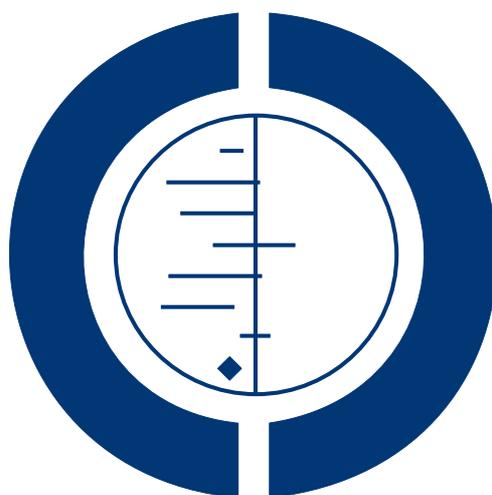


Exercise or exercise and diet for preventing type 2 diabetes mellitus (Review)

Orozco LJ, Buchleitner AM, Gimenez-Perez G, Roqué i Figuls M, Richter B, Mauricio D



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[Intervention Review]

Exercise or exercise and diet for preventing type 2 diabetes mellitus

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ABSTRACT

Background

The incidence of type 2 diabetes is associated with the 'Westernised lifestyle', mainly in terms of dietary habits and physical activity. Thus an intensive diet and exercise intervention might prevent or delay the appearance of diabetes in persons at high risk.

Objectives

To assess the effects of exercise or exercise and diet for preventing type 2 diabetes mellitus.

Search methods

We searched *The Cochrane Library*, MEDLINE, EMBASE, CINAHL, LILACS, SocioFile, databases of ongoing trials and reference lists of relevant reviews.

Selection criteria

Studies were included if they were randomised controlled trials of exercise and diet interventions of at least six month duration and reported diabetes incidence in people at risk for type 2 diabetes.

Data collection and analysis

Two authors independently assessed trial quality and extracted data. Study authors were contacted to obtain missing data. Data on diabetes incidence and secondary outcomes were analysed by means of random-effects meta-analysis.

Main results

We included eight trials that had an exercise plus diet (2241 participants) and a standard recommendation arm (2509 participants). Two studies had a diet only (167 participants) and exercise only arm (178 participants). Study duration ranged from one to six years. Overall, exercise plus diet interventions reduced the risk of diabetes compared with standard recommendations (RR 0.63, 95% CI 0.49 to 0.79). This had also favourable effects on weight and body mass index reduction, waist-to-hip ratio and waist circumference. However, statistical heterogeneity was very high for these outcomes. Exercise and diet interventions had a very modest effect on blood lipids. However, this intervention improved systolic and diastolic blood pressure levels (weighted mean difference -4 mmHg, 95% CI -5 to -2 and -2 mmHg, 95% CI -3 to -1, respectively). No statistical significant effects on diabetes incidence were observed when comparing exercise only interventions either with standard recommendations or with diet only interventions. No study reported relevant data on diabetes and cardiovascular related morbidity, mortality and quality of life.

Authors' conclusions

Interventions aimed at increasing exercise combined with diet are able to decrease the incidence of type 2 diabetes mellitus in high risk groups (people with impaired glucose tolerance or the metabolic syndrome). There is a need for studies exploring exercise only interventions and studies exploring the effect of exercise and diet on quality of life, morbidity and mortality, with special focus on cardiovascular outcomes.

PLAIN LANGUAGE SUMMARY

Exercise or exercise and diet for preventing type 2 diabetes mellitus

Type 2 diabetes is mainly characterised by a reduced ability of the hormone insulin to stimulate glucose uptake in body fat and muscles (insulin resistance) combined with insufficient insulin secretion that leads to increased blood glucose levels. It has been shown that weight reduction and an increase in daily energy expenditure decreases insulin resistance. There are some factors that are associated with an increased risk of type 2 diabetes: these are obesity, previous gestational diabetes, hypertension, family history of type 2 diabetes, dyslipidaemia and some ethnical groups are more at risk. Persons with "prediabetes" are also at high risk: they have abnormal blood glucose levels but not in the range of diabetes. Prediabetes often precedes the development of type 2 diabetes. We searched for trials that intended to prevent the development diabetes type 2 in the above mentioned at risk groups. We assessed the effects of increased physical activity alone or in combination with dietary interventions on diabetes incidence and other outcomes.

We included eight trials with 2241 participants randomised to exercise and diet intervention and 2509 participants to standard recommendation. Furthermore, 178 participants were randomised to an exercise only intervention and 167 participants to a diet only intervention. The duration of the interventions in the trials ranged from one year to six years. Interventions varied between studies but mainly consisted of caloric restriction if the person was overweight, low fat content (especially saturated fat), high carbohydrate content and the increase of fibre intake. Physical activity varied but on average at least 150 minutes each week of brisk walking or other activities such as cycling or jogging were recommended. Interventions were mainly delivered by frequent individual counselling by a physiotherapist, an exercise physiologist and a dietitian. Incidence of diabetes was reduced by 37% (relative risk reduction) with exercise and diet. This had favourable effects on body weight, waist circumference and blood pressure. More evidence is required on effects of exercise alone in the prevention of type 2 diabetes. No study reported relevant data on diabetes and cardiovascular related morbidity, all-cause mortality and quality of life.

BACKGROUND

Description of the condition

Diabetes mellitus is a metabolic disorder resulting from a defect in insulin secretion, insulin action, or both. A consequence of this is chronic hyperglycaemia (that is, elevated levels of plasma glucose) with disturbances of carbohydrate, fat and protein metabolism.

Long-term complications of diabetes mellitus include retinopathy, nephropathy and neuropathy. The risk of cardiovascular disease is increased. For a detailed overview of diabetes mellitus, please see under 'Additional information' in the information on the Metabolic and Endocrine Disorders Group in *The Cochrane Library* (see 'About', 'Cochrane Review Groups (CRGs)'). For an explanation of methodological terms, see the main glossary in *The Cochrane Library*.

Type 2 diabetes mellitus is the most common type of diabetes. In Western countries the disease affects up to 7% of the population (Harris 1998; WHO 1994). Its incidence is associated with the 'Westernised lifestyle', mainly in terms of dietary habits and physical activity (ADA 1996). Special attention is to be paid to the increasing incidence of the disease in newly industrialized and developing countries in which lifestyle changes have occurred (WHO 1994). Also, an increasing incidence in adolescents, especially in the US, has been shown particularly in the non-white population (Rosenbloom 1999). Obesity and decreased physical activity are associated with the development of glucose intolerance and type 2 diabetes (Eriksson 1991). The events leading to the development of the disease are mainly an abnormal insulin secretion and insulin resistance. Thus, an insufficient insulin secretion combined with a reduced capacity of peripheral tissues to utilise glucose and an increased glucose production by the liver leads to the progressive development of hyperglycaemia (Lillioja 1993). However, the exact sequence of events leading to the development of the disorder is still to be fully characterised. As the progression from normoglycaemia to overt hyperglycaemia is slow, a significant proportion of individuals remain undiagnosed during the initial period of the disease. A majority of individuals later developing the disease present with obesity, which further contributes to an increased insulin resistance (Beck-Nielsen 2000). Other known factors are also associated with the appearance of the disease, for example increasing age and lack of physical activity. As there is a strong familial predisposition, first-degree relatives of known type 2 diabetic patients are at increased risk of developing the disorder (Rewers 1995).

Impaired glucose tolerance (IGT) and impaired fasting glucose (IFG) are generally recognised as an expression of abnormal glucose metabolism regulation. These two conditions can be considered as an intermediate stage between normal glucose tolerance and diabetes mellitus. They should be regarded as risk factors for the development of diabetes rather than a disease as they do not produce any symptoms. People with IGT or IFG are at increased risk of developing type 2 diabetes and cardiovascular disease (even before the onset of diabetes). They are also associated to other risk factors for diabetes such as obesity, unfavourable dietary habits and lack of exercise. The term IGT (sometimes referred as 'prediabetes') was introduced in 1979 (NDDG 1979). The term IFG has been introduced much later (ADA 1997). IGT and IFG represent different pathophysiological mechanisms: IGT is seen as a characteristic of peripheral insulin resistance and IFG is seen

as an expression of raised hepatic glucose output and a defect in early insulin secretion. Currently, the criteria for IGT and IFG are as follows (plasma venous glucose concentrations): IGT - fasting blood glucose less than 7.0 mmol/L and two-hour post-load blood glucose 7.8 to 11.0 mmol/L; and IFG - fasting blood glucose 6.1 to 6.9 mmol/L (two-hour post-load blood glucose less than 7.8 mmol/L, if measured) (ADA 1999; WHO 1999). However, in 2003 the American Diabetes Association recommended to change these latter criteria to 5.6 to 6.9 mmol/L (ADA 2003).

Description of the intervention

It has been shown that weight reduction and an increase in daily energy expenditure decrease insulin resistance and increase glucose tolerance (Ross 2000). Indeed, advice on diet and exercise are an important part of the treatment of type 2 diabetes. Nutritional advice usually consists of caloric restriction if the patient is overweight, low total fat content (especially saturated fat) and high (predominantly unrefined) carbohydrate content. It may be hypothesised that interventions aimed at preventing the development of obesity and at increasing physical activity will lower the incidence of type 2 diabetes in those individuals at high risk. Further, the adoption of a healthy lifestyle, that is avoiding being overweight and exercising regularly, may provide a protective effect against other elements of the metabolic syndrome usually associated with impaired glucose tolerance and type 2 diabetes mellitus, such as hypertension and hyperlipidaemia, which may subsequently increase morbidity and mortality from cardiovascular disease (Stamler 1999; Stampfer 2000).

How the intervention might work

Diet and exercise as preventive measures

Primary prevention covers the activities aimed at preventing diabetes from occurring in susceptible individuals or in the general population. This can be done through modification of environmental, behavioural determinants (for example dietary habits) or both, or by any specific intervention (for example pharmacological). Diet and exercise interventions are sometimes termed 'lifestyle interventions'.

There are prospective cohort studies that have shown that increased physical activity, independent of other risk factors, has a protective effect against the development of type 2 diabetes (Helmrich 1991; Manson 1992). These epidemiological prospective studies demonstrated that various levels of regular physical activity one to several times a week were associated with a decreased incidence of the disease at long-term follow-up (14 years and five years respectively), in both men and women of different age groups (Helmrich 1991; Manson 1992).

Pan et al. concluded that diet or exercise or both interventions produced a 31% to 46% reduction in the incidence of diabetes during a period of six years in those with impaired glucose tolerance (Da Qing 1997). After the Da Qing study (Da Qing 1997), some studies based on randomised controlled trials for high-risk persons revealed the potential of lifestyle modifications for preventing type 2 diabetes: The Diabetes Prevention Program (DPP 2002) was a multicenter randomised controlled trial in the United States with the three intervention arms lifestyle intervention (diet and exercise), metformin and placebo. This study reported that the lifestyle intervention was more effective than metformin in reducing the incidence of diabetes in persons at high risk; whereas in Finland, the Diabetes Prevention Study found that an intensive lifestyle intervention reduced the diabetes risk compared with a general diet and exercise advice (DPS 2003). A recent meta-analysis of randomised controlled trials showed that a lifestyle intervention reduced the 2-h plasma glucose by 0.84 mmol/L (95% confidence interval (CI) 0.39 to 1.29), and the one year incidence of diabetes was reduced by approximately 50% (relative risk (RR) 0.55, 95% CI 0.44 to 0.69) compared with the control group (Yamaoka 2005). However, this meta-analysis published in 2005 considered only papers published in English in the two databases MEDLINE and ERIC. There is also a Cochrane review (Norris 2005) that addresses the issue of lifestyle changes in people with prediabetes (IGT or IFG) on weight that concluded that these interventions produce a positive effect in terms of weight loss. Recently, another systematic review and meta-analysis showed a positive effect of lifestyle interventions in terms of type 2 diabetes prevention in people with IGT (Gillies 2007). Another upcoming Cochrane review will address the question on the effect of diet only interventions in the prevention of type 2 diabetes (Moore 2005). Therefore, it is advised that the current review is read alongside this latter review.

Adverse effects of the intervention

Exercise or diet interventions are not generally considered to be associated with any serious adverse event. However, physical activity may cause traumatic injuries of variable severity depending on the type and intensity of exercise. Additionally, exercising may produce adverse effects on the cardiovascular system in those people with insufficient training or unfavourable cardiovascular fitness (even cardiovascular events and death may potentially occur while exercising). Also, the implementation of dietary measures may produce several deficiencies in the nutritional status if restrictive low-calorie diets are used. Further, dieting may produce a derangement in the quality of life of persons under this treatment. Unfortunately, very few information on these issues is available from randomised controlled trials.

Why it is important to do this review

As mentioned above, type 2 diabetes mellitus affects an important proportion of the population in most countries. Additionally, an increasing incidence of the disease is already seen in both in industrialized and developing countries. Therefore, type 2 diabetes mellitus is an important health care issue worldwide.

Although other reviews are available (Gillies 2007; Norris 2005; Yamaoka 2005;), the scope of the current review is a wider one and covers not only those people with IFG or IGT but interventions on all other type 2 diabetes at-risk populations. Also, this review offers an up-to-date literature search and provides detailed description of the identified studies.

OBJECTIVES

To assess the effects of exercise or exercise and diet for preventing type 2 diabetes mellitus.

METHODS

Criteria for considering studies for this review

Types of studies

Randomized controlled clinical trials of interventions that followed-up participants for at least six months.

Types of participants

Participants of any age, sex or ethnicity belonging to any of the major risk groups for the development of type 2 diabetes (ADA 2004b):

- impaired glucose tolerance according to the World Health Organisation criteria (WHO 1999);
- impaired fasting glucose according to the American Diabetes Association criteria (ADA 2004);
- previous gestational diabetes;
- hypertension equal to or greater than 140/90 mmHg;
- family history of type 2 diabetes in first degree relatives;
- obesity (that is a body mass index (BMI) equal or greater than 30 kg/m²);
- dyslipidaemia (that is HDL-cholesterol equal or less than 35 mg/dl, triglycerides equal or more than 250 mg/dl, or both);
- high risk ethnic groups (for example African-Americans, Hispanic-Americans, native Americans, Asian-Americans, Pacific Islanders).

Types of interventions

- exercise versus standard recommendations or no intervention;
- exercise and diet versus standard recommendations or no intervention;
- exercise versus diet.

Trials where the intervention or control group comprised the administration of any pharmacological agent were excluded.

Types of outcome measures

Primary outcomes

- development of type 2 diabetes mellitus (incidence);
- diabetes and cardiovascular related morbidity (for example angina pectoris, myocardial infarction, stroke, peripheral vascular disease, neuropathy, retinopathy, nephropathy, erectile dysfunction, amputation).

To be consistent with changes in the classification and diagnostic criteria of type 2 diabetes mellitus through the years, the diagnosis should have been established using the standard criteria valid at the time of the beginning of the trial (for example [ADA 1997](#); [ADA 1999](#); [ADA 1999](#); [WHO 1980](#); [WHO 1985](#); [WHO 1998](#)). Ideally, diagnostic criteria should have been described in the publication. When it was necessary, authors' definition of diabetes mellitus was used. Diagnostic criteria were planned to be eventually subjected to a sensitivity analysis.

Secondary outcomes

- development of impaired glucose tolerance (plasma glucose two hours after a 75 g oral glucose load equal or greater than 140 mg/dl (7.8 mmol/L) and less than 200 mg/dl (11.1 mmol/L) ([WHO 1999](#)));
- development of impaired fasting glucose (fasting plasma glucose equal or greater than 100 mg/dl (5.6 mmol/L) and less than 126 mg/dl (7.0 mmol/L) ([ADA 2004](#)));
- anthropometric measures: body weight, body mass index (BMI) and waist-to-hip-ratio;
- systolic and diastolic blood pressure;
- lipid levels: total cholesterol, LDL- and HDL-cholesterol, triglycerides;
- quality of life, ideally measured with a validated instrument;
- adverse effects (for example traumatic injuries secondary to leisure physical activity, nutritional deficits);
- all-cause mortality;
- costs.

Covariates, effect modifiers and confounders

- compliance;
- co-morbidities;
- age.

Timing of outcome measurement

Outcomes were planned to be assessed in the middle (up to two years of follow-up) and long term (more than two years of follow-up) according to clinical criteria.

Search methods for identification of studies

See Cochrane Metabolic and Endocrine Disorders Group methods used in reviews.

Electronic searches

We used the following sources for the identification of trials:

- *The Cochrane Library* (issue 1, 2008);
- MEDLINE (until March 2008);
- EMBASE (until March 2008);
- CINAHL (until March 2008);
- LILACS (until March 2008);
- SocioFile (until March 2008)

We also searched databases of ongoing trials: Current Controlled Trials (www.controlled-trials.com - with links to other databases of ongoing trials).

The described search strategy (see for a detailed search strategy under [Appendix 1](#)) was used for MEDLINE. For use with EMBASE, *The Cochrane Library* and the other databases the search strategy was slightly adapted. For the database LILACS, we used a simplified search strategy because the database does not permit to introduce so many search terms.

Searching other resources

We tried to identify additional studies by searching all the reference lists of relevant trials, reviews and meta-analysis. Studies published in any language were included.

Data collection and analysis

Selection of studies

To determine the studies to be assessed further, three authors (DM, GGP, AMB) independently scanned the abstracts or titles, or both sections and the keywords of every study identified. Each study was evaluated independently by two authors (DM in combination with GGP or AMB). All potentially relevant articles were investigated

as full text. Where differences in opinion existed, the third author who initially did not evaluate the article reviewed it to reach a final decision between the three authors. An adapted QUOROM (quality of reporting of meta-analyses) flow-chart of study selection is attached (Moher 1999).

Data extraction and management

For studies that fulfilled inclusion criteria, two authors (LJOS, AMB) independently abstracted relevant population and intervention characteristics using standard data extraction templates (for details see [Characteristics of included studies](#) and [Appendix 2](#); [Appendix 3](#); [Appendix 4](#); [Appendix 5](#) and [Appendix 6](#)) with any disagreements resolved by discussion, or if required by a third party. We attempted to contact the original authors of the articles for missing data.

Assessment of risk of bias in included studies

The risk of bias of the included trials was assessed by examining sequence generation, allocation concealment, addressing of incomplete outcome data, selective reporting and other potential bias. Blinding of participants and caregiver or treatment administrator to group assignment is not feasible in trials on lifestyle interventions (diet and/or exercise) but blinding of outcome assessors to group assignment and blinding of participants and caregivers or treatment administrators to outcomes are evaluated. Risk of bias assessment of all included studies was performed independently by two authors (AMB, MR). When differences in opinion between these two authors were found, a third author (DM) evaluated the study to reach a final decision between the three reviewers. Studies were not excluded on the basis of high risk of bias; a sensitivity analysis was performed to compare results between studies with potential bias and those without.

Measures of treatment effect

Dichotomous data

The effect sizes for dichotomous data were expressed as risks ratios in all trials except the [Da Qing 1997](#).

As the [Da Qing 1997](#) study was randomised at the clinic level, the consequential clustering effect was adjusted for by re-analysing the reported data by fitting a Poisson regression model, with clinic included as a random effect. As number of events is modelled, rather than rate, person years of follow-up are entered as an offset in the linear predictor. The output was an incidence rate ratio for each comparison adjusted for clustering. The incidence rate ratio can be assumed to be equivalent to a hazard ratio and included in the meta-analyses as such. The analysis was carried out in STATA ([Gillies 2007](#)).

