopes did not differ significantly	1) 2- 2) 1- 3) 2- 4) 2-	17
Avenell et al. 2004	Adding exercise to diet & behaviour therapy	Meta-analysis of RCTs making this comparison	1) 7 (166) 2) 3 (237)	Weight (kg)	1) 12mths 2) 24mths	Adding exercise to diet & behaviour therapy produced additional weight loss of:- 1) -3.02 kg (95%CI: -4.94 to -1.11) 2) -2.16 kg (95%CI: -4.20 to -0.12)	1+ 1+	16
Shaw et al. 2006	Exercise versus diet	Meta-analysis of RCTs making this comparison	7 (467)	Weight (kg)	3 to12mths (median 26 wks)	Exercise produced less weight loss than dietary intervention by 3.6 kg (95%CI: 2.95 to 4.26)	1-	16

Table S8: Behaviour Change Techniques

Study	Comparisons	Method of comparison	N studies (N participants)	Outcome	Follow-up time	Results	Evidence Grade	OQAQ Review Quality (out of 18)
Shaw et al. 2006	High versus low intensity exercise with no dietary change	Meta-analysis of RCTs making this comparison	4 (317)	Weight (kg)	3.5 - 12mths (median 34 wks)	All trials favoured high intensity exercise. Weight loss was -1.47 kg (95%CI: -2.28 to -0.66) greater in the high intensity exercise group	1-	16
Shaw et al. 2006	High versus low intensity exercise with dietary change	Meta-analysis of RCTs making this comparison	7 (224)	Weight (kg)	12 to 20wks (median 16 wks)	Weight loss was not significantly greater in the high intensity exercise group -0.08 kg (95%CI: -1.20 to 1.04).	1-	16

Abbreviations: BCT = Behaviour Change Technique, CBT = Cognitive behavioural therapy,. RCT = Randomised Controlled Trial. SMD = Standardised Mean Difference. BMI = Body Mass Index (Kg/m2). SD = Standard Deviation. OQAQ = Oxman Quality Assessment Questionnaire, Mean Diff = Mean difference, NR = not reported, Mths = Months, Wks = Weeks, GP = General practitioner, NB = nota bene.

Table S9: Mode of Delivery

Study	Comparisons	Method of comparison	N studies (N participants)	Outcome	Follow-up time	Results	Evidence Grade	OQAQ Review Quality (out of 18)
Avenell et al. 2004	Group versus individual (one-to-one) intervention	Meta-analysis of RCTs making this comparison	1) 4 (94) 2) 1 (17) 3) 1 (58) 4) 1 (53)	Weight (kg)	1) 12mths 2) 18mths 3) 24mths 4) 60mths	Net weight loss in favour of group intervention mode: 1) 1.59 kg (95% CI: -1.81 to 5.00) 2) -0.74 kg (95% CI: -4.21 to 5.69) 3) 8.10 kg (95% CI: 2.19 to 14.01) 4) 4.40 kg (95% CI: -3.51 to 12.31)	1, 2, 3 & 4) Ungraded	16
Michie et al. 2008	Group versus individual (one-to-one) or mixed mode intervention	Multi-variate and uni-variate meta-regression of RCT data	71 (28,838)	Objective or self-report of behavior change (diet and physical activity)	1 wk to 24 mths (mean 6 mths)	Delivery mode was not significantly associated with behaviour change ($p > 0.05$)	2+	15
Dombrowski et al. 2008	Group versus individual (one-to-one) or mixed mode intervention	Stratified meta-analysis of RCT data and comparison of groups using meta-regression	11 (1108) 6 (822) 6 (3090)	Weight (kg)	Active intervention phase (nr. Estimate mean 6 mths)	One-to-one interventions were less effective than group ($p=0.07$) or combined modes ($p=0.05$). Groups delivered -4.0 kg (95% CI: -6.1 to -2.2), one-to-one -0.9 kg (95% CI: -1.5 to -0.4) and combined -3.8 kg (95% CI: -5.4 to -2.1)	2+	15
Dombrowski et al. 2008	Group versus individual (one-to-one) or mixed mode intervention	Stratified meta-analysis of RCT data and comparison of groups using meta-regression	2 (84) 2 (148) 7 (3457)	Weight (kg)	Maintenance phase (nr. Estimate mean 19mths)	One-to-one interventions were not significantly different from group or combined modes. Groups delivered -5.1 kg (95% CI: -9.5 to -0.8), one-to-one -4.0 kg (95% CI: -5.8 to -2.2) and combined -3.1 kg (95% CI: -5.3 to -1.0)	2+	15

Table S9: Mode of Delivery

Study	Comparisons	Method of comparison	N studies (N participants)	Outcome	Follow-up time	Results	Evidence Grade	OQAQ Review Quality (out of 18)
McTigue et al. 2003	Group versus individual (one-to-one) intervention	Descriptive review of study characteristics	nr	Weight (kg)	12 to 34 mths (median 12 mths)	Treating patients on an individual rather than a group basis seemed less important than intervention intensity	2-	16
Ogilvie et al. 2007	Group versus individual (one-to-one) intervention	Descriptive review of study characteristics	27 (8764)	Self-reported or pedometer-recorded walking (minutes/week)	6 wks to 10 yrs (median 6mths)	Both individual and group approaches seem capable of delivering modest changes in physical activity	2-	16

Abbreviations: RCT = Randomised Controlled Trial. OQAQ = Oxman Quality Assessment Questionnaire, NR = not reported, Mths = months, Wks = Weeks.

Table S10: Intervention Provider

Study	Comparisons	Method of comparison	N studies (N participants)	Outcome	Follow-up time	Results	Evidence Grade	OQAQ Review Quality (out of 18)
Michie et al. 2008	Medically or non-medically trained health professional, or non-health professional	Multi-variate & uni-variate meta-regression of RCT data	71 (28,838)	Objective or self-report of behaviour change (diet and physical activity)	1 wk to 24 mths (mean 6 mths)	Intervention provider had no statistically significant association with behaviour change ($p > 0.05$)	2+	15
Dombrowski et al. 2008	Professional, layperson, or both	Stratified meta-analysis of RCT data and comparison of groups using meta-regression	11 (1263) 5 (509) 7 (3248)	Weight (kg)	Active intervention phase: 1 to 14 mths (mean 6.2)	Professionals -2.7 kg (95% CI: -4.2 to -1.2); lay people -2.9 kg (95% CI: -4.9 to -1.0); lay people with professionals -4.1 kg (95% CI: -7.2 to -1.1). No significant difference between intervention providers ($p > 0.05$)	2+	15
Eakin et al. 2000	Physicians, nurses, health educators or public health students	Descriptive review of study characteristics	15 (26,219)	Self-reported physical activity	1) < 12 mths (median 6 wks) 2)>=12 mths (median 12 mths)	No clear association was found between type of intervention provider and effectiveness	2-	14
Ogilvie et al. 2007	Doctor, nurse, exercise specialist, or other	Descriptive review of study characteristics	27 (8764)	Self-reported or pedometer-recorded walking (mins/week)	6 wks to 10 yrs (median 6mths)	No clear relationship was found between type of intervention provider and effectiveness	2-	16
Thompson et al. 2003	Dietician versus self-help resources	Meta-analysis of RCTs making this comparison	4 (588)	Weight (kg)	26 wks to 2yrs (median 12 mths)	There was no significant difference between dietician and self-help (-0.42 kg, 95% CI: -1.0, 0.2). This may reflect poor study design and other confounding factors noted by the authors	Ungraded	18

Table S10: Intervention Provider

Study	Comparisons	Method of comparison	N studies (N participants)	Outcome	Follow-up time	Results	Evidence Grade	OQAQ Review Quality (out of 18)
Thompson et al. 2003	Dietician versus counsellor	Meta-analysis of RCTs making this comparison	1 (78)	Weight (kg)	12 mths	One small study showed a significant difference in favour of dieticians (-5.8 kg, 95% CI: -8.91, -2.69)	Ungraded	18

Abbreviations: RCT = Randomised Controlled Trial. OQAQ = Oxman Quality Assessment Questionnaire, Mths = Months, Wks = Weeks

Table S11: Intervention Intensity

Study	Comparisons	Method of comparison	N studies (N participants)	Outcome	Follow-up time	Results	Evidence Grade	OQAQ Review Quality (out of 18)
1. Changes in weight or BMI								
Shaw et al. 2005	More intensive versus less intensive behavioural intervention (based on frequency of contacts, duration of intervention or no. of behavioural strategies)	1) Meta-analysis of RCTs making this comparison 2) Single RCT comparing different intensities	1) 10 (306) 2) 1 (58)	Weight (kg)	1) <= 12mths (median 7 mths) 2) 30 mths	1) Eight studies favoured more intensive behavior therapy and two studies favoured less intensive behaviour therapy. More intensive intervention produced 2.3 kg more weight loss (95% CI: 1.4 to 3.3) 2) Intensive intervention -1.6 kg, less intensive intervention -1.4 kg (p = 0.45)	1) 1+ 2) Ungraded	17
Shaw et al. 2005	More intensive versus less intensive behavioural intervention (based on frequency of contacts, duration of intervention or no. of behavioural strategies)	Descriptive summary of RCTs with different intervention intensities (not suitable for meta-analysis)	6 (390)	Weight (kg)	1) <= 12mths (median 7 mths)	In 4 studies high intensity intervention produced greater weight loss, in 2 studies low intensity produced greater weight loss. Weight loss ranged from 1.4 to 8.4 kg in high intensity and 0.9 to 10.5 kg in low intensity interventions	2+	17

Table S11: Intervention Intensity

Study	Comparisons	Method of comparison	N studies (N participants)	Outcome	Follow-up time	Results	Evidence Grade	OQAQ Review Quality (out of 18)
McTigue et al. 2003	Number of contacts in first 3 months in relation to weight change in RCTs and other studies	Descriptive summary of groups of studies with different intensities	11 (7425)	Weight (kg)	12 to 54 mths (median 12 mths)	Higher intensity was associated with increased effectiveness, but this is almost perfectly confounded with use of BCTs (see Table 4). The mean weight loss for higher intensity (and behavioural) interventions ranged from 3 to 5 kg more than controls. In studies with true control groups, the mean weight loss was (range) 2.5 to 5.5 kg for high intensity (and behavioural) interventions and 0.2 to 0.9 kg for low and medium intensity (and non-behavioural) interventions	2-	16
Norris et al. 2007	Number of contacts in relation to net weight change	Multi-variate meta-regression of RCT data	9 (5137)	Weight (kg)	1-10yr (mean 3.2yrs)	The total number of intervention contacts correlated significantly with a decrease in weight ($p = 0.015$)	2+	17
Tsai & Wadden 2005	Number of sessions attended in relation to weight change	Descriptive summary of RCT findings	1 (148)	Weight (%)	2yrs	Participants who attended the most group sessions over 2 yrs maintained the largest weight loss	2-	15
McTigue et al. 2006	Frequency of monthly contacts during the first 3 months in relation to weight change in RCTs and other studies	Descriptive summary of groups of studies with different intensities	10 (nr)	Weight (kg)	12 to 48 mths (median 15 mths)	In 7 controlled trials of higher intensity intervention, 3 found significant weight loss of 3-4 kg more than control at 18-30 mths, 1 found borderline significance (-2 kg) and 3 found no significant difference (although 2 were comparisons between interventions rather than vs. controls). Of 3 studies with lower intensity intervention, only 1 showed significant weight loss (-1.4 kg)	2-	16

Table S11: Intervention Intensity

Study	Comparisons	Method of comparison	N studies (N participants)	Outcome	Follow-up time	Results	Evidence Grade	OQAQ Review Quality (out of 18)
Dombrowski et al. 2008	Contact frequency 1) above median 2) median 3) below median	Stratified meta-analysis of RCT data and between group comparison using uni-variate meta-regression	1) 7 (847) 2) 7 (484) 3) 9 (3689)	Weight (kg)	Active intervention phase: 1 to 14 mths (mean: 6.2mths)	Above median -3.6 kg (95% CI: -6.1 to -1.2), median -3.7 kg (95% CI: -6.4 to -1.0), below median -2.3 kg (95% CI: -4.2 to -0.3). No significant differences for median or above median compared with low frequency ($p > 0.70$)	2+	15
Dansinger et al. 2007	Frequency of meetings during intervention in relation to weight change in 1) Active phase 2) Maintenance phase	Multi-variate meta-regression of RCT data	nr (46 (11,853) with about 15% insufficient data)	BMI (kg/m^2)	Active phase: <= 12 mths Maintenance phase: 12 to 60 mths	1) During the active phase more scheduled support meetings were independent predictors of greater weight loss ($p= 0.009$) 2) During the maintenance phase, the frequency of meetings in the first year was not a predictor of weight change ($p= 0.29$)	1) 2++ 2) 2++	17
Richardson et al. 2008	Duration of intervention in relation to weight change in pedometer-based walking interventions	Multi-variate meta-regression of RCT data	9 (307)	Weight (kg)	4 wks to 1yr (median 16 wks)	Duration of intervention was significantly associated with increased weight change ($\beta = -0.05$; $p = .003$)	2+	15
Norris et al. 2007	Duration of intervention in relation to net weight change in diet and /or physical activity interventions	Multi-variate meta-regression of RCT data	9 (5137)	Weight (kg)	1 to 10yrs (mean 3.2yrs)	There was no significant association between intervention duration and weight change. However, any association with duration may have been captured by the co-variate 'total no. of contacts' (see below)	2+	17