Continuous data

For continuous outcomes, weighted mean differences and 95% confidence intervals (CI) were calculated.

Dealing with missing data

Relevant missing data were planned to be obtained from authors. Evaluation of important numerical data such as screened, eligible and randomised patients as well as intention-to-treat (ITT) and per-protocol (PP) population was carefully performed. Attrition rates, for example drop-outs, losses to follow-up and withdrawals were investigated. Issues of missing data, ITT and PP were critically appraised and compared to specification of primary outcome parameters and power calculation.

Dealing with duplicate publications

In the case of duplicate publications and companion papers of a primary study, we tried to maximise yield of information by simultaneous evaluation of all available data. In cases of doubt, the original publication (usually the oldest version) obtained priority.

Assessment of heterogeneity

In the event of substantial clinical, methodological or statistical heterogeneity study results were not planned to be combined by means of meta-analysis. Heterogeneity was examined with I^2 ([Higgins 2002](#)), where I^2 -values of 50% and more indicate a substantial level of heterogeneity ([Higgins 2003](#)). When heterogeneity was found, we attempted to determine potential reasons for it by examining individual study characteristics and those of subgroups of the main body of evidence.

Assessment of reporting biases

The assumption of publication bias was planned to be visually evaluated by using a funnel plot, whereby effect estimates of the common outcome measure were plotted against trial sample size. There are a number of explanations for the asymmetry of a funnel plot, including true heterogeneity of effect with respect to study size, poor methodological design of small studies and publication bias ([Sterne 2001](#)). Therefore, we carefully used this tool ([Lau 2006](#)).

Data synthesis

All data were summarised statistically under a random-effects model meta-analysis. Continuous outcomes were combined with the Der-Simonian method, and diabetes incidence with the inverse-variance method. Statistical analysis were performed according to the statistical guidelines referenced in the newest version of the *Cochrane Handbook for Systematic Reviews of Interventions* ([Higgins 2008](#)).

Subgroup analysis and investigation of heterogeneity

Subgroup analyses were planned to be performed, if feasible, to assess whether some groups of participants at risk for type 2 diabetes could obtain more benefit from exercise or exercise and diet interventions. Subgroups were planned to be analysed according to risk factors for diabetes mellitus (impaired glucose tolerance, abnormal fasting glucose, previous gestational diabetes, family history of type 2 diabetes, obesity, dyslipidaemia, hypertension, high risk ethnic groups). Additionally, sex and age subgroups and different types of diets (for example weight reduction versus emphasis on 'healthy eating') or exercise schedules (for example daily exercise versus twice a week exercise, types of exercise), were planned to be analysed. Finally, intervention duration was considered in the subgroup analysis.

Sensitivity analysis

Sensitivity analyses took into account the influence of the following factors on effect size:

- repeating the analysis to explore the influence of risk of bias, as described above;
- repeating the analysis excluding very large or long studies to evaluate how much they influence the results;
- repeating the analysis excluding trials, if any, supported by industry;
- changes in the diagnostic criteria of type 2 diabetes mellitus through the years could produce significant variability in the clinical characteristics of the patients included as well as in the results obtained.

The robustness of the analysis was planned to be explored further by repeating the analysis using different measures of effects size

(odds ratio, risk difference) and different statistical models (fixed- and random-effects models).

RESULTS

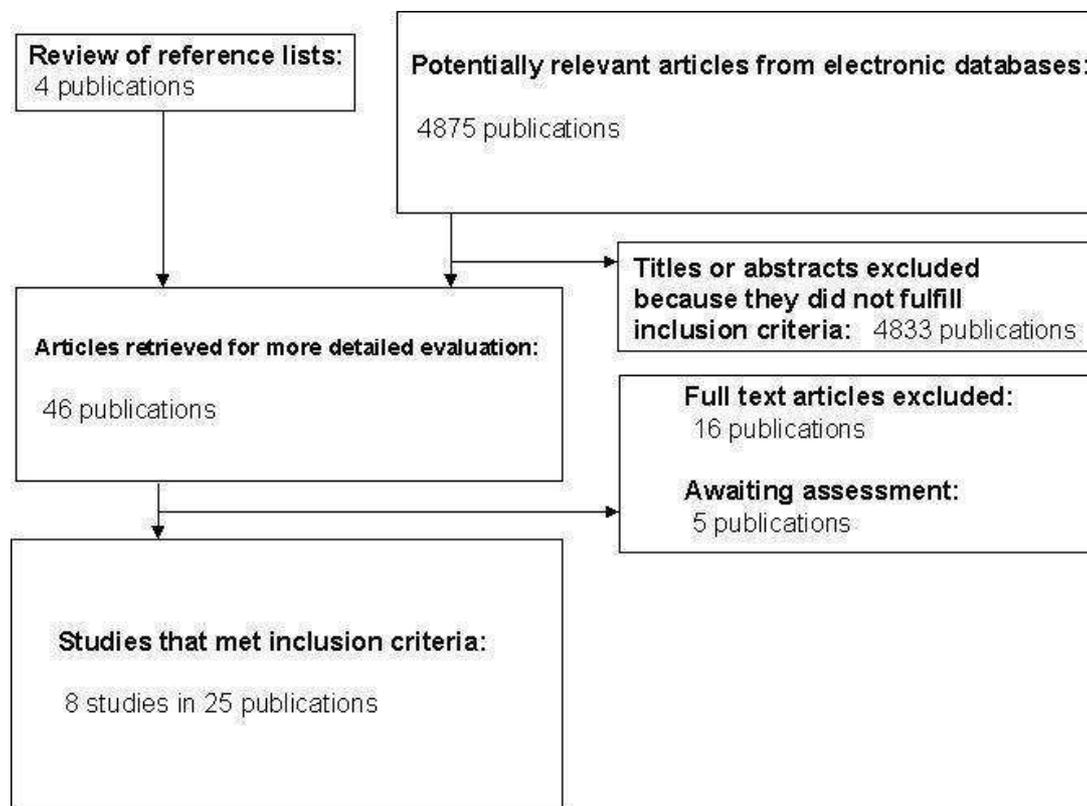
Description of studies

See: [Characteristics of included studies](#); [Characteristics of excluded studies](#); [Characteristics of studies awaiting classification](#); [Characteristics of ongoing studies](#).

Results of the search

The initial search identified 4875 records. After revising all titles and abstracts, full papers were obtained from all potentially relevant studies (46 in total) for further examination. Finally 25 publications describing eight studies met the inclusion criteria ([Bo 2007](#); [Da Qing 1997](#); [DPP 2002](#); [DPS 2001](#); [IDPP 2006](#); [Kosaka 2005](#); [Oldroyd 2005](#); [Wing 1998](#)). Four of the included papers were found by hand searching. The other studies were excluded on the basis of their abstracts or full texts because they were not relevant to the question under study (see [Figure 1](#) for details of the amended QUOROM (quality of reporting of meta-analyses) statement). No non-published studies were identified. One ongoing trial was identified ([EDPS](#)). Five papers describing three studies ([Kinmonth 2008](#); [Mensink 2003](#); [Savoie 2007](#)) had not published yet the diabetes incidence, these studies might be included in further updates.

Figure 1. QUOROM (quality of reporting of meta-analyses) flow-chart of study selection.



Included studies

For details about the included studies see 'Characteristics of included studies'. Heterogeneity was found in terms of the inclusion criteria, the intervention, ethnic groups, age, weight and body mass index (BMI). There was also heterogeneity in the diagnostic criteria to define impaired glucose tolerance and type 2 diabetes. Agreement in study selection, that is qualifying a study as 'included' or 'potentially relevant', was complete among authors.

Interventions

Comparisons

All included publications focused their interventions on improving physical activity and encouraging weight loss. Two of them (Da Qing 1997; Wing 1998) separated the intervention in four study arms: exercise only, diet only, exercise plus diet and control group. All publications included diet and exercise interventions in the same group.

Two of the publications included pharmacological interventions in separated arms (DPP 2002; IDPP 2006), in these cases, and for the purpose of this review, the results of these arms are not reported. None of the studies focused exclusively on exercise interventions for the prevention of diabetes.

The exercise interventions differed largely between trials, from the advise to promote physical activity (Bo 2007; Da Qing 1997; IDPP 2006; Kosaka 2005; Oldroyd 2005), to a few times weekly supervised exercise programmes, that differed in intensity (DPP 2002; DPS 2001; Wing 1998). Most of the programmes included exercises like walking, jogging and cycling, with different intensities.

The diet interventions were based mainly on caloric restriction, reduced fat intake and increased fibre intake (Bo 2007; Da Qing 1997; DPP 2002; DPS 2001; IDPP 2006; Oldroyd 2005; Wing 1998). In one of the publications, advise was given to decrease 5% to 10% the amount of each meal, depending on the body mass index of each individual, when this was equal or greater than 24 kg/m², and the avoidance of weight gain if BMI was lower than 24 kg/m² (Kosaka 2005).

Two of the publications did not report any behavioural interven-

tion (Bo 2007; Da Qing 1997). All other publications included different forms of behavioural interventions. The record of the physical activity or the dietetic conduct for self-feedback was used in two of the publications (DPS 2001; Wing 1998). In the remaining publications, motivational strategies and setting up of goals were used (DPP 2002; DPS 2001; IDPP 2006; Kosaka 2005; Oldroyd 2005; Wing 1998).

In one of the included studies, the control group did not receive any intervention (Oldroyd 2005). In the seven remaining studies, the control group received habitual recommendations, advice or education on how to increase physical activity and have a healthier diet to achieve weight loss.

Number of study centres

Three publications report the number of centres where the trial was performed, five in DPS 2001, 27 in DPP 2002 and 33 in Da Qing 1997. In the remaining publications the number of study centres was not clearly reported.

Setting

Two of the trials were performed in the United States (DPP 2002; Wing 1998); one in Italy, one in Finland, one in the UK, one in Japan, one in China and one in India, respectively (Bo 2007; DPS 2001; Oldroyd 2005; Kosaka 2005; Da Qing 1997; IDPP 2006).

Methods

Duration of the interventions

The interventions lasted from one year in Bo 2007 to six years in Da Qing 1997. The number of contacts with the individuals in the interventions ranged from five in Bo 2007 to 51 in Wing 1998. The intervention was always given directly to the participants, in groups or on an individual basis. In most of the publications the intervention facilitators were a physiotherapist, an exercise physiologist and/or a dietitian.

Duration of follow-up

Follow-up duration differed largely between trials; it ranged from one year in Bo 2007 to seven years in DPS 2001. Follow-up times from Da Qing 1997; DPP 2002; IDPP 2006; Kosaka 2005; Oldroyd 2005; Wing 1998 were 6, 2.8, 3, 4, 2 and 2 years respectively. Intervention in DPS 2001 was prematurely terminated by an independent end-point committee on the basis of the results of the first data analysis. Median duration of the intervention in that

study was four years (mean 3.2 years). Participants were followed up until a median of seven years. In the data analysis, results of DPS 2001 are presented at mean follow-up time of 3.2 years (end of intervention).

Compliance measures

For details of compliance measures see Table 1.

All studies reported some compliance measurement. Seven studies used self-reporting methods (Bo 2007; Da Qing 1997; DPP 2002; DPS 2001; IDPP 2006; Oldroyd 2005; Wing 1998). Self-reporting methods comprised three day food diaries (Da Qing 1997; DPS 2001; Wing 1998), questionnaires (Bo 2007; Da Qing 1997; Wing 1998), self-reporting (DPP 2002; IDPP 2006; Oldroyd 2005) and individual interviews (Da Qing 1997; DPS 2001). One study measured improvement in physical condition with a half-mile walk test (Wing 1998) measuring time to completion and predicting VO₂ max using regression formulas. One study measured improvement in physical condition measuring resting pulse and with a shuttle walking test (Oldroyd 2005). Two studies considered achievement of weight loss as a compliance measure (DPP 2002; Kosaka 2005). The Bo 2007 study evaluated attendance.

Language of publication

Two of the initially selected studies were published in Chinese (Fang 2004; Tao 2004) and one of the studies was published in Japanese (Sakane 2006). After data extraction was performed by original language speakers these studies were excluded because they did not meet the inclusion criteria (see table 'Characteristics of excluded studies'). All included studies were published in English.

Participants

Who participated

In total, the eight included studies had 5956 participants (range 78 to 3234), the mean age was 50.3 years and the mean BMI was 31.2 kg/m². In two studies (Da Qing 1997; IDPP 2006) female participants constituted less than 50%, in one study (Kosaka 2005) no female individuals participated. In the five remaining studies male participation was less than 50%.

Most of the included individuals were recruited from the community (Da Qing 1997; DPS 2001; IDPP 2006; Wing 1998), from a clinic population (Kosaka 2005), from a combination of the community and a sample of clinical persons in DPP 2002, from a combination of research studies, local hospital biochemistry laboratory databases and general practitioner surgeries in Oldroyd 2005 and

persons aged 45 to 64 from family physicians, representative of the local health districts (Bo 2007).

Inclusion criteria

In one study the inclusion criterion was to have a metabolic syndrome or two components of the metabolic syndrome plus high-sensitivity CRP (hs-CRP) serum values equal or greater than three mg/L (Bo 2007). In one study the inclusion criterion was to be overweight (30% to 100% ideal body weight), nondiabetic and to have one or two biological parents with diabetes mellitus (Wing 1998). In the other six studies an inclusion criterion was to present some kind of glucose tolerance alteration. Nonetheless, the definition of glycaemic values varied. Two of the studies had the additional inclusion criterion to have a BMI equal or greater than 24 kg/m² and equal or greater than 25 kg/m², respectively (DPP 2002; DPS 2001).

Exclusion criteria

Generally, exclusion criteria were the presence of chronic diseases that could interfere with the participation in the intervention group or to complete follow-up, and the use of medications that could interfere with the results (Bo 2007; DPP 2002; DPS 2001; Kosaka 2005; Oldroyd 2005). Three studies did not report any exclusion criteria (Da Qing 1997; IDPP 2006; Wing 1998).

Diagnostic criteria

The way to define glycaemic values to determine glucose intolerance and the diagnosis of diabetes varied among studies: In one study (Kosaka 2005) impaired glucose tolerance (IGT) was defined as a fasting plasma glucose (FPG) value below 140 mg/dl and a plasma glucose two hours after a 100 g glucose load between 160 and 239 mg/dl, these values were described by the authors as roughly corresponding to the 140 to 199 mg/dl range in the 75 g oral glucose tolerance test (75 g OGTT) and thus corresponding to IGT according to the World Health Organization in 1980 (WHO 1980).

Four studies (Bo 2007; Da Qing 1997; DPS 2001; Oldroyd 2005) used the criteria defined in 1985 (WHO 1985). The criteria of the American Diabetes Association in 1997 (ADA 1997) was used in DPP 2002. The IDPP 2006 study used the glycaemic diagnostic criteria of WHO 1999.

Wing 1998 used the criteria of WHO 1985, diabetes incidence was tried to be assessed retrospectively using the new criteria for diabetes in WHO 1997.

Outcomes

Primary outcomes

All the included studies reported the incidence of diabetes but only one of them reported cardiovascular related morbidity (DPP 2002). For details of primary outcomes see Appendix 5.

Secondary outcomes

For details on secondary outcomes see Appendix 6.

Non of the studies reported the incidence of impaired glucose tolerance or impaired fasting glucose. Most of the studies reported the change from baseline to follow-up of fasting plasma glucose values (Bo 2007; Da Qing 1997; DPP 2002; DPS 2001; IDPP 2006; Oldroyd 2005; Wing 1998) or values at two hours after a glucose load (Da Qing 1997; DPS 2001; IDPP 2006; Oldroyd 2005). Seven studies reported changes from baseline to follow-up in body weight or body mass index (Bo 2007; DPP 2002; DPS 2001; IDPP 2006; Kosaka 2005; Oldroyd 2005; Wing 1998). Waist circumference or waist-to-hip ratio was available from six studies (Bo 2007; DPP 2002; DPS 2001; IDPP 2006; Oldroyd 2005; Wing 1998). Data on lipid profiles were reported in five studies (Bo 2007; DPS 2001; IDPP 2006; Oldroyd 2005; Wing 1998). Systolic and diastolic blood pressure were available from six studies (Bo 2007; DPP 2002; DPS 2001; IDPP 2006; Oldroyd 2005; Wing 1998).

Three studies (DPP 2002; IDPP 2006; Da Qing 1997) described adverse effects. Cost-effectiveness of the intervention was investigated in two studies (DPP 2002; IDPP 2006). None of the studies reported the results of quality of life measures.

Excluded studies

Sixteen papers had to be excluded after careful evaluation of the full publication. There were different reasons for exclusion (for details see Characteristics of excluded studies).

Risk of bias in included studies

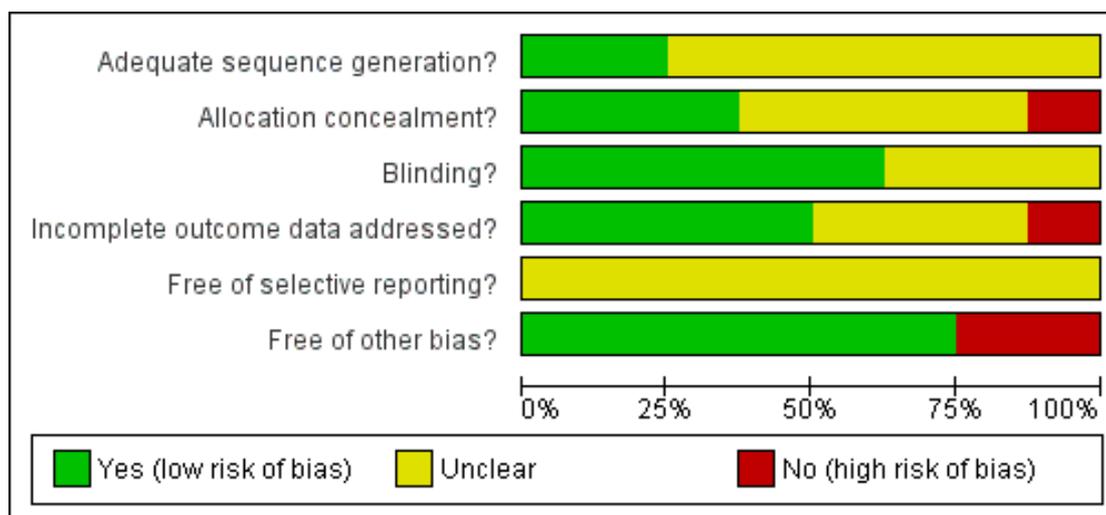
For details on risk of bias of included studies see Characteristics of included studies, Table 2 and Appendix 2.

For an overview of review authors' judgments about each risk of bias item for individual included studies see Figure 2 and Figure 3.

Figure 2. Risk of bias summary: review authors' judgments about each risk of bias item for each included study.

	Adequate sequence generation?	Allocation concealment?	Blinding?	Incomplete outcome data addressed?	Free of selective reporting?	Free of other bias?
Bo 2007	+	+	+	+	?	+
Da Qing 1997	?	?	?	?	?	-
DPP 2002	?	+	+	+	?	+
DPS 2001	?	-	+	+	?	+
IDPP 2006	?	?	+	+	?	+
Kosaka 2005	?	?	?	?	?	+
Oldroyd 2005	+	+	?	-	?	-
Wing 1998	?	?	+	?	?	+

Figure 3. Risk of bias graph: review authors' judgments about each risk of bias item presented as percentages across all included studies.