Table S11: Intervention Intensity

Study	Comparisons	Method of comparison	N studies (N participants)	Outcome	Follow-up time	Results	Evidence Grade	OQAQ Review Quality (out of 18)
Bravata et al. 2007	Duration of intervention in relation to weight change in RCTs and cohort studies of pedometer-based walking interventions	Multi-variate meta-regression of intervention arms	26 (2645)	BMI (kg/m^2)	3 to 104 wks (median 10.5 wks)	BMI change was associated with increased intervention duration (p=0.07 trend only)	2-	14
2. Changes in diet								
Brunner et al. 2007	Number of personal contacts in relation to weight change	Stratified meta-analysis of groups of RCTs with different intensities	1) 20 (6170) 2) 18 (8416)	Self-reported dietary change 1) Fat 2) Fruit & vegetable intake	3mths to 4 yrs (median 12mths)	1) High intensity interventions produced significantly higher reductions in total dietary fat (-5.72% (95% CI: -7.75 to -3.69) vs. -1.68% (95% CI: -3.13 to -0.23) with high heterogeneity in the high intensity subgroup 2) A similar pattern was seen for reported fruit and vegetable intake (data not reported)	1) 2- 2) 2-	15
3. Changes in physical activity								
Bravata et al. 2007	Duration of intervention in relation to weight change in RCTs and cohort studies of pedometer-based walking interventions	Multi-variate meta-regression of intervention arms	26 (2645)	Physical activity	3 to 104 wks (median 10.5 wks)	Intervention duration was not a significant predictor of physical activity	2-	14

Table S11: Intervention Intensity

Study	Comparisons	Method of comparison	N studies (N participants)	Outcome	Follow-up time	Results	Evidence Grade	OQAQ Review Quality (out of 18)
Eakin et al. 2000	Brief (3 to 10 minutes physical activity counselling) versus more lengthy intervention (15 to 120 minutes of multiple risk factor counselling)	Descriptive summary of groups of RCTs and other studies with different intensities	10 (4170)	Self-reported physical activity levels	Up to 12 mths (median 6 wks)	5 out of the 7 studies with significant short-term effects involved brief counselling sessions	2-	14
4. Combined outcomes								
Burke et al. 2003	High dose intervention (>60 mins) versus low dose (5 to 60 mins)	Stratified meta-analysis of RCT data	4 (366) with 1(84) low dose	Standardised mean difference in combined physical activity & dietary intake (Cohen's d)	12 to 18 wks (median 15 wks)	High dose interventions seemed to deliver stronger effects (SMD=0.69, no CIs reported) than lower intensity of intervention (SMD=0.03 no CIs reported)	2-	14

Abbreviations: RCT = Randomised Controlled Trial. OQAQ = Oxman Quality Assessment Questionnaire, SMD = Standardised mean difference, BCT = Behaviour change technique, NR = Not reported, Mths = Months, Wks = Weeks.

Table S12: Population Characteristics

Study	Comparisons	Method of comparison	N studies (N participants)	Outcome	Follow-up time	Results	Evidence Grade	OQAQ Review Quality (out of 18)
Shaw et al. 2006	Gender: male versus female	Stratified meta-analysis of single-gender trials	9 (100 males, 367 females)	Weight (kg)	12 to 24 wks (median 12 wks)	No apparent difference in effectiveness (in trials of diet and exercise versus diet) between trials with male (-0.23 kg, 95% CI: -0.68 to 0.23) and female (-0.55, 95% CI: -1.26 to 0.16) participants	2+	16
Dombrowski et al. 2008	Gender: male versus female	Stratified meta-analysis of women-only and mixed-gender trials	6 (556 women) 17 (4464 mixed populations)	Weight (kg)	Active intervention phase: Range: 1 to 14 mths, mean: 6.2mths	Weight loss in women-only studies (-2.6 kg, 95% CI: -5.4 to -2.1) was similar to that for mixed-sex studies (-3.1 kg, 95% CI: -4.6 to -1.6) and not significantly different ($p>0.05$)	2+	15
Foster et al. 2005	Gender: male versus female	Descriptive summary of within-RCT sub-group analyses	8 (3024)	Self-reported physical activity, cardio-respiratory fitness	min. 6 mths (median not available)	Greater improvements in cardio-respiratory fitness for women were found in 3 studies, while 2 reported greater benefits in men (1 for cardio-respiratory fitness and 1 for physical activity) and 3 found no difference	2-	17
Whitlock et al. 2003	Gender: male versus female (dietary behaviour)	Descriptive summary of RCTs & other studies, examining gender effects (by sub-group or regression analysis)	9 (7524)	Self-reported physical activity or dietary outcomes	6 to 18 mths (median 12 mths)	No substantial differences were found between men and women in 8 of 9 studies. In one study (despite no differences in other outcomes) women showed “modestly larger” self-reported intake of both fruit and vegetables and fat	2-	14

Table S12: Population Characteristics

Study	Comparisons	Method of comparison	N studies (N participants)	Outcome	Follow-up time	Results	Evidence Grade	OQAQ Review Quality (out of 18)
Whitlock et al. 2003	Gender: male versus female (physical activity)	Descriptive summary of RCTs & other studies, examining gender effects (by sub-group or regression analysis)	5 (6315)	Cardio-respiratory fitness & self-reported energy expenditure	6 to 24 mths (median 16 mths)	Only one study reported any gender effects in that women (but not men) receiving more intensive intervention had significantly greater effects than less intense intervention (on expended energy at 6 (but not 12 & 24 months) mths and on cardiorespiratory fitness at 24 mths)	2-	14
Dansinger et al. 2007	People with type 2 diabetes versus those without	Multi-variate meta-regression of RCT data	46 (6386), 10 with participants with diabetes	BMI (kg/m^2)	Active intervention 3 to 36 mths (median 12 mths) Maintenance phase 6 to 60 mths (median 18 mths)	Not having diabetes was an independent predictor of weight loss (or slower weight regain) during the active intervention ($p< 0.001$) and maintenance phases ($p< 0.012$) At 3 mths (-0.47 vs. -1.19 kg/m^2), 6 mths (-0.75 vs. -1.56) and 12 mths (-1.19 vs -2.04) of active intervention, studies of participants with diabetes reported about half the net weight loss for studies of participants without diabetes ($p<.0.001$) Findings were controlled for frequency of support meetings, recommended calorie intake, type of intervention (Diet vs Diet + Exercise), attrition and methodological quality	2++	17