Allocation

All included studies were randomised controlled clinical trials of parallel design. One study was randomised by clinics (Da Qing 1997) and all other studies randomised individuals. Adequate sequence generation was performed in two studies (Bo 2007; Oldroyd 2005), the other studies did not report how the sequence generation was performed. Three studies reported how allocation concealment was performed (Bo 2007; DPP 2002; Oldroyd 2005). In DPS 2001 allocation concealment was not performed and in the rest of the studies it was not mentioned in the publications. Kosaka 2005 was the only study that specified a randomisation ratio other than 1:1; the randomisation ratio of this study was 1:4 (intervention:control). The control group was divided into three subgroups: a group in which body weight increased by 1.0 kg or more, a group in which body weight remained unchanged, and a group in which body weight decreased by 1.0 kg or more.

Blinding

Double-blinding is not possible or practical in these studies because of the type of intervention. Two studies had a medication treatment arm; in DPP 2002 double-blinding in the medication and control (placebo) arms was stated. Three studies reported the blinding of outcome assessors (Bo 2007; DPS 2001; Wing 1998)

and two studies the blinding of investigators and/or participants to some of the results (DPP 2002; IDPP 2006).

Incomplete outcome data

All studies reported discontinuation rates. Four studies described some details about discontinuing participants (Da Qing 1997; DPS 2001; IDPP 2006; Oldroyd 2005). Discontinuing rates in the exercise plus diet group ranged from 8.7% (DPS 2001) to 23% (Oldroyd 2005). In the control group attrition rates varied between 2.2% (IDPP 2006) to 38% (Oldroyd 2005). Attrition rates between intervention and control groups were dissimilar in three studies (IDPP 2006; Oldroyd 2005; Wing 1998). Two studies did not report discontinuation rates of each arm separately (Da Qing 1997; DPP 2002). In the Bo 2007 study participants signed the informed consent after randomisation, all discontinuing participants were participants who did not sign the informed consent before the beginning of the intervention. In the Oldroyd 2005 study discontinuation rates were very high and dissimilar between groups. In two studies (Kosaka 2005; Wing 1998) no reasons for missing data were provided.

Selective reporting

Selective reporting was unclear in all studies. One study (DPP 2002) had published a protocol, but data were presented in many publications, most of them are not included in this review. Therefore, it was not possible to track if all pre-specified outcomes were reported and if they were reported in the pre-specified way.

Other potential sources of bias

In one study (Da Qing 1997) physical exercise, expressed in units per day, was significantly higher at baseline in the diet plus exercise group than in the control group. In the Oldroyd 2005 study a significantly larger proportion of control participants reported engaging in regular physical activity at least once a week compared with intervention participants (53% versus 24%) and there were fewer women (10/32 (32%)) than men (22/32 (69%)) in the control group compared with the intervention group.

Effects of interventions

Baseline characteristics

For details of baseline characteristics see Appendix 3.

Two studies demonstrated clinically relevant differences between intervention and control groups. In one study, the number of participants reporting engaging in regular physical activity sufficient to get their heart thumping at least once a week, was more prevalent in the control group as was the the proportion of men (Oldroyd 2005). In another study, physical exercise expressed in units per day, was significantly higher at baseline in the diet plus exercise group than in the control group (Da Qing 1997).

In most studies the proportion of female participants was higher than the proportion of males. In three studies the proportion was around 50% in the intervention group (Bo 2007; Da Qing 1997; Oldroyd 2005) and in one study there were no female participants (Kosaka 2005).

The mean age of patients randomised to intervention groups ranged from 44.2 to 58.1 years. The main ethnic groups participating in the trials consisted of Asian and Caucasian participants. One study included other ethnic groups (DPP 2002). Three studies did not state the ethnic group of the participants (Bo 2007; DPS 2001, Wing 1998).

Most study participants were overweight or obese, the mean body mass indices (BMI) in patients randomised to intervention groups ranged between 24.0 and 36.1 kg/m². Most participants had impaired fasting glucose and/or impaired glucose tolerance. Mean fasting plasma glucose (FPG) in intervention groups ranged between 5.4 and 6.27 mmol/L, and mean two hours plasma glucose after a 75 g glucose load (2h PG) ranged between 8.5 and 9.15 mmol/L. Three studies did not report the 2h PG values at baseline (Bo 2007; Kosaka 2005; Wing 1998).

Primary outcomes

For details of primary outcomes see Appendix 5.

Diabetes incidence

Five of the included studies had as primary outcome the incidence of diabetes. Two studies had diabetes incidence as a secondary outcome (Bo 2007; Wing 1998) and one study did not have diabetes incidence as a primary or secondary outcome, but reported it (Oldroyd 2005). Overall, 4573 participants provided information on the incidence of diabetes.

For the analysis of the data an intention-to-treat (ITT) analysis was performed in all studies where data were presented in a per-protocol analysis when sufficient data were available (Bo 2007; DPS 2001; IDPP 2006; Kosaka 2005; Oldroyd 2005; Wing 1998). Diabetes incidence of discontinuing participants was considered to be the same as in the control group. In one study there were not enough data to perform an ITT analysis: randomised participants in each group were not specified in the publication (Da Qing 1997).

All eight studies included an exercise and diet group, a standard recommendation or no intervention group. The total number of events was 339 of 1976 in the exercise plus diet groups and 616 of 2252 in the control groups. Pooling of the eight studies by means of random-effects meta-analysis revealed a risk ratio of 0.63 (95% CI 0.49 to 0.79). The test for heterogeneity indicated an I²-value of 55%. The use of a fixed-effect model resulted in a risk ratio of 0.59 (95% CI 0.52 to 0.67). The robustness of this result was tested by repeating the analysis using odds ratio as a different measure of effect size. In a random-effects model the odds ratio was 0.51 (95% CI 0.40 to 0.65) and in a fixed-effect model the odds ratio was 0.48 (95% CI 0.40 to 0.56).

We repeated the analysis excluding the largest study (DPP 2002) which had a weight of 26% in the random-effects model and had a low risk of bias. The risk ratio in the random-effects model was then 0.69 (95% CI 0.55 to 0.87). Heterogeneity decreased to an I² of 22%.

Two studies had a diet only and an exercise only arm (Da Qing 1997; Wing 1998). The total number of events was 62 of 178 in the exercise groups and 92 of 173 in the control groups. Data were combined in a random-effects meta-analysis comparing the exercise group versus the control group resulting in no statistical significant differences between the groups. The test for heterogeneity indicated an I²-value of 42%. When combining the data in a fixed-effect meta-analysis, the exercise group was favoured (RR 0.58, 95% CI 0.37 to 0.92) demonstrating that these results are not very robust.

The total number of events was 62 of 178 in the exercise groups and 72 of 167 in the diet groups. Data were combined in a random-effects meta-analysis comparing the exercise group versus the diet group. No statistical significant differences between the groups

were found. The test for heterogeneity indicated an I^2 -value of 39%.

Diabetes and cardiovascular related morbidity

One study reported cardiovascular related morbidity (DPP 2002). The IDPP 2006 study mentioned the number of cardiovascular events, four in the exercise plus diet intervention group and two in the control group. These outcomes were not the primary objective of these studies.

Secondary outcomes

For details of secondary outcomes see Appendix 6.

Development of impaired glucose tolerance

No study investigated the development of impaired glucose tolerance. Three studies reported changes from baseline in the 2-h plasma glucose (DPS 2001; IDPP 2006; Oldroyd 2005). The Da Qing 1997 study reported data on 2-h plasma glucose but it was not included in the meta-analysis because participants were cluster randomised. Overall, 756 participants provided information on the changes from baseline of 2h PG. In the random-effects meta-analysis no significant difference between groups was found. The test for heterogeneity indicated an I^2 -value of 78%. Robustness of the analysis was tested by repeating the analysis in a fixed-effect model.

Heterogeneity could only be reduced to an I^2 of 36% when excluding the Oldroyd 2005 study from the analysis. When excluding the Oldroyd 2005 study, the weighted mean difference between groups in the random-effects meta-analysis resulted to be -0.59 (95% CI -1.14 to -0.04).

Data of 2-h plasma glucose for the comparison of the exercise group versus the control group and the exercise versus the diet group were only available from Da Qing 1997. Therefore, it was not combined by means of a meta-analysis.

Development of impaired fasting glucose

No study investigated the development of impaired fasting glucose. Six studies reported changes from baseline in fasting plasma glucose (FPG) (Bo 2007; DPP 2002; DPS 2001; IDPP 2006; Oldroyd 2005; Wing 1998). The Da Qing 1997 study reported data on changes from baseline in FPG but it was not included in the meta-analysis because participants were cluster randomised. In total, 3315 participants provided information on the changes from baseline of FPG in the comparison exercise and diet versus control. Combining the data in a random-effects meta-analysis resulted in statistically significant differences between groups, favouring the exercise plus diet intervention group. The test of heterogeneity indicated an I^2 -value of 71%. Robustness of the analysis was tested by repeating the analysis in a fixed-effect model.

Data of FPG for the comparison of exercise group versus control group and exercise versus diet group were available from Da Qing 1997 and Wing 1998. Because the Da Qing 1997 study was cluster randomised, data were not combined by means of a meta-analysis.

Anthropometric measures

For the comparison exercise and diet group versus control group there were six studies reporting body mass index (BMI) (Bo 2007; DPP 2002; DPS 2001; IDPP 2006; Oldroyd 2005; Wing 1998). In total, 3315 participants provided information on the changes from baseline of BMI in the comparison exercise plus diet versus control. When data were combined in a random-effects model, statistically significant differences were found favouring the exercise plus diet intervention group. The test for heterogeneity indicated an I^2 -value of 97%.

Seven studies reported body weight (Bo 2007; DPP 2002; DPS 2001; IDPP 2006; Kosaka 2005; Oldroyd 2005; Wing 1998). Overall, 3773 participants provided information on the changes from baseline of body weight in the comparison exercise plus diet versus control. Pooling these seven studies by means of a random-effects meta-analysis resulted in statistically significant differences in the mean weighted difference favouring the exercise plus diet group. The test for heterogeneity indicated an I^2 -value of 98%.

Four studies reported the waist-to-hip-ratio (WHR) (DPP 2002; IDPP 2006; Oldroyd 2005; Wing 1998). In total, 2546 participants provided information on the changes from baseline of WHR in the comparison exercise plus diet versus control. No significant differences were found for WHR. The test for heterogeneity indicated an I^2 -value of 83%.

Four studies reported waist circumference (Bo 2007; DPP 2002; DPS 2001; Oldroyd 2005). Overall, 2983 participants provided information on the changes from baseline of waist circumference in the comparison exercise plus diet versus control. In the random-effects meta-analysis the weighted mean difference was statistically significant, favouring the treatment group. The test for heterogeneity indicated an I^2 -value of 92%.

We could not analyse body weight, BMI, WHR and waist circumference in the comparison of groups of exercise versus control group and diet versus exercise group because data were only available from one study.

Lipid levels

Comparing exercise and diet groups versus control groups, five studies reported total cholesterol (Bo 2007; DPS 2001; IDPP 2006; Oldroyd 2005; Wing 1998), five studies reported HDL-cholesterol (Bo 2007; DPS 2001; IDPP 2006; Oldroyd 2005; Wing 1998), three studies reported LDL-cholesterol (IDPP 2006; Oldroyd 2005; Wing 1998) and four studies reported triglycerides (Bo 2007; DPS 2001; IDPP 2006; Oldroyd 2005). Overall, 1154, 1154, 385 and 1091 participants provided information on the

changes from baseline of total cholesterol, HDL-cholesterol, LDL-cholesterol and triglycerides, respectively. No statistically significant differences were found in total, HDL- and LDL-cholesterol between groups when pooling the data by means of a random-effects meta-analysis. When combining the data for triglycerides by means of a random-effects meta-analysis, it resulted in a weighted mean difference of -0.14 mmol/L (95% CI -0.22 to -0.05). No important heterogeneity was found in any of the lipid level analyses except in the HDL-cholesterol analysis where a heterogeneity of I^2 of 67% was found. Heterogeneity was reduced to 9% after excluding the [Bo 2007](#) study from the analysis and results did not change substantially.

The [DPS 2001](#) study reported changes in serum total cholesterol-to-HDL cholesterol. At one year of follow-up changes in the intervention group were -0.4(0.8) mmol/L and in the control group -0.1(0.8) mmol/L. At three years of follow-up changes were -0.6(0.9) mmol/L and -0.3(0.8) mmol/L in the control group (data are presented as means (SD)).

Two studies reported the use of pharmacological therapy for dyslipidaemia. In the [DPP 2002](#) study, at baseline 5.2% of the participant reported taking medication for dyslipidaemia. At three years of follow-up, 12% in the exercise plus diet group compared to 16% in the control group of the participants were taking medication for dyslipidaemia. In the [DPS 2001](#) study 6% and 5% of the participant were taking cholesterol-lowering drugs in the control and exercise plus diet group respectively at baseline. By the end of year one, 8% of the participants in the control and 6% in the exercise plus diet group were taking cholesterol-lowering drugs.

In the comparison of the groups exercise versus control group and diet versus exercise group there was just one study reporting lipid levels ([Wing 1998](#)).

Systolic and diastolic blood pressure

Data of systolic and diastolic blood pressure were obtained from six studies ([Bo 2007](#); [DPP 2002](#); [DPS 2001](#); [IDPP 2006](#); [Oldroyd 2005](#) [Wing 1998](#)). Overall, 2521 participants provided information on the changes from baseline of systolic and diastolic blood pressure in the comparison exercise plus diet versus control.

Combining the data of systolic blood pressure in a random-effects meta-analysis, the test for heterogeneity resulted in an I^2 -value of 66%. Heterogeneity could only be substantially reduced by excluding the [IDPP 2006](#) study from the analysis. The weight of this study was 17%. The I^2 -value was reduced to 9%. The random-effects meta-analysis consequently resulted in a mean difference of -4 (95% CI -5 to -2). Data on systolic and diastolic blood pressure in the [IDPP 2006](#) study were non-published data.

Combining the data of diastolic blood pressure by means of a random-effects meta-analysis resulted in a weighted mean difference of -2 (95% CI -3 to -1). No statistical heterogeneity was found.

Two studies reported the use of antihypertensive medication ([DPP 2002](#); [DPS 2001](#)). In the [DPP](#) study the use of antihypertensive

medication at baseline was 17% in both groups, at three years of follow-up the use of hypertensive pharmacological therapy was 23% in the exercise plus diet group and 31% in the control group. In the [DPS](#) study at baseline 31% of the participants in the control group and 30% of the participants in the intervention group were taking antihypertensive drugs. These values did not vary at one year of follow-up.

Quality of life

No study reported measurements of quality of life.

Adverse effects

For details on adverse effects see [Appendix 4](#).

One study mentioned musculoskeletal symptoms ([DPP 2002](#)), 728 events in the exercise plus diet intervention group and 639 events in the control group. The same study mentioned hospitalisation, 168 in the exercise plus diet intervention group and 174 in the control group. The [IDPP 2006](#) study mentioned a total of 25 cases of hospitalisation for various surgical procedures.

All-cause mortality

For details see [Appendix 4](#).

Four studies made some statement about the number of participants who died during the course of the trial ([Da Qing 1997](#); [DPP 2002](#); [IDPP 2006](#); [Oldroyd 2005](#)). The overall percentage of deaths was comparable between the intervention and control groups. These outcomes were not the primary objective of these studies.

Costs

Two studies published a within trial cost-effectiveness analysis of the exercise and diet intervention ([DPP 2002](#); [IDPP 2006](#)). Both studies concluded to be cost-effective from perspective of a Health-Care System.

Heterogeneity

In the overall analysis of diabetes incidence the comparison between exercise plus diet versus control groups heterogeneity was found as indicated by I^2 of 55%. After elimination of the largest study heterogeneity was significantly reduced (I^2 of 22%).

In the analysis of 2h plasma glucose, heterogeneity was observed by an I^2 -value of 78%. Heterogeneity could be reduced to an I^2 -value of 36% by excluding the [Oldroyd 2005](#) study from the analysis. The [Oldroyd 2005](#) study presented high attrition rates not balanced between treatment groups and had significant differences between the groups at baseline in participants who reported engaging in regular physical activity sufficient to get their heart

thumping at least once a week and in the proportion of women and men in each group.

High heterogeneity was found in the overall analysis of fasting plasma glucose (I^2 of 71%), which could not be reduced.

We also found high heterogeneity in the analysis of all anthropometric measures. Heterogeneity could be substantially reduced in the BMI and body weight analysis by excluding from this the [DPP 2002](#) and [IDPP 2006](#) study. In the WHR analysis heterogeneity could be substantially reduced by excluding from the analysis either the [DPP 2002](#) or the [IDPP 2006](#) study. Mean baseline BMI differed between studies. In the meta-analysis of all anthropometric measures studies are sorted by baseline BMI. A general correlation between baseline BMI and decrease in BMI, body weight and WHR at follow-up could be observed. The [IDPP 2006](#) and the [IDPP 2006](#) study are the studies with the lowest and the highest median BMI from the studies that presented data on anthropometric measures if not taking in account the [Wing 1998](#) study that falls out of the general tendency and the [Kosaka 2005](#) study in the body weight analysis. See [Analysis 1.5](#); [Analysis 1.6](#) and [Analysis 1.7](#).

Important heterogeneity was found in the HDL-cholesterol analysis (I^2 of 67%). Heterogeneity was reduced to 9% after excluding the [Bo 2007](#) study from the analysis. Exclusion of this study did not significantly influence the effect of the intervention.

Combining the data of systolic blood pressure in a random-effects meta-analysis, the test for heterogeneity resulted in an I^2 -value of 66%. Heterogeneity could only be substantially reduced by excluding from the analysis the [IDPP 2006](#) study. The I^2 -value was reduced to 9%. Data on systolic blood pressure from the [IDPP 2006](#) study were non-published data.

Subgroup analyses

We did not perform subgroups analyses because covariates were unevenly distributed and there were not enough studies to estimate an effect in various subgroups.

For the planned BMI subgroup analysis, there were confounding characteristics in the different studies (studies with lower mean baseline BMI as well as studies mainly with Asian participants and studies with higher mean BMI with mainly Caucasian participants). One study presented data of study participants separated in lean (BMI less than 25 kg/m²) and overweight participants (BMI equal or greater than 25 kg/m²) ([Da Qing 1997](#)). Diabetes incidence was higher in overweight participants in all four groups (exercise and diet, diet only, exercise only and control group) but there were no statistical significant differences between risk ratios in both subgroups in any of the comparisons (exercise and diet versus control, exercise versus control and exercise versus diet).

Mean age at baseline was very similar between studies. Only the [DPP 2002](#) study investigated the influence of age on the effects of exercise and diet interventions in the prevention of diabetes. Three age groups were established: 25 to 44, 45 to 59 and 60

to 85. The results show that the exercise and diet intervention was more effective with increasing age (6.3, 4.9, and 3.3 cases per 100 person-years, in the 25 to 44, 45 to 59, and 60 to 85 year age groups, respectively). There were other baseline differences between the three age groups. With increasing age there were more male (21%, 31%, 49% respectively) and Caucasian participants (47%, 55%, 66% respectively). The 60 to 85 year age group also had the lowest baseline BMI. Baseline fasting plasma glucose and 2-hour glucose were similar in all 3 groups.

Sensitivity analyses

Sensitivity analyses were performed for every element on the risk of bias table by excluding studies that had a high risk of bias. No statistically significant differences in the effects were observed when comparing these results with the overall analysis.