Table S12: Population Characteristics

Study	Comparisons	Method of comparison	N studies (N participants)	Outcome	Follow-up time	Results	Evidence Grade	OQAQ Review Quality (out of 18)
Dombrowski et al. 2008	People with 1) type 2 diabetes (t2d) 2) t2d-related conditions (eg. pre-diabetes) 3) CVD-related conditions 4) other conditions (eg. cancer)	Stratified meta-analysis by group and between group comparison using meta-regression techniques. All based on RCT data	44 (10,560)	Weight (kg)	End of active intervention (mean 6.2 mths)	Weight loss was lowest in people with t2d (-1.2 kg, 95% CI: -0.2 to -2.1) and highest in those with t2d-related conditions (-5.5 kg, 95% CI: -1.8 to -9.2). Weight loss for people with t2d was significantly lower than for t2d-related ($p<0.005$) and CVD-related co-morbidities ($p=0.05$)	2+	15
Galani & Schneider 2007	Lifestyle intervention versus standard care in people with high cardiovascular risk	Meta-analysis of RCTs	5 (1910)	Weight (kg)	Mean 36 mths	Obese and overweight people with CV risk factors achieved a net mean weight loss of -2.30 kg (95% CI: -3.67 to -0.92)	1++	16
Galani & Schneider 2007	Lifestyle intervention versus standard care in people with impaired glucose tolerance (IGT)	Meta-analysis of RCTs	8 (3150)	Weight (kg)	Not stated (min. 12 mths, likely mean 36 mths)	Obese and overweight people with IGT achieved a net mean weight loss of -2.93 kg (95% CI: -4.35 to -1.52)	1++	16
Galani & Schneider 2007	Lifestyle intervention versus standard care in overweight and obese people	Stratified meta-analysis of RCTs 1) Overweight and 2) Obese populations	1) 13 (3566) 2) 17 (8013)	Weight (kg) & BMI (kg/m^2)	Mean 36 mths	Weight loss was achieved in both groups, but was numerically higher (no statistical comparison) in obese populations 1) –2.19 kg (95%CI: -2.81 to -1.57). BMI -1.11 kg/m^2 (95% CI: -1.56 to -0.66) 2) –3.49 kg (95%CI: -4.70 to -2.27). BMI -1.33 kg/m2 (95% CI: -1.93 to -0.72)	2+ 1) 1++ 2) 1++	16

Table S12: Population Characteristics

Study	Comparisons	Method of comparison	N studies (N participants)	Outcome	Follow-up time	Results	Evidence Grade	OQAQ Review Quality (out of 18)
Foster et al. 2005	Population characteristics in relation to effectiveness 1) age (above or below 70/75 yrs) 2) self-reported physical activity 3) overweight 4) chronic health condition	Description of within-RCT sub-group analyses	1) 2 (457) 2) 2 (457) 3) 2 (457) 4) 1 (284)	Cardio-respiratory fitness & self-reported physical activity	min. 6 mths (median not available)	1) No age effects were found 2) No differences were found between high and low baseline physical activity groups 3) One study found a greater increase in physical activity for overweight participants (BMI > 27). One found no difference for any of 4 BMI groups 4) No significant difference for less than two vs. two or more self-reported health conditions	1) 2- 2) 2- 3) 2- 4) 2-	17
Bravata et al. 2007	Age, gender, ethnicity, sedentary population, initial weight in pedometer-based walking interventions	Multi-variate meta-regression of data from RCT intervention arms and cohort studies	26 (2645)	Pedometer measured physical activity (steps /day)	3 to 104 wks (median 10.5 wks)	Gender, BMI, ethnicity and baseline activity were not significant predictors of increased physical activity, although trends were identified for age and sedentary baseline physical activity	2-	14
Bravata et al. 2007	Changes in BMI in relation to age, gender, ethnicity, sedentary population, initial weight	Multi-variate meta- regression of data from RCT intervention arms and cohort studies	18 (2645)	BMI (kg/m^2)	3 to 104 wks (median 10.5 wks)	Decreased BMI was associated with older age (p =.001), increasing percentage of white participants (p =.009), having a step goal (p =.04), and longer intervention duration (p =.07). It was not significantly associated with baseline steps per day, changes in steps per day, sex, dietary counseling, or baseline BMI	2-	14

Table S12: Population Characteristics

Study	Comparisons	Method of comparison	N studies (N participants)	Outcome	Follow-up time	Results	Evidence Grade	OQAQ Review Quality (out of 18)
Michie et al. 2008	Disadvantaged/ low income target population (yes, no); Sedentary / obese target population (yes, no); women only (yes, no)	Multi-variate & uni-variate meta-regression of RCT data	71 (28,838)	Objective or self-report of behavior change (diet and physical activity)	1 wk to 24 mths (mean 6 mths)	None of the target population variables were significantly associated with intervention effectiveness	2+	15
Gillies et al. 2007	Baseline BMI in relation to effectiveness of diet /physical activity interventions	Multivariate meta-regression on RCT data	10 (5885)	Hazard ratio for progressing to diabetes	1.8 to 4.6 yrs (mean 3.4 yrs)	Each unit increase in BMI at baseline was associated with a decrease in hazard ratio of −7.3% (95% CI: −13.6 to −0.9). This was independent of age and follow-up time	2++	17
Ogilvie et al. 2007	Sedentary versus non-sedentary targeted populations	Descriptive / 'vote counting' summary of RCTs and other studies	27 (8764)	Self-reported or pedometer-recorded walking (mins/week)	6 wks to 10 yrs (median 6mths)	Many of the successful interventions to promote walking were targeted at sedentary people. 10 of 14 studies found significant effects (71%) compared with 5 of the 13 (38%) non-sedentary target interventions	2+	16
Shaw et al. 2006	age: <45 yrs versus >45 yrs	Stratified meta-analysis of RCTs with different age groups	12 (433 <45yrs; 268 >45yrs)	Weight (kg)	12 to 52 wks (median 16 wks)	People with a mean age of less than 45 lost -0.44 kg (95% CI: -0.86 to -0.02) more in the exercise and diet group than the diet-only group People with a mean age over 45 yrs lost -1.12 kg (95% CI: -1.75 to -0.50) more in the exercise and diet group than the diet-only group	2+	16