Publication and small study bias

Not performed due to insufficient amount of data.

DISCUSSION

Summary of main results

This systematic review shows that educational interventions based on exercise and diet are effective in reducing the incidence of type 2 diabetes mellitus in people presenting with impaired glucose tolerance and the metabolic syndrome. Many of the individuals included in the studies had an additional risk factor for the development of diabetes, i.e. they were overweight or obese. Therefore, the conclusions of this review apply to this type 2 diabetes risk category of individuals. Also, it must be pointed out that although the interventions were heterogeneous in nature they were effective in different settings. However, as interventions aimed at changing the behavioural pattern of people are complex we do not presently know how these interventions perform outside a trial setting. It must be stressed that the effects of these interventions are consistently seen in all the studies except for two ([Oldroyd 2005](#); [Wing 1998](#)). In the study by Oldroyd, the absence of effectiveness of the intervention may be at least in part explained by the fact that more individuals in the control group were physically active at inclusion in the trial. Additionally, the study by Wing found no effect of exercise alone or in combination with diet in the prevention of diabetes in the long term (two years), participants of this study were obese first-degree relatives of persons with type 2 diabetes. The results may be partly explained by the low proportion of individuals demonstrating long-term behavioural changes in this study. From the available information on follow-up of participants of some of the studies, the exercise and diet interventions show an effect that

lasts even after the intervention had ceased. However, both studies (Oldroyd 2005; Wing 1998) had a high risk of bias (Figure 2). No firm conclusion can be drawn about the effectiveness of exercise alone in preventing diabetes (see further comments under 'Limitations') as only two studies are available. The combined data from these two studies showed no significant difference when compared to the control participants, although the larger trial alone showed a positive effect of exercise in preventing diabetes. Further, in these same studies no difference was seen between the groups of exercise alone and diet alone in terms of diabetes incidence. The results of this systematic review are consistent with those of previously issued reviews (Gillies 2007; Norris 2005; Yamaoka 2005;). Additionally, one of these reviews already showed that lifestyle interventions are at least as effective as pharmacological interventions in terms of type 2 diabetes prevention (Gillies 2007). Individuals suffering from type 2 diabetes mellitus have a lower quality of life and a higher risk of cardiovascular morbidity and mortality. It may be stated that any diabetes-free period of life attained through these preventive strategies may be associated with an improved quality of life in people at risk. However, a major issue is the increased cardiovascular morbidity and mortality associated with diabetes; we do not know whether the evaluated interventions are able to prevent cardiovascular events in the population at risk. Additional cardiovascular risk factors associated with type 2 diabetes mellitus are high body weight and increased waist-to-hip ratio, dyslipidaemia and high blood pressure. The combined exercise plus diet intervention has favourable effects on weight reduction, waist circumference and blood pressure (systolic and diastolic). It may be predicted that any improvement in these risk factors may be associated with a favourable cardiovascular outcome. However, exercise and diet have a very modest effect on the lipid profile. Concerning the use of medications for lipid and blood pressure control, a conclusion can not be drawn although, if any, an effect of a lower use of these medications will favour the intervention arms of the two major trials (DPP 2002; DPS 2001). In terms of cost-effectiveness, the available data of one of the large trials (DPP 2002) show that 'lifestyle programs' are associated with modest incremental costs compared with the placebo group (DPP 2002). The analysis showed that lifestyle interventions are cost-effective from the perspective of the Health-Care System (DPP 2002). The Markov simulation model showed that the delay in the development of diabetes and its associated complications was highly cost-effective in all age groups and dominated the pharmacological intervention with metformin (Herman 2005).

Limitations of the review

Concerning the effectiveness of exercise alone the results of the current review are insufficient to draw a final conclusion. Only two studies were identified addressing this question. The combination of the data coming from these two studies showed no significant effect of exercise alone in terms of prevention of type 2

diabetes mellitus. One of the studies (Da Qing 1997) showed a positive effect of exercise alone in terms of diabetes prevention as compared to standard recommendations. The other study (Wing 1998), as previously noted, showed no significant effect of such a strategy, probably as the intervention failed to keep participants compliant with the exercise intervention. However, the comparison of interventions based on exercise alone against those based on diet alone yielded important differences although again only a small number of individuals were included in these studies. Only two studies with low risk of bias were identified (Bo 2007; DPP 2002). Exclusion of these trials in the analyses resulted in a decreased effect of the interventions under assessment. Unfortunately, publication and small study bias could not be assessed at present due to the insufficient amount of the data. However, updating of this issue is planned in future versions of this review.

AUTHORS' CONCLUSIONS

Implications for practice

Overall, interventions aimed at increasing exercise combined with diet are able to decrease the incidence of type 2 diabetes mellitus in participants with impaired glucose tolerance or the metabolic syndrome. There are insufficient data on exercise alone for diabetes prevention. Also, there are no data providing evidence of the effect of these interventions on morbidity and mortality. Further, no firm conclusions can be drawn from the available evidence on which strategy to follow when trying to induce behavioural changes in people at risk. These results should be taken into account by health-care policy makers when planning the implementation of these strategies in real-life settings. Additionally, the favourable cost-effectiveness of lifestyle measures over pharmacological intervention is to be taken into account when planning implementation of prevention programmes into routine clinical practice.

Implications for research

There is a need for studies exploring the effect of interventions on exercise alone or combined with diet on morbidity and mortality, with special focus on cardiovascular outcomes.

This review has found evidence for the effects of exercise plus diet mainly in individuals already presenting with impaired glucose tolerance. Only a few studies were identified in other at risk populations such as overweight or obese individuals with normal glucose tolerance, first-degree relatives of type 2 diabetic individuals, individuals with hypertension or dyslipidaemia and high-risk ethnic groups. Therefore, we are still in need of randomised controlled trials aimed at exploring the effectiveness of exercise alone or combined with diet in the prevention of type 2 diabetes in these

at-risk groups. Additionally, focus should be placed on the investigation of the effect of exercise alone interventions to prevent type 2 diabetes mellitus. Further research is also needed to determine the health-care costs of these interventions.

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REFERENCES

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* Indicates the major publication for the study

CHARACTERISTICS OF STUDIES

Characteristics of included studies [ordered by study ID]

Bo 2007

Methods	<p>Follow-up: 1 year.</p> <p>Number study arms: 2: exercise+diet and control group; number of participants randomised to each group: 187 randomised to I2 and 188 to CG..</p> <p>Setting: Asti (Northwestern Italy).</p> <p>Number of study centres: NR.</p> <p>Language of publication: English.</p> <p>ITT analysis: N.</p> <p>Per-protocol analysis: Y.</p>
Participants	<p>Randomised number: I2:187, CG: 188</p> <p>Analysed number: I2: 169, CG: 166.</p> <p>Age (years): I2: 55.7(5.7); C1: 55.7(5.6)</p> <p>Sex (% female): I2: 58.6; C1: 57.8</p> <p>Baseline BMI: I2: 29.7(4.1); C1: 29.8(4.6)</p> <p>Inclusion criteria: age: 45-64 years metabolic syndrome or two components of metabolic syndrome plus high-sensitivity CRP (hs-CRP) serum values ≥ 3 mg/L, the cutoff point that differentiates high-risk groups for future cardiovascular events</p> <p>Exclusion criteria: Diseases which require specific diet and exercise recommendations: diabetes, cardiovascular diseases, chronic liver or kidney disease and advanced cancer</p> <p>Ethnic group: NR.</p> <p>BL comparable: Yes.</p>
Interventions	<p>Duration of intervention: 1 year.</p> <p>Intervention groups:</p> <p>I2: Family physician advice plus detailed verbal and written recommendation including individually prescribed diet and advice on exercise mainly by suggesting moderate-intensity activity, such as brisk walks for at least 150 minutes/week. Sessions had a flexible structure, sensitive to cultural differences and patient expectations.</p> <p>CG: family physician advice emphasizing on the importance of a healthy lifestyle according to their usual clinical practice.</p> <p>Behavioral intervention: NR.</p> <p>Frequency: NR.</p> <p>No. of contacts: 5.</p> <p>Group/Individual: Individual.</p> <p>Medium: In person.</p> <p>Facilitator: nutritionists, specialists in endocrinology and internal medicine</p>
Outcomes	<p>Primary outcomes: IDM</p> <p>Secondary outcomes: IFG, FPG, W, BMI, Waist, TG, HDL, Chol, SBP, DBP</p>
Notes	<p>Stated aim of study: To know whether a program of moderate intervention might effectively reduce metabolic abnormalities in the general population</p> <p>Randomization procedure: performed by using an SAS program stratifying participants</p>

		according to sex, education level, general practitioner, area of residence, and number of metabolic syndrome components. Allocation concealment: Yes. Attrition (%): 11 Blinding assessor: Yes.
Risk of bias		
Item	Authors' judgement	Description
Adequate sequence generation?	Yes	Quote: "Participants were stratified according to age, sex, education level..." "the randomisation procedure was automatically performed by a statistician using a SAS programme developed to minimize the differences between the two groups for all stratifying variables."
Allocation concealment?	Yes	Quote: "Random allocation with a minimization algorithm was centrally performed in a single step. The researchers then received the two lists of nominative data."
Blinding? All outcomes	Yes	Quote: "Because of the nature of the intervention, blinding participants and health professionals was not possible. Family physicians, the physicians who collected data, the dietician, and the laboratory personnel were blinded to the group assignment."
Incomplete outcome data addressed? All outcomes	Yes	Quote: "Written informed consent to participate was not given by 18 of 187 (9.6%) and 22 of 188 (11.7%) subjects from the intervention group and the control group, respectively."
Free of selective reporting?	Unclear	Comment: Insufficient information provided.
Free of other bias?	Yes	

Da Qing 1997

Methods	<p>Follow-up: 6 years.</p> <p>Number study arms: 4: exercise -only, exercise+diet, diet-only and control group; number of participants randomised to each group: NR.</p> <p>Setting: Chinese community.</p> <p>Number of study centres: 33 health care clinics.</p> <p>Language of publication: English.</p> <p>ITT analysis: trial authors stated: Yes.</p> <p>Per-protocol analysis: Yes.</p>
Participants	<p>Randomised number: 577.</p> <p>Analysed number: I1 141, I2: 126, I3: 130, CG: 133.</p> <p>Age (years):45.0 (9.1).</p> <p>Sex (% female): 47.0.</p> <p>Baseline BMI: 25.8 (3.8).</p> <p>Inclusion criteria: 2h PG glucose\geq120 mg/dl (6.7 mmol/L) and <200 mg/dl (11.0 mmol/L), followed by 2h OGTT (WHO 1985).</p> <p>Exclusion criteria: NR.</p> <p>Ethnic group: Asian.</p> <p>BL comparable: Yes.</p>
Interventions	<p>Duration of intervention: 6 years.</p> <p>Intervention groups:</p> <p>I1: encouraged to increase the amount of physical exercise; duration dependent on intensity.</p> <p>I2: instructions and counseling similar to those for diet only and exercise only intervention groups.</p> <p>I3: reducing energy intake: diet and diet+exercise groups: if BMI <25, 25-30 kcal/kg with 55-65% carbohydrate, 10%-15% protein, 25%-30% fat; if BMI>25, goal to lose 0.5 to 1.0 kg/month until BMI = 23 kg/m².</p> <p>CG: general instructions for diet and/or increased leisure physical activities.</p> <p>Behavioral intervention: NR.</p> <p>Frequency: both diet and exercise interventions: counselling sessions weekly for 1 month, monthly for 3 months, and then once every 3 months.</p> <p>No. of contacts: 30.</p> <p>Group/Individual: Both.</p> <p>Medium: In person.</p> <p>Facilitator: Physician and team.</p>
Outcomes	<p>Primary outcomes: IDM</p> <p>Secondary outcomes: FPG, 2h PG, M</p>
Notes	<p>Stated aim of study: to determine whether diet and exercise interventions in those with IGT may delay the development of DM.</p> <p>Randomization procedure: by clusters, method of randomisation: NR.</p> <p>Allocation concealment: NR .</p> <p>Attrition (%):8. Blinding assessor: NR.</p>
<i>Risk of bias</i>	

Da Qing 1997 (Continued)

Item	Authors' judgement	Description
Adequate sequence generation?	Unclear	Quote: "subjects were randomised by clinic"
Allocation concealment?	Unclear	Comment: no information
Blinding? All outcomes	Unclear	Comment: no information
Incomplete outcome data addressed? All outcomes	Unclear	Quote: "7 people refused follow-up, 29 left Da Qing..., and 11 died... No deaths... occurred in the exercise... Three deaths occurred in the control..." "Those who left in 1988 very early in the study and before the first follow-up for reasons unrelated to their randomisation group were not included in the analysis. The 11 who died were retained, although none had developed diabetes before death."
Free of selective reporting?	Unclear	Comment: insufficient information provided.
Free of other bias?	No	Quote: "Physical exercise, expressed in units per day, was significantly higher at baseline in the diet-plus exercise group than in the control group."

DPP 2002

Methods	Follow-up: average 2.8 years; range 1.8-4.6. Number study arms: 3: lifestyle (exercise+diet), metformin (not reported here) and control group (standard recommendation+placebo) : 1079 randomised to I2 and 1082 to CG. Setting: USA. Number of study centres: 27. Language of publication: English. ITT analysis: Yes. Per-protocol analysis: No.
Participants	Randomised number: 3234 Analysed number: I2: 1079, CG: 1082. Age (years): 50.6 (10.7). Sex (% female): 67.7. Baseline BMI: 34.0 (6.7). Inclusion criteria: >=25 years, BMI>=24 in Asians BMI>=22, FPG 95-125 mg/dl (5.3-6.9 mmol/L) and 2-h OGTT

DPP 2002 (Continued)

	<p>140-199 mg/dl (7.8-11.0 mmol/L) (ADA 1997). Exclusion criteria: participants taking medicines known to alter glucose tolerance or if they had illnesses that could seriously reduce their life expectancy or their ability to participate in the trial. Ethnic group: White (54.7%), African American (19.9%), Hispanic (15.7%), American Indian (5.3%), Asian (4.4%). BL comparable: Yes.</p>
Interventions	<p>Duration: Average 2.8 years, range 1.8-4.6 Intervention groups: I2: physical activity intervention: moderate-intensity exercise for 150 min a week; supervised group exercise sessions twice a week were offered. Dietary intervention: goal 7% weight loss through a healthy low-calorie, low-fat diet. CG: written information and annual 30 min individual session on healthy lifestyles. Behavioral intervention: culturally sensitive materials and motivational strategies. Frequency: 16 lessons in first 24 weeks, then monthly. No.of contacts:40 Group/individual: both. Medium: In person. Facilitator: Case manager ("lifestyle coach"), usually a dietitian</p>
Outcomes	<p>Primary outcomes: IDM, CVD Secondary outcomes: FPG, W, BMI, WHR, Waist, SBP, DBP, Cost</p>
Notes	<p>Stated aim of study: to evaluate whether a lifestyle-intervention program or the administration of metformin would prevent or delay the development of diabetes. Randomisation procedure: adaptive randomisation. Allocation concealment: NR Attrition (%): 8. Blinding assessor: Yes.</p>

Risk of bias

Item	Authors' judgement	Description
Adequate sequence generation?	Unclear	Quote: "adaptive randomisation is stratified by clinical centre"
Allocation concealment?	Yes	Quote: "The urn method was used"
Blinding? All outcomes	Yes	Quote: "Investigators and participants remain masked to primary outcome data until progression to diabetes is confirmed." "Assignments to metformin and placebo were double-blinded"
Incomplete outcome data addressed? All outcomes	Yes	Quote: "Participants who prematurely discontinue their follow-up visits before confirmed development of diabetes will be cen-

DPP 2002 (Continued)

		sored as of their last follow-up visit.”
Free of selective reporting?	Unclear	Comment: Outcomes published in many different publications. Many outcomes are reported incompletely so that they cannot be entered in a meta-analysis
Free of other bias?	Yes	

DPS 2001

Methods	<p>Follow-up: 3.2 years. Number study arms: 2: exercise plus diet and control group: 265 randomised to I2 and 257 to CG. Setting: Finland. Number of study centres: 5. Language of publication: English. ITT analysis: stated yes by the trial authors. Per-protocol analysis: Yes.</p>
Participants	<p>Randomised number: 522. Analysed number: I2: 256, CG: 250. Age (years): 55 (7.0). Sex (%female): 67.0. Baseline BMI: 31.1 (4.6) Inclusion criteria: BMI\geq25; IGT (2-h post prandial plasma glucose 140-200 mg/dl [7.8-11.0 mmol/L]) and FPG <140mg/dl (7.8 mmol/L) (WHO 1985), 40-65 years. Exclusion criteria: diagnosis of diabetes mellitus, chronic disease, psychological or physical disabilities deemed likely to interfere with participation in the study. Ethnic group: NR. BL comparable: Yes.</p>
Interventions	<p>Duration of intervention: mean 3.2 years. Intervention group: I2: Individual counseling regarding moderate activity 30 minutes / day; supervised strength training; frequency and availability varied among study centers. Dietary intervention: Low fat, high-fiber diet; goal BMI <25 or 5-10kg weight loss; <50% carbohydrate, <30% fat, <300 mg / day cholesterol. CG: general written and oral information to prevent DM at baseline and annually. Behavioral intervention: food records; goal setting. Frequency: 7 sessions with dietitian first year, then every 3 months. No. of contacts: 15. Group/Individual: individual. Medium: In person. Facilitator: physician, nurse, nutritionist, physiotherapist</p>

DPS 2001 (Continued)

Outcomes	Primary outcomes: IDM Secondary outcomes: FPG, 2h PG, W, BMI, Waist, TG, HDL, Chol, SBP, DBP, Cost,	
Notes	Stated aim of study: to assess the efficacy of an intensive diet-exercise programme in preventing or delaying Type II DM in individuals with IGT. Randomization procedure: using a list, stratified by center, sex, and 2h PG value. Allocation concealment: NR . Attrition (%): 8. Blinding assessor: Yes.	
Risk of bias		
Item	Authors' judgement	Description
Adequate sequence generation?	Unclear	Quote: "randomization list, with stratification according to center, sex and mean 2hPG
Allocation concealment?	No	Quote: "randomly assigned to the intervention group or the control group by the study physician, with the use of a randomization list"
Blinding? All outcomes	Yes	Quote: "The nurses who scheduled the study visits did not have access to the randomization list... Laboratory staff did not know the subjects' group assignments, and the subjects were not informed of their plasma glucose concentrations during follow-up unless diabetes was diagnosed."
Incomplete outcome data addressed? All outcomes	Yes	Quote: "...were defined as dropouts... data from their earlier visits were included in the analyses." "40 subjects (8 percent) withdrew - 23 in the intervention group and 17 in the control group... 9 could not be contacted, 3 withdrew due to severe illness, 1 died, and 27 withdrew for personal reasons."
Free of selective reporting?	Unclear	Comment: Insufficient information provided.
Free of other bias?	Yes	