Table S12: Population Characteristics

Study	Comparisons	Method of comparison	N studies (N participants)	Outcome	Follow-up time	Results	Evidence Grade	OQAQ Review Quality (out of 18)
McTigue et al. 2006	Summary of data for older people	Descriptive summary of RCTs and other studies	11 (nr)	Weight (kg)	12 to 48 mths (median 15 mths)	Of 11 studies, 4 found significant weight loss (typically 3-4 kg more than controls in RCT studies at 18-30 mths), 1 demonstrated weight loss of borderline significance (2 kg more than controls), 6 found no significant weight loss (although 2 were comparisons between interventions rather than with controls)	1+	16
Knowler et al. 2002	Age: 1) <45 yrs 2) 45-59 yrs 3) 60+	Analysis of effectiveness within sub-groups in a single RCT	1 (3234) N= 1) 1000 2) 1586 3) 648)	Incidence of type 2 diabetes (cases /100 person yrs)	1.8 to 4.6 yrs (mean 2.8 yrs)	Incidence of type 2 diabetes reduced more as age increased. Age-group figures (with 95% CIs) were: 1) 48% (27 to 63) 2) 59% (44 to 70) 3) 71% (51 to 83)	2+ 1) 1+ 2) 1+ 3) 1+	-
Knowler et al. 2002	Ethnicity: 1) White 2) African American 3) Hispanic 4) American Indian 5) Asian	Analysis of effectiveness within sub-groups in a single RCT	1 (3234) N= 1) 1768 2) 645 3) 508 4) 171 5) 142	Incidence of type 2 diabetes (cases /100 person yrs)	1.8 to 4.6 yrs (mean 2.8 yrs)	Incidence of type 2 diabetes (with 95% CIs) was reduced by 1) 51% (35 to 63) 2) 61% (37 to 76) 3) 66% (41 to 80) 4) 65% (7 to 87) 5) 71% (24 to 89)	1+	-

Abbreviations: RCT = Randomised Controlled Trial. OQAQ = Oxman Quality Assessment Questionnaire. CV = Cardiovascular, CVD = Cardiovascular Disease. BMI = Body Mass Index. IGT = Impaired Glucose Tolerance. T2D = Type 2 Diabetes, NR = Not reported, N = Number, Mths = months, Wks = weeks, Mins = Minutes.

Table S13: Intervention setting

Study	Comparisons	Method of comparison	N studies (N participants)	Outcome	Follow-up time	Results	Evidence Grade	OQAQ Review Quality (out of 18)
Michie et al. 2008	Community, primary care, or workplace setting in relation to RCT effectiveness	Multi-variate & uni-variate meta-regression	71 (28,838)	Standardised effect size for objective or self-report measures of diet and physical activity	1 to 14 mths (mean: 6.2mths)	Intervention setting was not significantly associated with changes in diet and /or physical activity	2+	15
Ashworth et al. 2005	Home-based versus center-based physical activity intervention	Descriptive summary of a single RCT	1) 1 (151) 2) 1 (143)	Self-reported physical activity (% adherence to prescribed physical activity programme)	1) 1yr 2) 2yrs	1) Home-based participants adhered to their exercise program significantly better than centre-based participants (79% vs. 53%; mean diff 26.1%, 95%CI: 15.9 to 36.3) 2) The difference between the home-based and the centre-based programs was mostly maintained at 2yrs (68% vs 36%; mean diff 31.4%, 95%CI: 18.3 to 44.5)	1) 1- 2) 1-	17
Brunner et al. 2007	Healthcare versus work place or community based dietary interventions	Stratified meta-analysis of RCTs conducted in different settings	1) 20 (6170) 2) 19 (8469)	1) Self-reported dietary fat (%) 2) Self-reported fruit and vegetable intake (servings /day)	1) 3 to 48 mths (median 12 mths) 2) 6 to 48 mths (median 12 mths)	Trials in a healthcare setting tended to show 1) numerically greater reductions in dietary fat (-5.22%, 95%CI: -7.80 to -2.64 vs. -3.15%, 95%CI: -4.73 to -1.56) and 2) numerically greater increases in fruit and vegetable consumption (1.88 servings/day, 95%CI: 1.07 to 2.70 vs. 0.83 servings/day, 95%CI: 0.20 to 1.47) than trials in workplace /community settings	1) 2- 2) 2-	15

Table S13: Intervention setting

Study	Comparisons	Method of comparison	N studies (N participants)	Outcome	Follow-up time	Results	Evidence Grade	OQAQ Review Quality (out of 18)
Kahn et al. 2002	Social support based physical activity interventions in community settings	Descriptive summary of results from RCTs and other studies	1) 4(nr) 2) 3(nr) 3) 3(nr) 4) 4 (nr)	1) Self-reported physical activity (time spent) 2) Self-reported physical activity (frequency) 3) Aerobic capacity (VO2 max) 4) Adiposity (BMI, waist-to-hip ratio or % body fat)	nr	Median net increase of 44.2% (IQR: 19.9% to 45.6%) in time spent in physical activity. Net median increases of 19.6% (IQR: 14.6% to 57.6%) in frequency of exercise/physical activity. Median net increase in aerobic capacity of 4.7% (IQR: 3.3% to 6.1%). Median net change in adiposity of -7.3% (IQR: -8.1% to -6.8%)	1) 2- 2) 2- 3) 2- 4) 2-	15
Ogilvie et al. 2007	Remote support in walking interventions by internet or telephone	Descriptive summary of results from RCTs and other studies	3 (264)	Self-reported or pedometer-recorded walking (minutes/week)	3 to 6 mths (median 3 mths)	A significant difference in walking was found in all 3 studies (Range: +32 to +62 mins/wk)	2+	16
Tsai & Wadden 2005	eDiets.com compared with use of a behavioural weight loss manual	Descriptive summary of results from a single RCT	1 (46)	Weight (kg)	1yr	People using the weight loss manual lost significantly more weight than those using eDiets.com (4.0% vs. 1.1%, p = 0.04)	Ungraded	15

Abbreviations: RCT = Randomised Controlled Trial. OQAQ = Oxman Quality Assessment Questionnaire, Mean diff = Mean difference, IQR = Interquartile range, BMI = Body mass index, VO2max = maximum volume of oxygen, Mins = minutes, Wks = Weeks, VS = Versus, NR = Not reported