IDPP 2006

Methods	Follow-up: mean 30 months. Number study arms: 4: exercise+diet defined as lifestyle modification (LSM), metformin group (not reported here), LSM+metformin (not reported here), and control group: 133 randomised to I2 and 136 to CG. Setting: India. Number of study centers: NR. Language of publication: english. ITT analysis: No. Per-protocol analysis: Yes.
Participants	Randomised number: 531. Analysed number: I2: 120, I3: 129, I4: 133, CG: 136. Age (years): 45.9 Sex (%female): 21 Baseline BMI: 25.8 Inclusion criteria: IGT: mean 2-h post prandial plasma glucose 140-199 mg/dl [7.8-11.0 mmol/L] and FPG <126mg/dl (7.0 mmol/L) (WHO 1999). Exclusion criteria: diagnosis of DM during recruitment. Ethnic group: Asian Indian. BL comparable: Yes.
Interventions	Duration of intervention: 3 years. Intervention groups: I2: physical activity intervention: participants involved in exercise regularly were to ask to continue their routine activities. Sedentary or light physical activity participants encouraged to physical activity at least 30 min/day. Dietary intervention: reduction in total calories, refined carbohydrates and fats, inclusion of fiber-rich foods. CG: standard health care advice. Behavioral intervention: motivational strategies. Frequency: every 6 months. No.of contacts: 6. Group/individual: individual. Medium:In person. Facilitator: physician dietician and social worker.
Outcomes	Primary outcomes: IDM Secondary outcomes: FPG, 2h PG, W, BMI, WHR, Chol, HDL, LDL, TG, SBP, DBP, M
Notes	Stated aim of study: tested whether the progression to diabetes could be influenced by interventions in native Asia Indians with IGT. Randomization procedure: NR. Allocation concealment: NR . Attrition (%): 6. Blinding assessor: the principal investigators were blinded to interim results
<i>Risk of bias</i>	

IDPP 2006 (Continued)

Item	Authors' judgement	Description
Adequate sequence generation?	Unclear	Quote: "were consecutively randomised in the four groups"
Allocation concealment?	Unclear	Comment: no information
Blinding? All outcomes	Yes	Quote: "The principal investigators were blinded to the interim results."
Incomplete outcome data addressed? All outcomes	Yes	Comment: Lost to follow-up and drop outs described in a flow chart
Free of selective reporting?	Unclear	Comment: Insufficient information provided.
Free of other bias?	Yes	

Kosaka 2005

Methods	<p>Follow-up: 4 years. Number study arms: 2: Intensive intervention group (intervention group) and standard intervention group (control group): 102 randomised to I2 and 356 to CG. Setting: Japan. Number of study centers: NR. Language of publication: english. ITT analysis: NR. Per-protocol analysis: Yes.</p>
Participants	<p>Randomised number: 484. Analysed number: I2: 102, CG: 356. Age (years): 51.5 (NR). Sex (% female): 0. Baseline BMI: 23.9 (2.2) Inclusion criteria: FPG<140 mg/dl and a 2-h PG value between 160 and 239 mg/dl on 100 g OGTTs; the individuals had IGT according to the WHO criteria in 1980. Exclusion criteria: Known DM, diagnosed or suspected malignant neoplasm, diagnosed or suspected disease of the liver, pancreas, endocrine organs, or kidney; ischemic heart disease or cerebrovascular disease. Ethnic group: Asian. BL comparable: Yes.</p>
Interventions	<p>Duration of intervention: 4 years. Intervention group: I2: physical activity: walking 30-40 min/day or 30 min cycling in weekends was recommended. advised to lose weight if BMI >=22 Kg/m2 by eating smaller meals</p>

Kosaka 2005 (Continued)

	<p>(reduce amount about 10%), reduce consume of fat-rich foods. CG: advised to lose weight if BMI ≥ 24 Kg/m² taking 5-10% smaller meals, and to increase their physical activity. Behavioral intervention: encourage cooperation of the family members, goal setting. Frequency: every 6 months for controls and 3-4 months for intervention group. No.of contacts: 8. Group/individual: individual. Medium: In person. Facilitator: NR.</p>
Outcomes	<p>Primary outcomes: IDM Secondary outcomes: W</p>
Notes	<p>Stated aim of study: to assess the effect of lifestyle intervention on the incidence of diabetes in males with IGT. Randomization procedure: one of every five persons was randomly selected for allocating to the I2, and the others were assigned to the CG. Allocation concealment: NR . Attrition (%): 13. Blinding assessor: NR.</p>

Risk of bias

Item	Authors' judgement	Description
Adequate sequence generation?	Unclear	Quote: "One of every five subjects was randomly selected for allocation the intensive intervention group, and the others were assigned to the standard intervention (control) group."
Allocation concealment?	Unclear	Comment: no information
Blinding? All outcomes	Unclear	Comment: no information
Incomplete outcome data addressed? All outcomes	Unclear	Comment: no reasons for missing data provided.
Free of selective reporting?	Unclear	Comment: insufficient information provided.
Free of other bias?	Yes	

Oldroyd 2005

Methods	<p>Follow-up: 24 months.</p> <p>Number study arms: 2: I2: Live style (exercise+diet), CG: No lifestyle advice: 37 randomised to I2 and 32 randomised to CG.</p> <p>Setting: UK.</p> <p>Number of study centres: 1.</p> <p>Language of publication: English.</p> <p>ITT analysis: Yes.</p> <p>Per-protocol analysis: No.</p>
Participants	<p>Randomised number: 78</p> <p>Analysed number: I2: 37, CG: 32 at 6 month; I2: 32, CG: 30 at 12 month; I2: 30, CG: 24 at 24 month</p> <p>Age (years): I2: 58 (41-75); CG: 57 (41-73)</p> <p>Sex (%female): 43</p> <p>Baseline BMI: I2: 30.4 (5.6); CG: 29.9 (4.9)</p> <p>Inclusion criteria: IGT (2-h post glucose load plasma glucose 140-200 mg/dL [7.8-11.0 mmol/L]) (WHO 1985); 24-75 years.</p> <p>Exclusion criteria: Pregnant individuals, on therapeutic diets or whose medical condition prevent them from undertaking moderate physical activity.</p> <p>Ethnic group: White.</p> <p>BL comparable: Yes.</p>
Interventions	<p>Duration: 24 month.</p> <p>I2: Physical activity intervention: graded plan, tailored to the participants lifestyle and designed to enable them to achieve 20-30 min of aerobic activity at least once a week. CITY CARD is provided, offering up to 80% discount on use of public leisure facilities.</p> <p>Diet intervention: Reduce BMI to <25 in overweight; <=30 % of energy from fat; polyunsaturated to saturated fat ratio >=1.0; 50% from carbohydrate; >=20g per 4.2MJ dietary fibre intake.</p> <p>CG: No intervention.</p> <p>Behavioral intervention: motivational interviewing to develop an individual action plan for behaviour change.</p> <p>Frequency: first 6 months 3 appointments at 2 weekly intervals, followed by 3 at monthly intervals. One after 9 months and 5 at 2 monthly intervals between 12 and 24 months.</p> <p>No. of contacts: 12</p> <p>Group/Individual: Individual.</p> <p>Medium: In person.</p> <p>Facilitator: Dietitian and physiotherapist.</p>
Outcomes	<p>Primary outcomes: IDM</p> <p>Secondary outcomes: FPG, 2h PG, W, BMI, WHR, Waist, TG, HDL, LDL, Chol, SBP, DBP, M</p>
Notes	<p>Stated aim of study: To evaluate the efficacy of interventions to promote a healthy diet and physical activity in people with impaired glucose tolerance.</p> <p>Randomization procedure: using a random number table to the intervention or control group.</p> <p>Allocation concealment: YES (not clear if adequate)</p>

Oldroyd 2005 (Continued)

	Attrition (%): 31 Blinding assessor: NR	
Risk of bias		
Item	Authors' judgement	Description
Adequate sequence generation?	Yes	Quote: "...using a random number table to the intervention or control group at the first appointment."
Allocation concealment?	Yes	Quote: "Researchers performing the randomisation were blinded to the group allocation."
Blinding? All outcomes	Unclear	Comment: no information.
Incomplete outcome data addressed? All outcomes	No	Comment: there was a high attrition rate, not balanced between treatment groups. Attrition rate was 23% in the treatment group and 38% in the control group after 24 month of follow-up
Free of selective reporting?	Unclear	Comment: insufficient information.
Free of other bias?	No	Quote: "...a significantly larger proportion of control participants reported engaging in regular physical activity sufficient to get their heart thumping at least once a week compared with intervention participant (53% versus 24%)" "There were fewer women (10/32 (32%)) than men (22/32 (69%)) in the control group compared with the intervention group..."

Wing 1998

Methods	<p>Follow-up: 2 years.</p> <p>Number study arms: 4: exercise, exercise+diet, diet and control group: 37 randomised to I1, 40 to I2, 37 to I3 and 40 to CG.</p> <p>Setting: USA.</p> <p>Number of study centres: NR.</p> <p>Language of publication: English.</p> <p>ITT analysis: NR</p> <p>Per-protocol analysis: Yes.</p>
Participants	<p>Randomised number: 154.</p> <p>Analysed number: I1: 31, I2: 32, I3: 35, CG: 31, at 2 years.</p> <p>Age (years):45.7 (4.4).</p> <p>Sex (% female): 79</p> <p>Baseline BMI: 35.9 (4.3).</p> <p>Inclusion criteria: overweight subjects (30-100% of ideal body weight), aged 40-55 years, nondiabetic, and had one or two biological parents with DM.</p> <p>Exclusion criteria: NR.</p> <p>Ethnic group: NR.</p> <p>BL comparable: Yes.</p>
Interventions	<p>Duration of intervention: 2 years.</p> <p>Intervention groups:</p> <p>I1: encouraged to increase physical activity (e.g., walking 3 miles on each of 5 days in the week) in biweekly increments of 250 Kcal/week to achieve a goal of 1500 Kcal/week.</p> <p>I2: instructions and counselling similar to those for diet only and exercise only intervention groups.</p> <p>I3: reducing energy intake: 800-1,000 kcal/day, 20% of calories as fat, for weeks 1-8 then 1,200-1,500 kcal/day at week 16; both the diet and exercise interventions received behavioral therapy.</p> <p>CG: general written and oral information to lose weight and exercise on their own.</p> <p>Behavioral intervention: food records for feedback, individualization, motivational strategies.</p> <p>Frequency: I1, I2, I3: weekly for the first 6 months, and then biweekly meetings for 6 months, then two 6-week refresher courses during year 2.</p> <p>No. of contacts: 51.</p> <p>Group/Individual: Group.</p> <p>Medium: In person.</p> <p>Facilitator: nutritionist, exercise physiologist, behavior therapist</p>
Outcomes	<p>Primary outcomes: IDM</p> <p>Secondary outcomes: FPG, W, BMI, WHR, TG, HDL, LDL, Chol, SBP, DBP</p>
Notes	<p>Stated aim of study: to determine the effectiveness over 2 years of diet, exercise, or the combination of diet + exercise on changes in eating and exercise behavior, body weight, cardiovascular risk factors, and the incidence of diabetes in overweight individuals with a parental history of DM.</p> <p>Randomization procedure: NR.</p> <p>Allocation concealment: NR.</p> <p>Attrition (%): 15% at 6 month, 22% at 1 year and 16% at 2 years.</p>

Wing 1998 (Continued)

	Blinding assessor: NR.	
Risk of bias		
Item	Authors' judgement	Description
Adequate sequence generation?	Unclear	Quote: "...were randomly assigned to one of the four treatment conditions."
Allocation concealment?	Unclear	Comment: no information.
Blinding? All outcomes	Yes	Quote: "All scoring of the 3-day records was done blinded to treatment condition and phase"
Incomplete outcome data addressed? All outcomes	Unclear	Comment: no information on reasons for missing data provided
Free of selective reporting?	Unclear	Comment: insufficient information provided.
Free of other bias?	Yes	

FPG: fasting plasma glucose, IFG: impaired fasting glucose, IGT: impaired glucose tolerance, 2h PG: 2h plasma glucose, 2h OGTT: 2h 75-g after oral glucose tolerance test, I1: exercise group, I2: exercise+diet group, I3: diet group, CG: Control Group, DM: Type II diabetes mellitus, IDM: incidence of diabetes mellitus, DCM: diabetes and cardiovascular related morbidity, CHD: coronary heart disease, TG: triglycerides, HDL: HDL-cholesterol, LDL: LDL-cholesterol, Chol: total cholesterol, W: weight, BMI: body mass index, WHR: waist-to-hip-ratio, SBP: systolic blood pressure, DBP: diastolic blood pressure, QL: quality of life, AE: adverse effects, M: mortality, BL: base line, AHA: American Heart Association, NR: not reported.

Characteristics of excluded studies [ordered by study ID]

Study	Reason for exclusion
Davey Smith 2005	Principal findings are based on a post-hoc sub-group analysis. Compared the incidence of diabetes in the intervention and control groups of 'The Multiple Risk Factor Intervention Trial', reported on an unexpected subgroup finding related to baseline cigarette smoking status
De la Rosa 2007	Not a randomised trial.
Dyson 1997	None of the primary or secondary objectives assessed the incidence of diabetes
Eriksson 1991	Inadequate randomisation, the control group was not randomised

(Continued)

Eriksson 2006	Included diabetic participants at baseline.
Fang 2004	Not a randomised controlled trial.
Grey 2004	Both experimental and control groups received the same nutritional education and physical activity training
Huang 2007	Follow-up time was less than six months.
Liao 2002	The control group received an intervention that differed to the standard recommendation
Lindahl 1999	Non of the primary or secondary objectives assessed the incidence of diabetes
Page 1992	Non of the primary or secondary objectives was to asses the incidence of diabetes
Sakane 2006	Not a randomised controlled trial.
Tao 2004	Inadequate randomisation: quasi-randomised patients.
Thompson 2008	Duration of intervention less than six months.
Villareal 2006	None of the primary or secondary objectives assessed the incidence of diabetes

Characteristics of studies awaiting assessment [ordered by study ID]

Kinmonth 2008

Methods	Randomised controlled trial
Participants	365 sedentary adults who had a parental history of type 2 diabetes
Interventions	Intervention 1: behavioural change programme delivered by a facilitator over the telephone(distance) Intervention 2: same programme, but delivered in the home (face to face) Control: comparison group (advice). Participants in the two intervention groups were taught to maximise personal advantages and opportunities, and to minimise disadvantages and obstacles to becoming more physically active
Outcomes	Maximal cardiorespiratory fitness(VO_2 max), and self-reported physical activity, Weight, ;body-fat percentage; and blood pressure, glycosylated haemoglobin, fasting plasma glucose, lipids, and insulin
Notes	Diabetes incidence was not reported, might be included in further updates

Mensink 2003

Methods	Randomised controlled trial.
Participants	102 participants with mean 2-h glucose concentration of two OGTTs of 7.8-12.5 mmol/L and FPG <7.8 mmol/L
Interventions	Intervention group: dietary and exercise intervention. Control group: general information.
Outcomes	change in glucose tolerance (2-h PG), FPG, plasma insulin concentration, insulin resistance, glycated haemoglobin, and changes in body weight, body composition and VO ₂ max. Changes in cardiovascular risk factors are assessed (blood pressure and blood lipid profile)
Notes	Final 3 year results not published.

Savoie 2007

Methods	Randomised controlled trial.
Participants	209 overweight children, ages 8-16 years.
Interventions	Intervention group: weight management intervention: intensive family-based program including exercise, nutrition, and behaviour modification Control group: diet and exercise counseling.
Outcomes	Changes in weight, BMI, body fat, and homeostasis model assessment of insulin resistance, blood pressure, FPG, lipid profile
Notes	Incidence of diabetes part of a paper that the authors are preparing for publication

Characteristics of ongoing studies [ordered by study ID]**EDPS**

Trial name or title	The European Diabetes Prevention Study (EDPS)
Methods	Multicentre, parallel design, randomised controlled study.
Participants	104 people aged 40 to 75, with IGT and overweight.
Interventions	Intervention group: regular and intensive diet and physical activity advice complemented by a number of small group educational activities Control group: will receive routinely available lifestyle advice
Outcomes	The primary outcome measure will be incidence of Type 2 diabetes. Secondary outcomes: The proportion of energy consumed from fat, protein, carbohydrates and saturated, monounsaturated, polyunsaturated fatty acids, fibre and cholesterol, physical activity, glucose tolerance, insulin sensitivity, cardiovascular risk factors, cardiovascular morbidity and mortality, quality of life

EDPS (Continued)

Starting date	20/07/2000
Contact information	University of Newcastle upon Tyne Public Health Research Group Faculty of Medical Sciences School of Population and Health Sciences Newcastle upon Tyne NE2 4HH United Kingdom Tel: +44 (0)191 222 6275 Fax: +44 (0)191 222 6461 Email: Martin.White@ncl.ac.uk
Notes	

DATA AND ANALYSES

Comparison 1. Exercise+diet vs standard recommendations (overall analysis)

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Diabetes incidence - ITT (RR/HR)	8		risk/hazard ratio (Random, 95% CI)	0.63 [0.49, 0.79]
2 Diabetes incidence - ITT (OR/HR)	8		odds/hazard ratio (Random, 95% CI)	0.51 [0.40, 0.65]
3 Mean differences between groups in fasting plasma glucose (mmol/L)	6	3315	Mean Difference (IV, Random, 95% CI)	-0.19 [-0.32, -0.05]
4 Mean differences between groups in 2-h plasma glucose (mmol/L)	3	756	Mean Difference (IV, Random, 95% CI)	-0.23 [-1.08, 0.61]
5 Mean differences between groups in body mass index (BMI - kg/m ²)	6	3315	Mean Difference (IV, Random, 95% CI)	-1.11 [-2.01, -0.21]
6 Mean differences between groups in weight (kg)	7	3773	Mean Difference (IV, Random, 95% CI)	-2.72 [-4.72, -0.72]
7 Mean differences between groups in waist-to-hip ratio (WHR)	4	2546	Mean Difference (IV, Random, 95% CI)	-0.01 [-0.02, 0.01]
8 Mean differences between groups in waist circumference (cm)	4	2983	Mean Difference (IV, Random, 95% CI)	-3.90 [-5.90, -1.91]
9 Mean differences between groups in total cholesterol (mmol/L)	5	1154	Mean Difference (IV, Random, 95% CI)	-0.09 [-0.19, 0.01]
10 Mean differences between groups in HDL cholesterol (mmol/L)	5	1154	Mean Difference (IV, Random, 95% CI)	Not estimable
11 Mean differences between groups in LDL cholesterol (mmol/L)	3	385	Mean Difference (IV, Random, 95% CI)	0.03 [-0.11, 0.17]
12 Mean differences between groups in triglycerides (mmol/L)	4	1091	Mean Difference (IV, Random, 95% CI)	-0.14 [-0.22, -0.05]
13 Mean differences between groups in systolic blood pressure (mmHg)	5	2268	Mean Difference (IV, Random, 95% CI)	-3.54 [-4.83, -2.24]
14 Mean differences between groups in diastolic blood pressure (mmHg)	6	2521	Mean Difference (IV, Random, 95% CI)	-1.79 [-2.45, -1.14]

Comparison 2. Exercise vs standard recommendations (overall analysis)

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Diabetes incidence - ITT (RR/HR)	2		risk/hazard ratio (Random, 95% CI)	0.69 [0.29, 1.65]
2 Diabetes incidence - ITT (OR/HR)	2		odds/hazard ratio (Random, 95% CI)	0.67 [0.29, 1.57]

Comparison 3. Exercise vs diet (overall analysis)

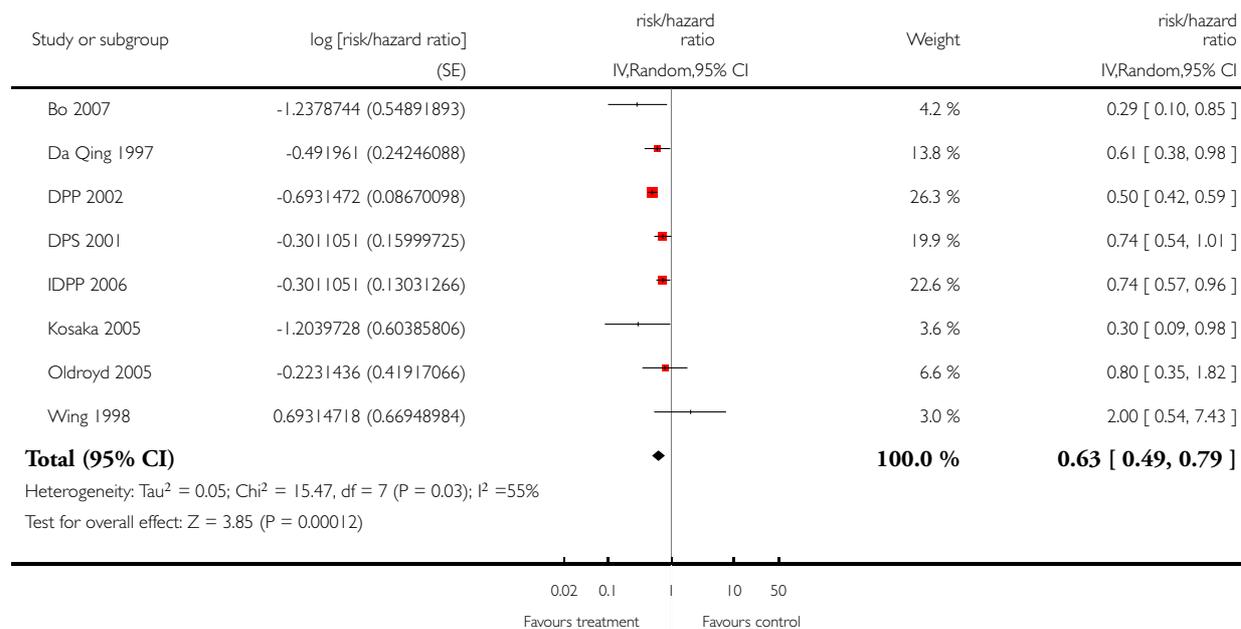
Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Diabetes incidence - ITT (RR/HR)	2		risk/hazard ratio (Random, 95% CI)	0.69 [0.37, 1.29]
2 Diabetes incidence - ITT (OR/HR)	2		odds/hazard ratio (Random, 95% CI)	0.65 [0.29, 1.44]

Analysis 1.1. Comparison 1 Exercise+diet vs standard recommendations (overall analysis), Outcome 1 Diabetes incidence - ITT (RR/HR).