Table S14: Intervention Effectiveness

Study	Comparisons	Method of comparison	N studies (N participants)	Outcome	Follow-up time	Results	Evidence Grade	OQAQ Review Quality (out of 18)
1. Changes in weight or BMI								
Norris et al. 2007	Dietary and /or physical activity interventions versus control	Meta-analysis of RCTs making this comparison	4 (1016)	Weight (kg) & BMI (kg/m^2)	1 yr	Interventions reduced weight by 2.8 kg (95% CI 1.0 to 4.7) (3.3% of baseline weight) and decreased BMI by 1.3 kg/m^2 (95% CI, 0.8 to 1.9)	1++	17
Norris et al. 2007	Dietary and /or physical activity interventions versus control	Meta-analysis of RCTs making this comparison	3 (700)	Weight (kg)	2 yrs	Interventions reduced weight by 2.6 kg (95% CI: 1.9 to 3.3)	1++	17
Galani & Schneider 2007	Dietary and physical activity intervention versus standard care	Meta-analysis of RCTs making this comparison	13 (3566)	Weight (kg)	1 yr to 7 yrs (median 2 yrs)	Interventions reduced weight by a net –2.19 kg (95%CI: -2.81 to -1.57, p<0.0001)	1++	16
Douketis et al. 2005	Dietary and /or physical activity interventions versus control	Summary of RCT & non-RCT mean differences using descriptive statistics (not meta-analysis)	1) 12 (6432) 2) 6 (1743)	Weight (kg)	1) 2 to 3 yrs (median not available) 2) 4 to 7 yrs (median not available)	1) Intervention resulted in a mean net weight loss (±SD) of -3.5±2.4 kg based on a completers method of analysis 2) Intervention resulted in a mean net weight loss (±SD) of -3.6±2.6 kg based on a completers method of analysis	1) 1+ 2) 1+	15

Table S14: Intervention Effectiveness

Study	Comparisons	Method of comparison	N studies (N participants)	Outcome	Follow-up time	Results	Evidence Grade	OQAQ Review Quality (out of 18)
Avenell et al. 2004	Diet, exercise and behaviour therapy compared to control	Meta-analysis of RCTs making this comparison	1) 11 (1956) 2) 4 (1928) 3) 4 (1440) 4) 2 (164) 5) 1 (1101)	Weight (kg)	1) 12mths 2) 18mths 3) 24mths 4) 30mths 5) 36mths	Intervention produced net weight changes (with 95% CIs) of: 1) -4.00 kg (-4.46 to -3.54) 2) -3.40 kg (-3.84 to -2.97) 3) -3.00 kg (-3.59 to -2.40) 4) -4.68 kg (-6.08 to -3.28) 5) -2.00 kg (-2.66 to -1.34)	1,2&3) 1+ 4&5) 1-	16
Dombrowski et al. 2008	Behavioural intervention versus usual care	Meta- analysis of RCTs making this comparison	23 (5020)	Weight (kg)	End of 'active phase' of intervention (Range 1 to14, mean 6.2 mths)	Intervention resulted in net changes of -3.0 kg (95%CI: -4.3 to -1.8)	1++	15
Dombrowski et al. 2008	Behavioural intervention versus usual care	Meta- analysis of RCTs making this comparison	11 (3689)	Weight (kg)	End of intervention maintenance phase (Range 6 to 36, mean 18.9 mths)	Intervention resulted in net changes of -3.6 kg (95%CI: -5.3 to -1.9)	1++	15
Dombrowski et al. 2008	Behavioural intervention versus usual care	Meta- analysis of RCTs making this comparison	7 (749)	Weight (kg)	No-intervention follow-up phase (Range: 12 to 24, mean: 16.7 mths)	Intervention resulted in net changes of -1.3 kg (95%CI: -2.6 to 0.1)	1++	15

Table S14: Intervention Effectiveness

Study	Comparisons	Method of comparison	N studies (N participants)	Outcome	Follow-up time	Results	Evidence Grade	OQAQ Review Quality (out of 18)
Murphy et al. 2007	Walking intervention versus control	Meta-analysis of RCTs making this comparison	18 (792)	Weight (kg)	8 to 52 wks, (median 24 wks)	Significant net weight loss of -0.95 kg (SD=0.61 kg, p<0.001) was observed after the walking programs. This represents a relative reduction of 1.4% in body weight	1+	15
Murphy et al. 2007	Walking intervention versus control	Meta-analysis of RCTs making this comparison	16 (816)	BMI (kg/m^2)	8 to 52 wks, (median 24 wks)	Significant net change in BMI of -0.28 kg/m^2 (SD 0.2 kg/m^2, p<0.05) was observed after the walking programs. This represents a relative reduction of 1.1% in BMI	1+	15
Shaw et al. 2006	Exercise intervention versus no treatment control	Meta-analysis of RCTs making this comparison	2 (270)	Weight (kg)	12 mths	Intervention produced a net weight change of -2.03 kg (95%CI: -2.82 to -1.23)	1-	16
Shaw et al. 2006	Exercise intervention versus no treatment control	Meta-analysis of RCTs making this comparison	2 (170)	BMI (kg/m^2)	6 mths and 12 mths	Intervention produced a net BMI change of -0.73 kg/m^2 (95%CI: -0.99 to -0.46)	1-	16
Williams et al. 2007	Exercise referral scheme versus control	Descriptive summary of individual RCT results	3 (1351)	BMI (kg/m^2)	37wks to 1yr (median 1yr)	No study reported any significant differences in BMI between exercise and control groups (no data provided)	1+	17
Dansinger et al. 2007	Dietary counseling intervention versus control	Meta-analysis of RCTs making this comparison	27 (1363)	BMI (kg/m^2)	1 yr	Mean net reduction in BMI of -1.88 kg/m^2 (95% CI: -2.29 to -1.49) equating to 6% of initial body weight [-5.1 kg]	1++	17