Review: Exercise or exercise and diet for preventing type 2 diabetes mellitus

Comparison: 1 Exercise+diet vs standard recommendations (overall analysis)

Outcome: 1 Diabetes incidence - ITT (RR/HR)

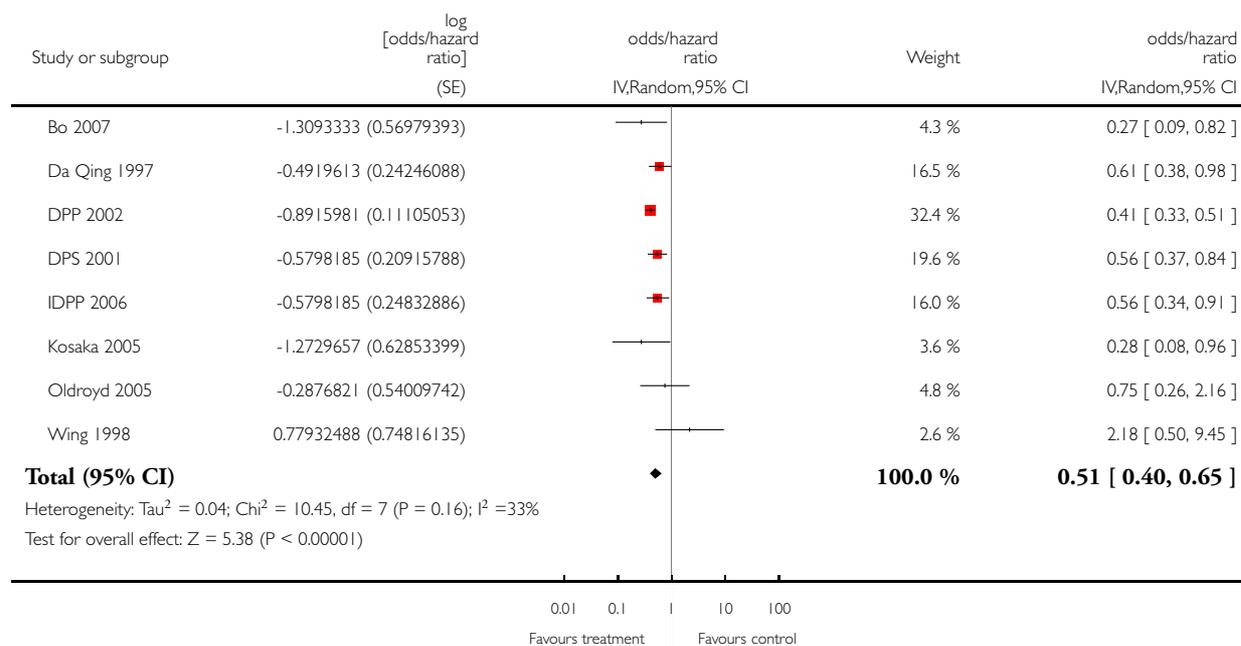


Analysis 1.2. Comparison 1 Exercise+diet vs standard recommendations (overall analysis), Outcome 2 Diabetes incidence - ITT (OR/HR).

Review: Exercise or exercise and diet for preventing type 2 diabetes mellitus

Comparison: 1 Exercise+diet vs standard recommendations (overall analysis)

Outcome: 2 Diabetes incidence - ITT (OR/HR)

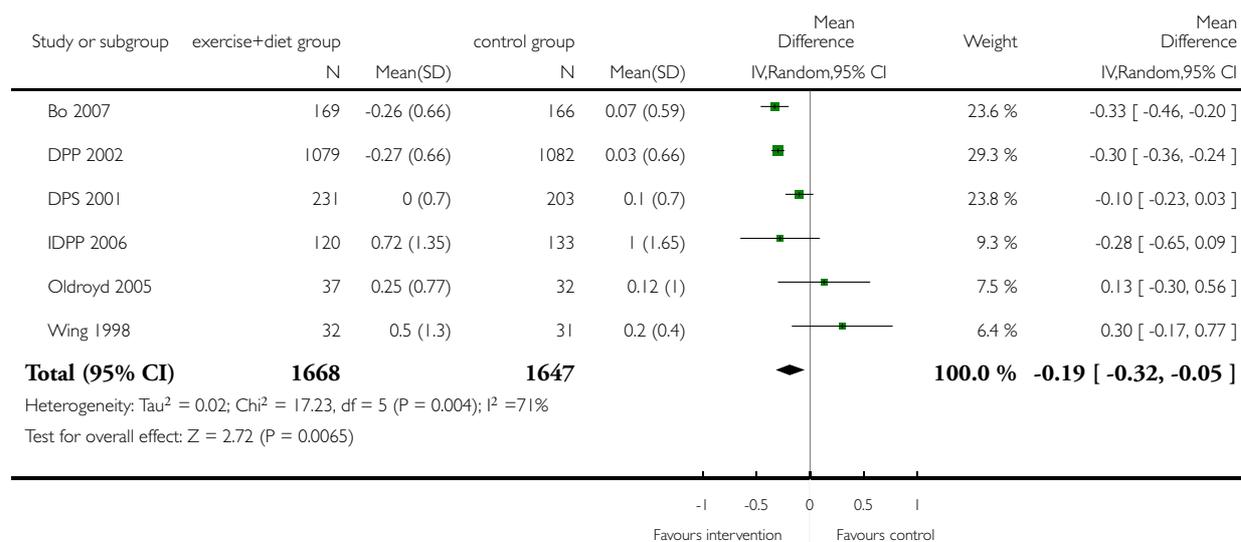


Analysis 1.3. Comparison 1 Exercise+diet vs standard recommendations (overall analysis), Outcome 3 Mean differences between groups in fasting plasma glucose (mmol/L).

Review: Exercise or exercise and diet for preventing type 2 diabetes mellitus

Comparison: 1 Exercise+diet vs standard recommendations (overall analysis)

Outcome: 3 Mean differences between groups in fasting plasma glucose (mmol/L)

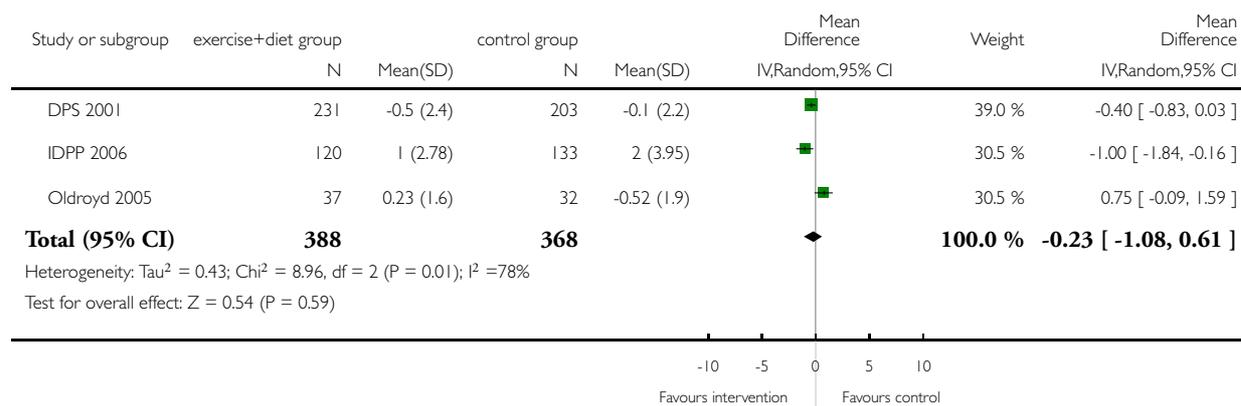


**Analysis 1.4. Comparison 1 Exercise+diet vs standard recommendations (overall analysis), Outcome 4
Mean differences between groups in 2-h plasma glucose (mmol/L).**

Review: Exercise or exercise and diet for preventing type 2 diabetes mellitus

Comparison: 1 Exercise+diet vs standard recommendations (overall analysis)

Outcome: 4 Mean differences between groups in 2-h plasma glucose (mmol/L)

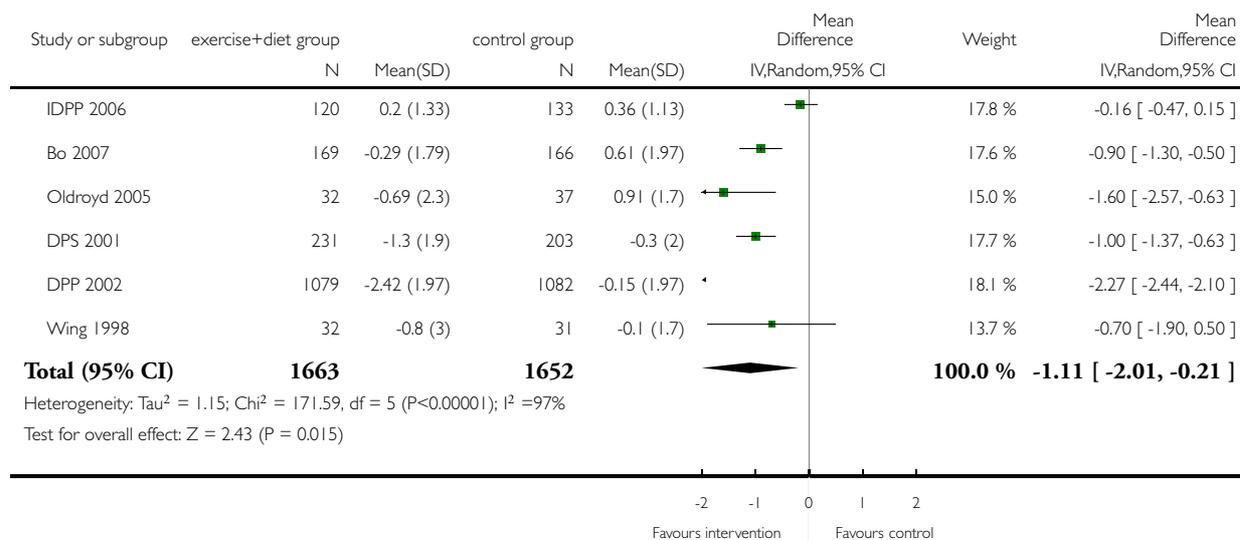


Analysis 1.5. Comparison 1 Exercise+diet vs standard recommendations (overall analysis), Outcome 5 Mean differences between groups in body mass index (BMI - kg/m2).

Review: Exercise or exercise and diet for preventing type 2 diabetes mellitus

Comparison: 1 Exercise+diet vs standard recommendations (overall analysis)

Outcome: 5 Mean differences between groups in body mass index (BMI - kg/m2)

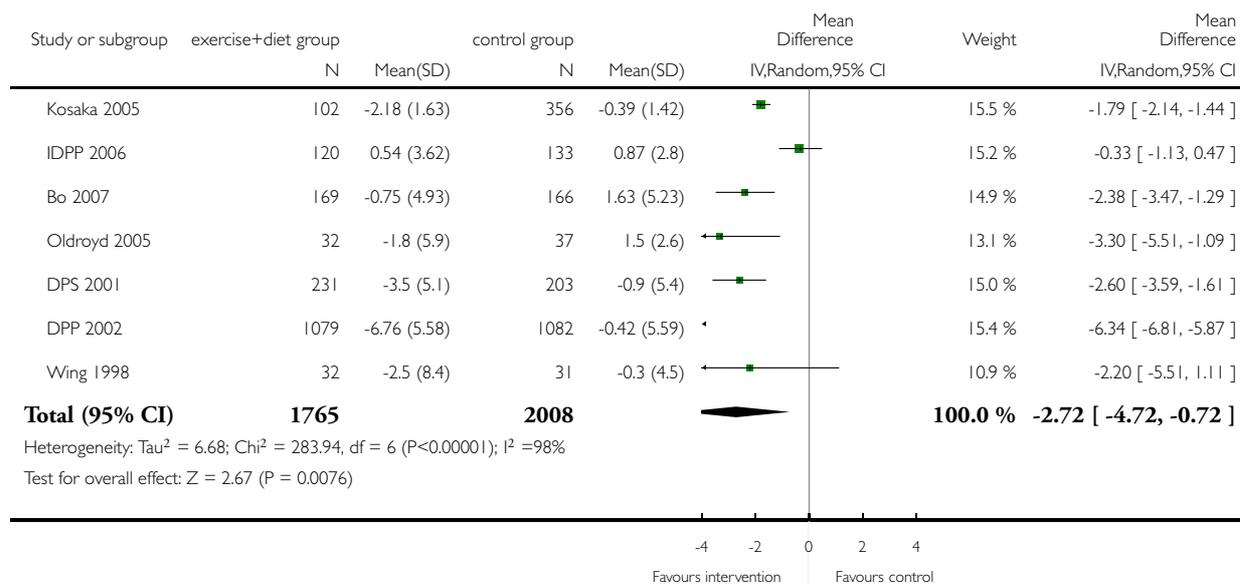


Analysis 1.6. Comparison 1 Exercise+diet vs standard recommendations (overall analysis), Outcome 6 Mean differences between groups in weight (kg).

Review: Exercise or exercise and diet for preventing type 2 diabetes mellitus

Comparison: 1 Exercise+diet vs standard recommendations (overall analysis)

Outcome: 6 Mean differences between groups in weight (kg)

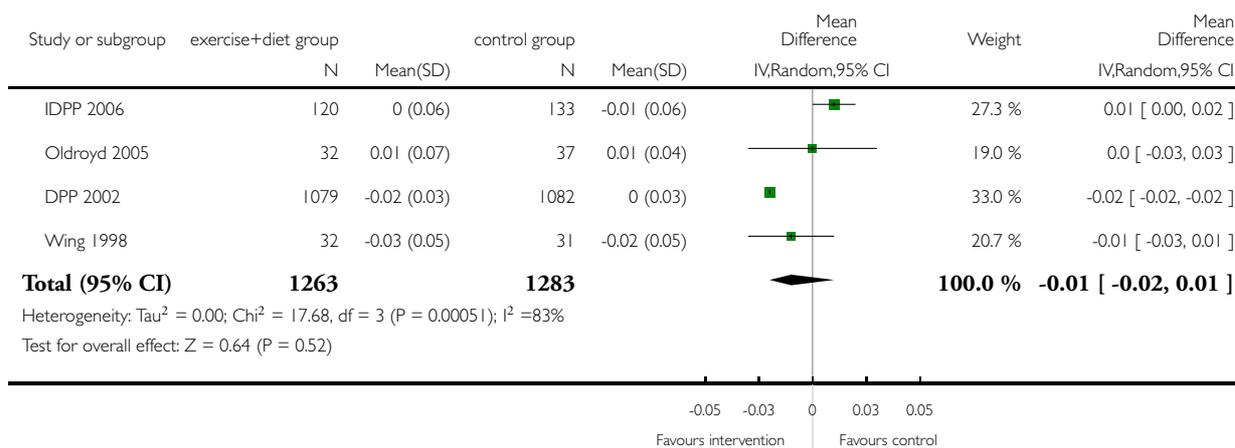


Analysis 1.7. Comparison 1 Exercise+diet vs standard recommendations (overall analysis), Outcome 7 Mean differences between groups in waist-to-hip ratio (WHR).

Review: Exercise or exercise and diet for preventing type 2 diabetes mellitus

Comparison: 1 Exercise+diet vs standard recommendations (overall analysis)

Outcome: 7 Mean differences between groups in waist-to-hip ratio (WHR)

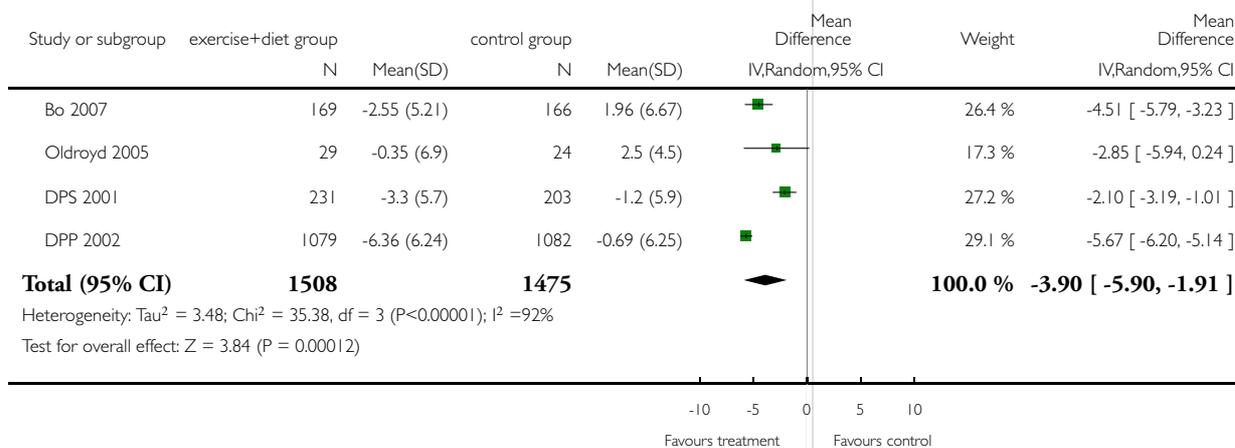


Analysis 1.8. Comparison 1 Exercise+diet vs standard recommendations (overall analysis), Outcome 8 Mean differences between groups in waist circumference (cm).