Table S14: Intervention Effectiveness

Study	Comparisons	Method of comparison	N studies (N participants)	Outcome	Follow-up time	Results	Evidence Grade	OQAQ Review Quality (out of 18)
Dansinger et al. 2007	Dietary counseling intervention versus control	Meta-analysis of RCTs making this comparison	4 (1807)	BMI (kg/m^2)	3yrs	Mean net reduction in BMI of -1.07 kg/m^2 (95%CI: -1.67 to -0.47), equating to 3.4% of initial body weight (-2.9 kg]	1++	17
Tsai & Wadden 2005	Weight Watchers program versus self-help intervention	Descriptive (single RCT)	1 (423) 1 (309)	Weight (%)	1) 1yr 2) 2yrs	1) Participants lost 5.3% of their initial weight compared with 1.5% in the self-help arm ($p < 0.001$) 2) A weight loss of 3.2% was maintained at 2 yrs, compared with 0.0% in the self-help arm ($p < 0.001$) based on analysis of completers only	1) 1- 2) 1-	15
Tsai & Wadden 2005	Medically supervised proprietary diet program. Within-participant changes pre and post intervention	Descriptive summary of individual study results (1 RCT, 4 observational studies)	1) 5 (1048) 2) 2 (557) 3) 1 (85) 4) 1 (100) 5) 1 (306)	Weight (%)	1) 3 to 6 mths 2) 1 yr 3) 2 yrs 4) 3 yrs 5) 4 yrs	Interventions providing a low-calorie or very-low-calorie diet produced weight loss of approximately:- 1) 15% to 27% of initial weight 2) 8 to 9% 3) 15% 4) 7% 5) 5%	1) 2- 2) 2- 3) Ungraded 4) 2- 5) 2	15
2. Changes in physical activity								
Foster et al. 2005	Physical activity intervention versus control 1) continuous measures 2) dichotomous measures	Meta-analysis of RCTs making this comparison	1) 19 (7598) 2) 10 (3595)	1) Self-reported physical activity 2) Self-reported achievement of physical activity targets	min. 6 mths (median not available)	1) The pooled effect size was moderate[a] (SMD 0.28, 95% CI 0.15 to 0.41) 2) The pooled odds ratio for achieving target levels of physical activity was 1.33 (95% CI 1.03 to 1.72)	1) 1++ 2) 1++	17

Table S14: Intervention Effectiveness

Study	Comparisons	Method of comparison	N studies (N participants)	Outcome	Follow-up time	Results	Evidence Grade	OQAQ Review Quality (out of 18)
Foster et al. 2005	Physical activity intervention versus control	Meta-analysis of RCTs making this comparison	11 (2195)	Objectively measured cardio-respiratory fitness	min. 6 mths (median not available)	The pooled effect size was moderate-to-strong (SMD 0.52, 95% CI 0.14 to 0.90)	1++	17
Dombrowski et al. 2008	Behavioural intervention versus usual care	Meta- analysis of RCTs making this comparison	21 (3048)	Standardised mean difference (Hedge's adjusted g) for objective or self-report measures of physical activity	End of 'active phase' of intervention (Range 1 to14 mths; mean 6.2 mths)	Intervention produced a moderate effect size (SMD 0.4, 95% CI 0.3 to 0.5)	1+	15
Dombrowski et al. 2008	Behavioural intervention versus usual care	Meta- analysis of RCTs making this comparison	9 (1444)	Standardised mean difference (Hedge's adjusted g) for objective or self-report measures of physical activity	End of intervention maintenance phase (Range 6 to 36 mths; mean 18.9 mths)	Intervention produced a moderate effect size (SMD = 0.3, 95% CI 0.1 to 0.5)	1+	15
Dombrowski et al. 2008	Behavioural intervention versus usual care	Meta- analysis of RCTs making this comparison	3 (458)	Standardised mean difference (Hedge's adjusted g) for objective or self-report measures of physical activity	No-intervention follow-up phase (Range: 12 to 24 mths, mean: 16.7 mths)	Intervention produced moderate effect size (SMD = 0.3, 95% CI 0.1 to 0.5)	1+	15

Table S14: Intervention Effectiveness

Study	Comparisons	Method of comparison	N studies (N participants)	Outcome	Follow-up time	Results	Evidence Grade	OQAQ Review Quality (out of 18)
Ogilvie et al. 2007	Walking intervention versus control (and observational study data)	Descriptive summary of individual study results	27 (8764) with 17 RCTs	Self-reported or pedometer-recorded walking (minutes/week)	6 wks to 10 yrs (median 6mths)	15 of 27 studies (12 of 17 RCTs) found significant increases in physical activity. Typical increases for successful RCTs were 30-60 mins per week of additional physical activity, compared with controls	1-	16
Williams et al. 2007	Exercise referral scheme versus control	Meta-analysis of RCTs making this comparison	5 (1923)	Physical activity (nr[b])	10 wks to 24 mths (median 52 wks)	The relative risk of achieving 90 to 150 mins/wk moderate-intensity activity was 1.20 (95%CI: 1.06 to 1.35) in favour of exercise referral on an intention-to-treat basis. Number needed to treat = 17.2	1++	17
Eakin et al. 2000	Primary care-based physical activity interventions versus control	Descriptive summary of individual RCT & quasi-experimental study results	10 (4170)	Self-reported physical activity (standardised effect size for continuous outcomes, odds ratio for categorical outcomes)	Up to 12 mths (median 6 wks)	7 out of 10 studies reported statistically significant short-term outcomes. Effect sizes were small[a] (SMD= 0.00 to 0.26; typical value of 0.26 for successful studies) and odds ratio from 1.04 to 3.73 (median 1.88, typically OR=1.48 for 'now active rather than sedentary'	1-	14
Eakin et al. 2000	Primary care-based physical activity interventions versus control	Descriptive summary of individual RCT & quasi-experimental study results	7 (23,573)	Self-reported physical activity (standardised effect size for continuous outcomes, odds ratio for categorical outcomes)	>=12 mths (median 12 mths)	3 out of 7 studies reported statistically significant longer-term outcomes. Effect sizes were typically small[a] (SMD = 0.09) for successful studies). Odds ratio from 0.92 to 1.39 (median 1.25, typically OR=1.28 for 'now active rather than sedentary'. No examples of successful intervention beyond 12 months	1-	14
3. Changes in dietary intake								

Table S14: Intervention Effectiveness

Study	Comparisons	Method of comparison	N studies (N participants)	Outcome	Follow-up time	Results	Evidence Grade	OQAQ Review Quality (out of 18)
Brunner et al. 2007	Dietary intervention versus control	Meta-analysis of RCTs making this comparison	1) 18 (6170) 2) 15 (8416) 3) 7 (2981)	Self-reported dietary intake 1) fat 2) fruit & vegetables 3) dietary fibre	3mths to 4 yrs (median 12mths)	Interventions produced net changes in 1) Fat intake of -4.49% (95%CI: -2.31 to -6.66) 2) Fruit & vegetable consumption of +1.25 servings (95%CI: 0.70 to 1.81) 3) Dietary fibre of+5.99 g/day (95%CI: 1.12 to 10.86)	1) 1- 2) 1- 3) 1-	15
Halcomb et al. 2007	Practice nurse advice versus usual care	Descriptive summary of individual RCT results	5, of which 2 with CVD patients (2580)	Self-reported dietary intake	4mths to 4yrs (median 12mths)	4 out of 5 studies (2 of 3 non-CVD studies) showed significant net changes in dietary intake (e.g. 5.7% change in absolute fat intake at 4 mths, 5% change in saturated fat intake at 1 & 3 yrs for the 2 non-CVD studies). Only 1 of 4 studies reported a significant effect at 12 mths or more (and only 1 of the 3 non-CVD studies)	Ungraded	14
Dombrowski et al. 2008	Behavioural intervention versus usual care	Meta- analysis of RCTs making this comparison	1) 13 (1686) 2) 16 (2468)	1) Self-reported total energy consumption (kcal) 2) Self-reported fat consumption (Standardised mean difference)	End of 'active phase' of intervention (Range 1 to14 mths; mean 6.2 mths)	Intervention resulted in net changes of: 1) -112kcal (95% CI: -217 to -7) 2) SMD = -0.5 (95% CI: -0.7 to -0.2)	1) 1+ 2) 1+	15

Table S14: Intervention Effectiveness

Study	Comparisons	Method of comparison	N studies (N participants)	Outcome	Follow-up time	Results	Evidence Grade	OQAQ Review Quality (out of 18)
Dombrowski et al. 2008	Behavioural intervention versus usual care	Meta- analysis of RCTs making this comparison	1) 6 (1117) 2) 7 (2962)	1) Self-reported total energy consumption (kcal) 2) Self-reported fat consumption (Standardised mean difference)	End of intervention maintenance phase (Range 6 to 36 mths; mean 18.9 mths)	Intervention resulted in net changes of: 1) -118 kcal (95% CI -178 to 57) 2) SMD = -0.4 (95% CI -0.7 to -0.2)	1) 1+ 2) 1+	15
Dombrowski et al. 2008	Behavioural intervention versus usual care	Meta- analysis of RCTs making this comparison	1) 2 (432) 2) 3 (474)	1) Self-reported total energy consumption (kcal) 2) Self-reported fat consumption (Standardised mean difference)	No-intervention follow-up phase (Range: 12 to 24 mths, mean: 16.7 mths)	Intervention resulted in net changes of: 1) -75 kcal (95% CI -189 to 40) 2) SMD = -0.2 (95% CI -0.7 to 0.3)	1) 1+ 2) 1+	15
4. Other outcomes								
Michie et al. 2008	1) Physical activity (PA) and healthy diet (HD) intervention versus control 2) separate effects of PA and HD interventions	Meta- analysis of RCTs making this comparison	1) 71 (28,838) 2) PA: 44 (nr) HD: 40 (nr)	Standardised mean difference (Cohen's d) for objective or self-report measures of diet and physical activity (outcomes were combined as SMDs)	1 wk to 24 mths (mean 6 mths)	1) A moderate, significant effect was found, favoring the intervention (SMD = 0.37, 95% CI: 0.29, 0.45), but with substantial heterogeneity (I^2 = 79%) 2) Individually, the review found that PA and HD interventions have moderate effect sizes; SMD = 0.34 (95% CI: 0.26, 0.43) and 0.38 (95% CI: 0.25, 0.52), respectively	1) 1- 2) 1-	15

Table S14: Intervention Effectiveness

Study	Comparisons	Method of comparison	N studies (N participants)	Outcome	Follow-up time	Results	Evidence Grade	OQAQ Review Quality (out of 18)
Gillies et al. 2007	Lifestyle (diet and/or physical activity) intervention versus control	Meta- analysis of RCTs making this comparison 1) All RCTs 2) Diet-only 3) Exercise-only 4) Diet-and-exercise	1) 10 (5885) 2) 3 (133) 3) 2 (193) 4) 7 (1592)	Development of type 2 diabetes	1) 1.8 to 4.6 yr (mean 3.4) 2) Median 4.3 yrs 3) Median 3.6 yrs 4) Median 3.2 yrs	1) Interventions produced a 49% relative reduction in risk of developing diabetes (hazard ratio 0.51; 95% CI: 0.44 to 0.60). Difference in absolute diabetes incidence -15.8% (95% CI: -19.8 to -11.9). Number needed to treat 6.4 (95%CI: 5.0 to 8.4) 2) Diet-only: hazard ratio = 0.67 (95%CI: 0.49, to 0.92) 3) Exercise: hazard ratio = 0.49 (95%CI: 0.32 to 0.74) 4) Diet-and-exercise: hazard ratio = 0.49 (95%CI: 0.40 to 0.59)	1) 1++ 2) 1++ 3) 1++ 4) 1++	17
Dansinger et al. 2007	Effectiveness of diet and/or physical activity intervention versus control in 1) Active phase 2) Maintenance	Stratified meta-analysis of RCTs	1) 29 (nr. Estimate 7470) 2) 17 (nr. Estimate 4380)	Slope of net BMI change during active and maintenance phases	1) 3 to 36 mths (median 12) 2) 6 to 60 mths (median 18)	1) Active phase: weight loss from 3-12 mths was statistically significant at 0.08 BMI unit/month ($p < 0.01$) 2) Maintenance phase: weight regain from 6- 60 mths, of 0.03 BMI unit/mth ($p<0.001$)	1++	17

Abbreviations: RCT = Randomised Controlled Trial. SMD = Standardised Mean Difference. BMI = Body Mass Index (kg/m2). SD = Standard Deviation. OQAQ = Oxman Quality Assessment Questionnaire, MTHS = Months, WKS = Weeks, NR = not reported, PA = Physical activity, HD = Healthy diet

[a] Where reported, standardised effect sizes are categorised as small (SMD =0 up to 0.2); moderate (SMD = 0.2 up to 0.5); strong (SMD = 0.5 and above).

[b] Type of physical activity measure analysed (self-report or other) not specified.

Appendix III: PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #	Notes
TITLE				
Title	1	Identify the report as a systematic review, meta-analysis, or both.	1	
ABSTRACT				
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	2	Not a registered review
INTRODUCTION				
Rationale	3	Describe the rationale for the review in the context of what is already known.	3, 4	
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	4	
METHODS				
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	Yes	Email the lead author
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	4, 5	
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	4	
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	Table S2	
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	4,5	
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	6	

Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	6	
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	6	Assessed at review level
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	5	No meta-analysis
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I^2) for each meta-analysis.	6,7	Data were graded and summarised

Section/topic	#	Checklist item	Reported on page #
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	6
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	n/a
RESULTS			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	7,8, Fig.1
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	Table S1, Refs
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	Table S4
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	Tables S6 - S13
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	n/a
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	8-17
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	n/a

DISCUSSION			
Summary of evidence	24	Summarise the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	18
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	20,21
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	18,19,21,22
FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	23

From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(6): e1000097. doi:10.1371/journal.pmed1000097. For more information, visit: **www.prisma-statement.org**.