Review: Exercise or exercise and diet for preventing type 2 diabetes mellitus

Comparison: 1 Exercise+diet vs standard recommendations (overall analysis)

Outcome: 8 Mean differences between groups in waist circumference (cm)

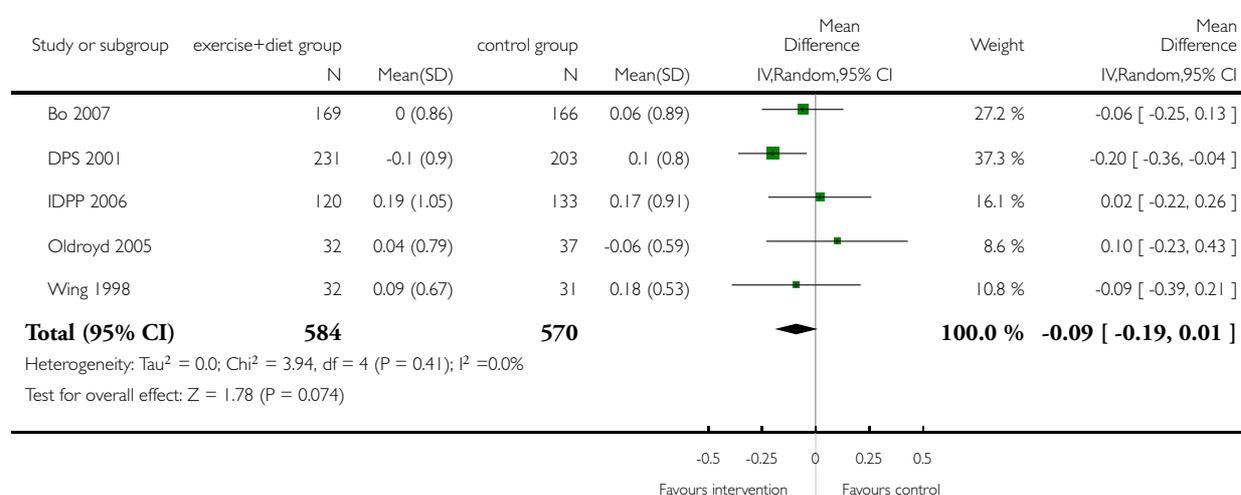


**Analysis 1.9. Comparison 1 Exercise+diet vs standard recommendations (overall analysis), Outcome 9
Mean differences between groups in total cholesterol (mmol/L).**

Review: Exercise or exercise and diet for preventing type 2 diabetes mellitus

Comparison: 1 Exercise+diet vs standard recommendations (overall analysis)

Outcome: 9 Mean differences between groups in total cholesterol (mmol/L)

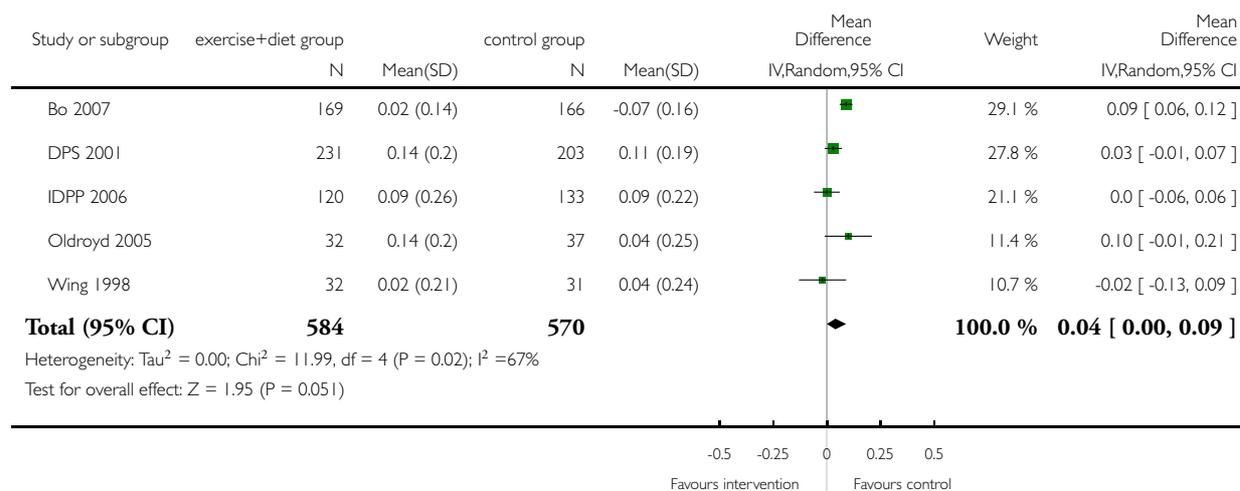


Analysis 1.10. Comparison 1 Exercise+diet vs standard recommendations (overall analysis), Outcome 10 Mean differences between groups in HDL cholesterol (mmol/L).

Review: Exercise or exercise and diet for preventing type 2 diabetes mellitus

Comparison: 1 Exercise+diet vs standard recommendations (overall analysis)

Outcome: 10 Mean differences between groups in HDL cholesterol (mmol/L)

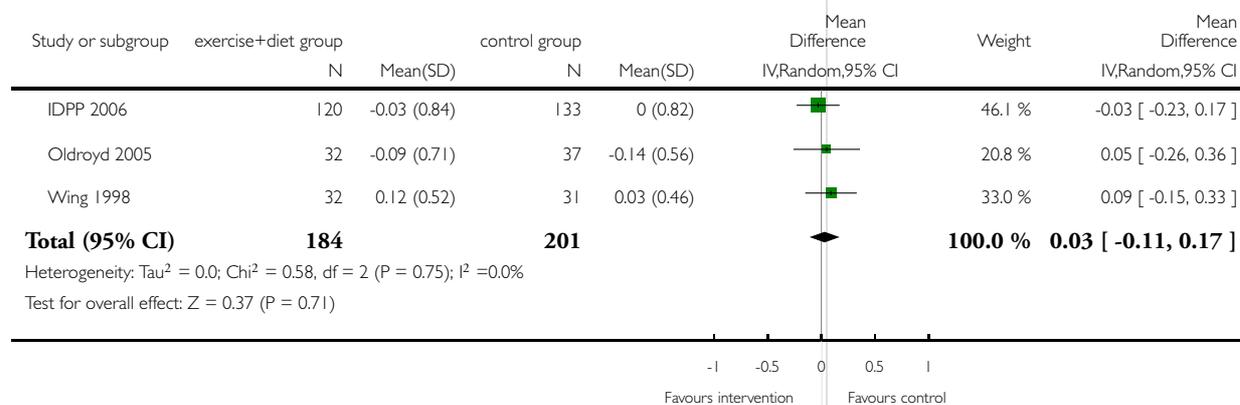


Analysis 1.11. Comparison 1 Exercise+diet vs standard recommendations (overall analysis), Outcome 11 Mean differences between groups in LDL cholesterol (mmol/L).

Review: Exercise or exercise and diet for preventing type 2 diabetes mellitus

Comparison: 1 Exercise+diet vs standard recommendations (overall analysis)

Outcome: 11 Mean differences between groups in LDL cholesterol (mmol/L)

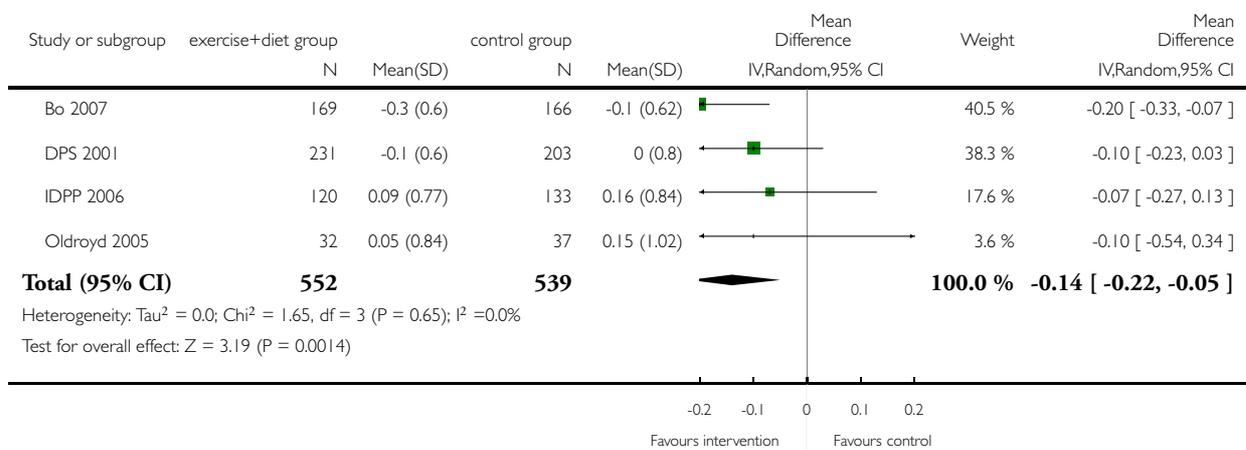


Analysis 1.12. Comparison 1 Exercise+diet vs standard recommendations (overall analysis), Outcome 12 Mean differences between groups in triglycerides (mmol/L).

Review: Exercise or exercise and diet for preventing type 2 diabetes mellitus

Comparison: 1 Exercise+diet vs standard recommendations (overall analysis)

Outcome: 12 Mean differences between groups in triglycerides (mmol/L)

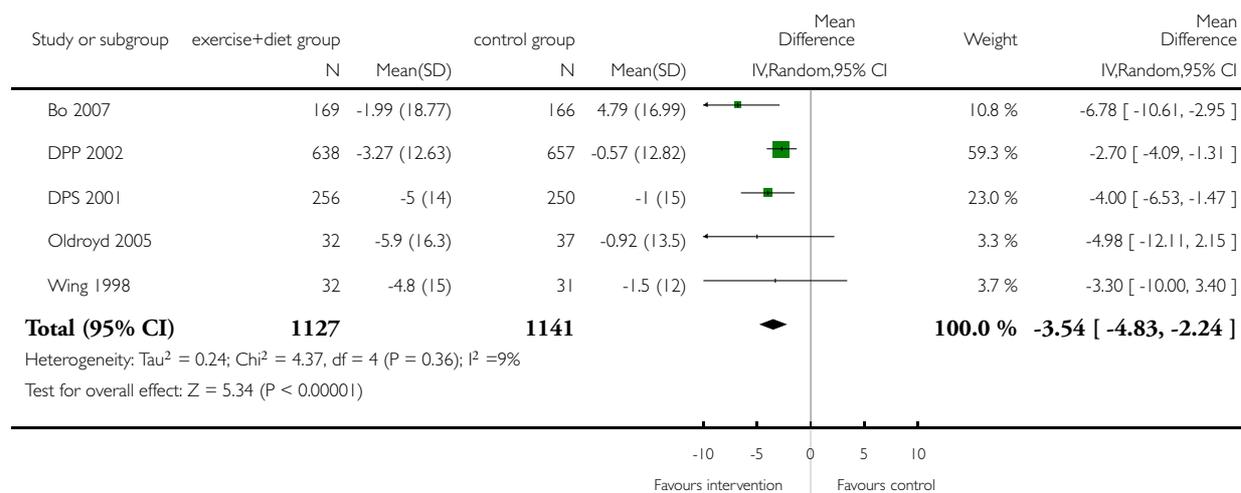


Analysis 1.13. Comparison 1 Exercise+diet vs standard recommendations (overall analysis), Outcome 13 Mean differences between groups in systolic blood pressure (mmHg).

Review: Exercise or exercise and diet for preventing type 2 diabetes mellitus

Comparison: 1 Exercise+diet vs standard recommendations (overall analysis)

Outcome: 13 Mean differences between groups in systolic blood pressure (mmHg)

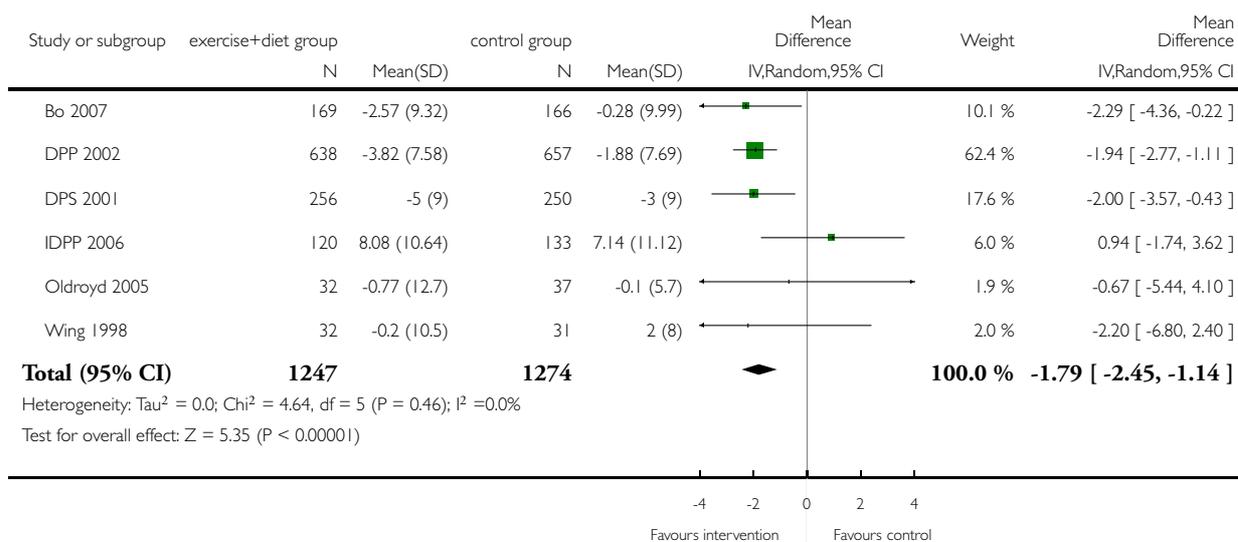


Analysis 1.14. Comparison 1 Exercise+diet vs standard recommendations (overall analysis), Outcome 14 Mean differences between groups in diastolic blood pressure (mmHg).

Review: Exercise or exercise and diet for preventing type 2 diabetes mellitus

Comparison: 1 Exercise+diet vs standard recommendations (overall analysis)

Outcome: 14 Mean differences between groups in diastolic blood pressure (mmHg)

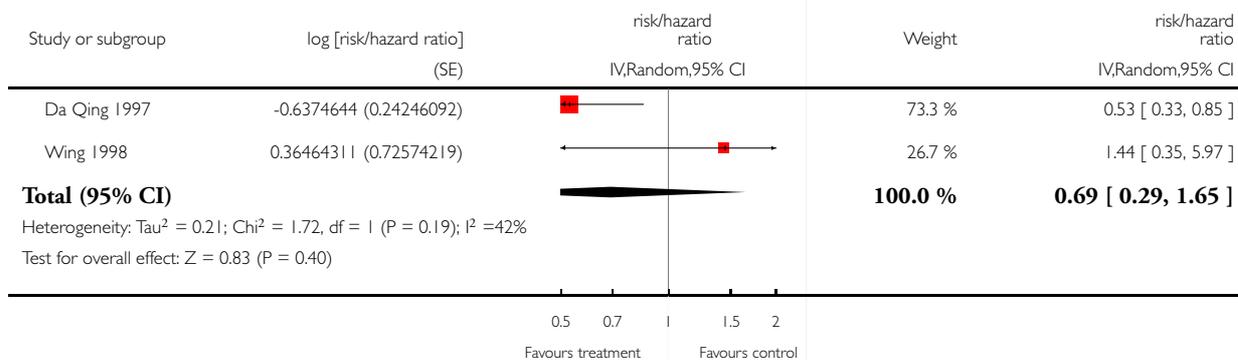


Analysis 2.1. Comparison 2 Exercise vs standard recommendations (overall analysis), Outcome 1 Diabetes incidence - ITT (RR/HR).

Review: Exercise or exercise and diet for preventing type 2 diabetes mellitus

Comparison: 2 Exercise vs standard recommendations (overall analysis)

Outcome: 1 Diabetes incidence - ITT (RR/HR)

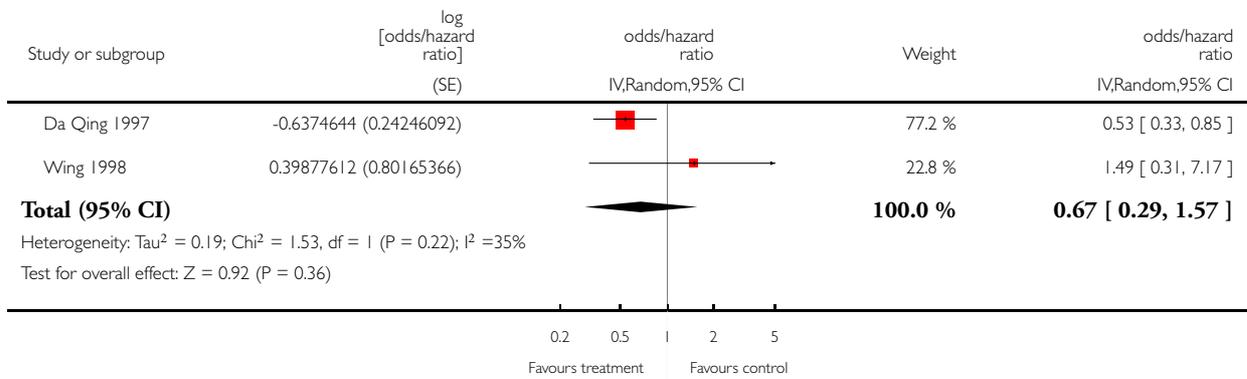


Analysis 2.2. Comparison 2 Exercise vs standard recommendations (overall analysis), Outcome 2 Diabetes incidence - ITT (OR/HR).

Review: Exercise or exercise and diet for preventing type 2 diabetes mellitus

Comparison: 2 Exercise vs standard recommendations (overall analysis)

Outcome: 2 Diabetes incidence - ITT (OR/HR)

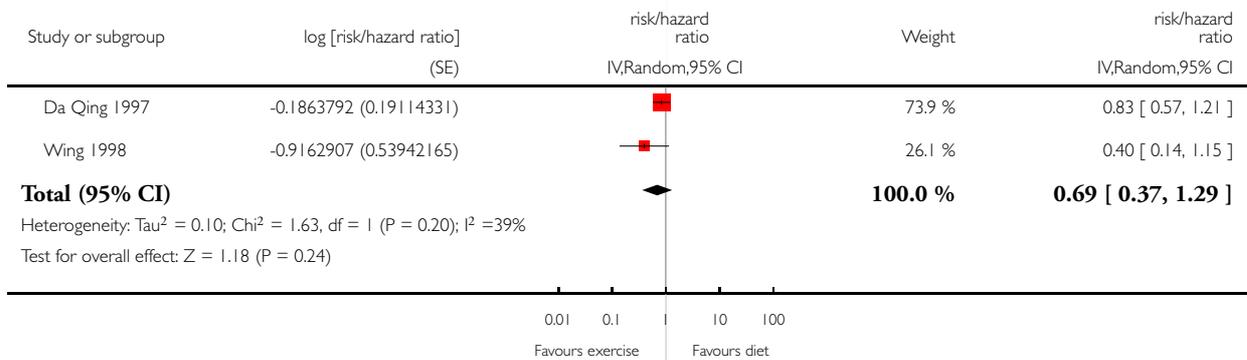


Analysis 3.1. Comparison 3 Exercise vs diet (overall analysis), Outcome 1 Diabetes incidence - ITT (RR/HR).

Review: Exercise or exercise and diet for preventing type 2 diabetes mellitus

Comparison: 3 Exercise vs diet (overall analysis)

Outcome: 1 Diabetes incidence - ITT (RR/HR)

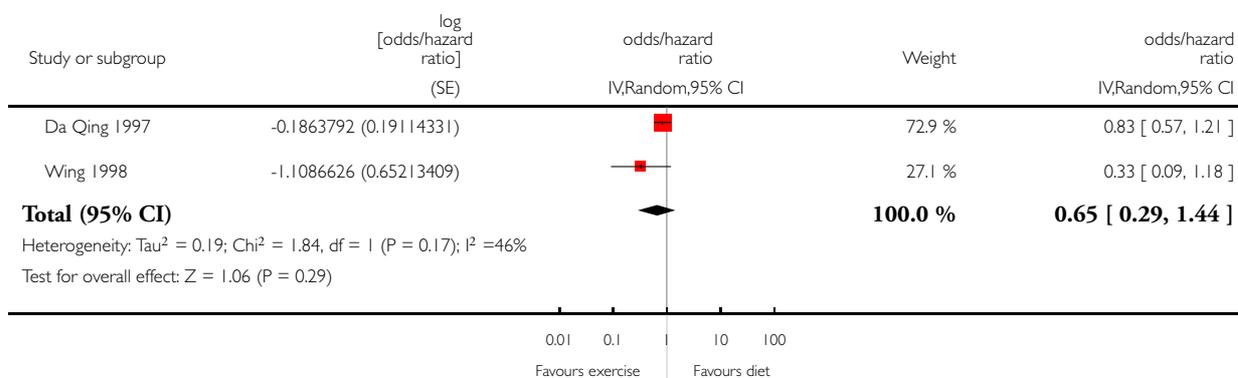


Analysis 3.2. Comparison 3 Exercise vs diet (overall analysis), Outcome 2 Diabetes incidence - ITT (OR/HR).

Review: Exercise or exercise and diet for preventing type 2 diabetes mellitus

Comparison: 3 Exercise vs diet (overall analysis)

Outcome: 2 Diabetes incidence - ITT (OR/HR)



ADDITIONAL TABLES

Table 1. Summary of main study characteristics

	Risk/hazard ratio IV, Random, 95% CI	Duration of inter- vention	Inclusion criteria	Diabetes diagnostic criteria	Compliance measure
Wing 1998	2.00 [0.54, 7.43]	2 years	- Age 40-50 years - Overweight (30-100% of ideal body weight) - 1 or 2 biological parents with type 2 diabetes.	FPG >7.78; 5 additional diabetes cases were found; when using new diagnostic criteria: FPG >7.0	Exercise: Paffenbarger Physical Activity Questionnaire and half-mile walk test (time to completion) VO ₂ max predicted using regression formulas. Diet: Black Food Frequency measure (6 month interval) and three day food diaries.

Table 1. Summary of main study characteristics (Continued)

Oldroyd 2005	0.80 [0.35, 1.82]	2 years	- Age 24-75 years - IGT (1985): 2hPG \geq 7.8 mmol/L <11.1 mmol/L	FPG \geq 7.8 mmol/L or 2hPG \geq 11.1 mmol/L	Exercise: Resting pulse, shuttle walking test and self reported physical activity
DPS 2001	0.74 [0.54, 1.01]	Mean 3.2 years	- Age 40-64 years - BMI >25 Kg/m ² - IGT (WHO 1985) 2hPG: 7.8-11.0 mmol/L FPG <7.8 mmol/L	WHO 1985	Monitored by individual interviews at each linial visit. Three day food records.
IDPP 2006	0.74 [0.57, 0.96]	3 years	- IGT (WHO 1999) 2hPG= 7.8-11.0 mmol/L (140-199 mg/dl) FPG <7.0 mmol/L (<126 mg/dl)	WHO 1999: FPG \geq 7.0 mmol/L (\geq 26 mg/dl) 2hPG \geq 11.1 mmol/L (\geq 200 mg/dl)	Adherence self reported, based on weekly pattern.
Da Qing 1997	0.61 [0.38, 0.98]	6 years	- IGT (WHO 1985) : 2hPG \geq 120 mg/dl and <200 mg/dl	FPG \geq 140 mg/dl (\geq 7.8 mmol/L) or 2hPG \geq 200 mg/dl (\geq 11.1 mmol/L)	Exercise and diet: quantified using standardized forms and interviews Three day food record.
DPP 2002	0.50 [0.42, 0.59]	Mean 2.8 years	- Age \geq 25y - BMI \geq 24 (=22 in asians) - FPG: 95-125 mg/dl (5.3-6.9 mmol/L) 2hPG: 140-199 mg/dl (7.8-11.0 mmol/l) ADA 1997	ADA 1997: FPG \geq 126 mg/dl (\geq 7.0 mmol/L) or 2hPG \geq 200 mg/dl (\geq 11.1 mmol/L)	Measuring % of participants achieving the goal of weight loss of 7% Physical activity: assessed on the basis of logs kept by the participants
Kosaka 2005	0.30 [0.09, 0.98]	4 years	- IGT (WHO 1980) FPG <140mg/dl 2hPG (100g OGTT): 160-239 mg/dl 140-199 mg/dl on 75g OGTT	FPG \geq 140 mg/dl	Changes in body weight and achievement of desirable body weight
Bo 2007	0.29 [0.10, 0.85]	1 year	- Age 45-64 years - Metabolic Syndrome	WHO 1985	Evaluating questionnaires and meeting attendance: Val-

Table 1. Summary of main study characteristics (Continued)

					idated semiquantitative food frequency questionnaire. - Minnesota-Leisure-Time-Physical-Activity questionnaire.
--	--	--	--	--	--

IGT: Impaired glucose tolerance; FPG: Fasting plasma glucose; 2hPG: 2 hours plasma glucose; OGTT: Oral glucose tolerance test; BMI: Body mass index

Table 2. Study populations

Study ID	[n] randomised	[n] safety	[n] ITT	[n] finished study	comments
Bo 2007	375	335	335	335	
Da Qing	577	541	530	530	Randomised numbers in each group not specified. Safety population reflects participants who were followed-up + deaths
DPP 2002	3234	3234	3234	2979	
DPS 2001	523	NR	475	475	Authors state that ITT analysis was performed but data are presented as a per protocol analysis
IDPP 2006	531	531	502	502	
Kosaka 2005	484	NR	458	458	ITT performed after the first year
Oldroyd 2005	78	77	54	54	Authors state that ITT analysis was performed but data are presented as a per protocol analysis
Wing 1998	154	NR	129	129	Analyses were completed only on the participants who attended the specific assessment

ITT: intention-to-treat; NR: not reported

APPENDICES

Appendix I. Search strategy

Search terms

Unless otherwise stated, search terms are free text terms; exp = exploded Mesh: Medical subject heading (Medline medical index term); \$ stands for 'any character(s)'; '?' to substitute for one or no characters; tw = text word; ot: original title; pt = publication type; adj = adjacency

Part I: Exercise and Diet

- 1 exp Health Behavior/
- 2 exp Health Promotion/
- 3 exp exercise/ or exp exercise therapy/
- 4 exp Exertion/
- 5 exp Sports/
- 6 exp Physical Fitness/
- 7 exp Diet Therapy/
- 8 exp Feeding Behavior/
- 9 exp Diet/
- 10 exp "Physical Education and Training"/
- 11 exp Life Style/
- 12 exp Health Education/
- 13 (lifestyl\$ or life styl\$).tw,ot.
- 14 (health\$ adj6 (behav\$ or educ\$ or promot\$)).tw,ot.
- 15 (exercis\$ or physic\$ activit\$ or exert\$ or physic\$ fit\$ or sport\$).tw,ot
- 16 (walk\$ or jog\$ or swim\$ or bicyc\$ or cycling or weight lift\$ or gymnastic or danc\$).tw,ot.
- 17 ((strength or resistance or circuit or enduran\$ or aerob\$ or physic\$ or fit\$) adj6 train\$).tw,ot.
- 18 (nutri\$ or diet\$ or food or eat\$).tw,ot.
- 19 or/1-18

Part II: Risk factors

- 20 exp risk factors/
- 21 exp Risk Reduction Behavior/
- 22 (risk adj6 (factor\$ or reduction\$ or high)).tw,ot.
- 23 or/20-22

Part III: I AND II

- 24 19 and 23

Part IV: Prevention

- 25 exp Preventive Medicine/
- 26 exp Preventive Health Services/
- 27 (prevent\$ or prophyla\$ or avoid\$).tw,ot.
- 28 or/25-27

Part V: III AND IV

- 29 24 and 28

(Continued)

Part VI: Diabetes mellitus, type 2

- 30 exp Diabetes Mellitus, Type 2/
- 31 exp Diabetes Complications/
- 32 (MODY or NIDDM or T2DM).tw,ot.
- 33 (non insulin\$ depend\$ or noninsulin\$ depend\$ or noninsulin?depend\$ or non insulin?depend).tw,ot.
- 34 ((typ\$ 2 or typ\$ II) adj3 diabet\$).tw,ot.
- 35 ((keto?resist\$ or non?keto\$) adj6 diabet\$).tw,ot.
- 36 ((late or adult\$ or matur\$ or slow or stabl\$) adj3 onset).mp. and diabet\$.tw,ot. [mp=title, original title, abstract, name of substance word, subject heading word]
- 37 or/30-36
- 38 exp Diabetes Insipidus/
- 39 diabet\$ insipidus.tw,ot.
- 40 38 or 39
- 41 37 not 40

Part VII: V AND VI

- 42 29 and 41

Part VIII: RCT's/CCT's, meta-analysis, reviews, and hta

- 43 exp Randomized Controlled Trials as topic/
- 44 Randomized Controlled Trial.pt.
- 45 exp Controlled Clinical Trials as topic/
- 46 Controlled Clinical Trial.pt.
- 47 exp Random Allocation/
- 48 exp Double-Blind Method/
- 49 exp Single-Blind Method/
- 50 or/43-49
- 51 exp Clinical Trials as topic/
- 52 Clinical Trial.pt.
- 53 (clinic\$ adj25 trial\$).tw,ot.
- 54 ((singl\$ or doubl\$ or trebl\$ or tripl\$) adj3 (mask\$ or blind)).tw,ot
- 55 exp Placebos/
- 56 (placebo\$ or random).tw,ot.
- 57 exp Research Design/
- 58 (latin adj3 square).tw,ot.
- 59 or/51-58
- 60 comparative study.pt.
- 61 exp Evaluation Studies as topic/
- 62 Evaluation Studies.pt.
- 63 exp Follow-Up Studies/
- 64 exp Prospective Studies/
- 65 (control\$ or prospectiv\$ or volunteer\$).tw,ot.
- 66 exp Cross-Over Studies/
- 67 or/60-66
- 68 50 or 59 or 67
- 69 exp "Review Literature as topic"/
- 70 exp Technology Assessment, Biomedical/
- 71 exp Meta-analysis as topic/

(Continued)

- 72 Meta-analysis.pt.
 73 hta.tw,ot.
 74 (health technology adj6 assessment\$.tw,ot.
 75 (meta analy\$ or metaanaly\$ or meta?analy\$).tw,ot.
 76 ((review\$ or search\$) adj10 (literature\$ or medical database\$ or medline or pubmed or embase or chochrane or cinhal or psychinfo or psychlit or healthstar or biosis or current content\$ or systemat\$)).tw,ot.
 77 or/69-76
 78 68 or 77
Part IX: VII AND VIII
 79 42 and 78

For the database Lilacs we used the following search strategy:

1. diabet\$
2. (prevenç\$ OR prevenc\$ OR profila\$ OR preventi\$ OR prophila\$)
3. ((Pt randomized controlled trial OR Pt controlled clinical trial OR Mh randomized controlled trials OR Mh random allocation OR Mh double-blind method OR Mh single-blind method) AND NOT (Ct animal AND NOT (Ct human and Ct animal)) OR (Pt clinical trial OR Ex E05.318.760.535\$ OR (Tw clin\$ AND (Tw trial\$ OR Tw ensa\$ OR Tw estud\$ OR Tw experim\$ OR Tw investiga\$)) OR ((Tw singl\$ OR Tw simple\$ OR Tw doubl\$ OR Tw doble\$ OR Tw duplo\$ OR Tw trebl\$ OR Tw trip\$) AND (Tw blind\$ OR Tw cego\$ OR Tw ciego\$ OR Tw mask\$ OR Tw mascar\$)) OR Mh placebos OR Tw placebo\$ OR (Tw random\$ OR Tw randon\$ OR Tw casual\$ OR Tw acaso\$ OR Tw azar OR Tw aleator\$) OR Mh research design) AND NOT (Ct animal AND NOT (Ct human and Ct animal)) OR (Ct comparative study OR Ex E05.337\$ OR Mh follow-up studies OR Mh prospective studies OR Tw control\$ OR Tw prospectiv\$ OR Tw volunt\$ OR Tw volunteer\$) AND NOT (Ct animal AND NOT (Ct human and Ct animal)))
4. 1 AND 2 AND 3

Appendix 2. Details of study features

Characteristic	Bo 2007	Da Qing	DPP	DPS	IDPP	Kosaka 2005	Oldroyd 2005	Wing 1998
Intervention 1: exercise group (I1) / intervention 2: exercise + diet group (I2) / Intervention (I3) / control group 1 (C1)	I2: Exercise+diet C1: Standard recommendations	I1: Exercise I2: Exercise+diet I3: Diet C1: Standard recommendations	I2: Exercise+diet I3: Metformin C1: Placebo+standard recommendation	I2: Exercise+diet C1: Standard recommendation	I2: Exercise+diet I3: Exercise+diet + metformin I4: Metformin C1: Standard recommendation	I2: Exercise+diet C1: Standard recommendation	I2: Exercise+diet C1: No intervention	I1: Exercise, I2: Exercise + diet I3: Diet C1: Standard recommendations

(Continued)

Randomised controlled clinical trial (RCT)	Y	Y	Y	Y	Y	Y	Y	Y
Non-inferiority / equivalence trial	N	N	N	N	N	N	N	N
Controlled clinical trial	Y	Y	Y	Y	Y	Y	Y	Y
Design: parallel, crossover, factorial RCT	Parallel	Parallel	Parallel	Parallel	Parallel	Parallel	Parallel	Parallel
Design: crossover study	N	N	N	N	N	N	N	N
Design: factorial study	N	N	N	N	N	N	N	N
Crossover study: wash-out phase	NA	NA	NA	NA	NA	NA	NA	NA
Crossover study: carryover effect tested	NA	NA	NA	NA	NA	NA	NA	NA
Crossover study: period effect tested	NA	NA	NA	NA	NA	NA	NA	NA
Method of randomisation (specify)	Automatically performed using an SAS program with stratification according to age, sex, education	NR	Adaptative (urn method)	Randomization list, with stratification according to centre, sex and mean 2hPG	NR	NR	Random number table	NR

(Continued)

	level, general practitioner, area of residence, and number of metabolic syndrome components							
Unit of randomisation (individuals, cluster - specify)	Members of the same family who lived and ate together were considered as a cluster the rest as individuals	By clusters. 33 health care clinics in a city in China.	Individuals	Individuals	Individuals	Individuals	Individuals	Individuals
Randomisation stratified for centres	N	NR	Y	Y	NR	NA	NA	NR
Randomisation ratio	1:1	1:1:1:1	1:1:1	1:1	1:1:1:1	1:4	1:1	1:1:1:1
Concealment of allocation (specify)	Random allocation with minimization algorithm was centrally performed in a single step. The researchers then received the two lists of nominative data	NR	NR	No (randomisation by the study physician with a randomisation list)	NR	NR	Researchers performing the randomisation were blind to the group allocation	NR
Stated blinding (open; single, double, triple blind)	NA	NR	Partially blinded (Masking of medication treatment groups)	Partially blinded	NR	NR	NR	NR

(Continued)

Actual blinding: participant	N	N	N (I2); Y (I3, C1)	N	N	N	N	N
Actual blinding: care-giver / treatment administrator	N	N	N (I2); Y (I3, C1)	N	N	N	N	N
Actual blinding: outcome assessor	Family physicians, the physicians who collected data, the dietitian, and the laboratory personnel were blinded to the group assignment	N	N	Laboratory staff did not know the subjects' group assignments. Participants were blinded to their plasma glucose concentrations during follow-up unless diabetes was diagnosed	N	N	N	Scoring of assessment was done blinded to treatment condition and phase
Actual blinding: others	N	N	Participants and investigators remain masked to primary outcome data until progression to diabetes is confirmed	N	Principal investigators were blinded to the interim results and to the outcome until they were asked to close the study	N	N	N
Blinding checked: participant	NA	NA	N	NA	NA	NA	NA	NA
Blinding checked: care-	NA	NA	N	NA	NA	NA	NA	NA

(Continued)

giver / treatment administrator								
Primary endpoint defined	Y: Between-group change in metabolic syndrome prevalence	Y: Development of diabetes	Y: Development of diabetes	Y: Development of diabetes	Y: Development of diabetes	Y: Development of diabetes	NR	NR
[n] of primary endpoint(s)	1	1	1	1	1	1	NA	0
[n] of secondary endpoints	19 (changes in dietary intake, exercise, weight, waist, BMI, SBP, DBP, fasting glucose, total cholesterol, HDL cholesterol, triglycerides, fasting insulin, HOMA, Hs-CRP, uric acid, diabetes, IFG, overweight)	1 (changes in diet and exercise)	11 (glycaemia, β -cell function and insulin sensitivity, cardiovascular risk profile, cardiovascular disease, kidney function, physical activity/nutrition/body composition, health-related quality of life, safety, health economics)	6 (glucose tolerance, insulin values, cardiovascular risk factors, cardiovascular risk score, cardiovascular morbidity and mortality, quality of life)	6 (body weight, waist circumference, adherence to diet/physical activity/drug prescription, adverse events)	2 (body weight, glucose tolerance)	11 (Nutrient intake; resting pulse, shuttle walking test and self reported physical activity; anthropometry and clinical variables; glucose tolerance; insulin sensitivity, c-peptide and intact proinsulin concentrations; serum lipid concentrations)	3 (weight, CHD risk factors and diabetes)
Total [n] of endpoints	20	2	12	7	7	3	11	3
Prior publication of study design	N	N	Y	N	N	N	N	N
Outcomes of prior and current pub-	NA	NA	Y (main outcome)	NA	NA	NA	NA	NA

(Continued)

lication identical								
Power calculation	Y	N	Y	Y	Y	N	Y	N
[n] participants per group calculated	375	NA	944	542 to be followed-up for 6 years or 650 subjects followed for 5 years	134	NA	50	NA
Non-inferiority trial: interval for equivalence specified	NA	NA	NA	NA	NA	NA	NA	NA
Intention-to-treat analysis (ITT)	Y (not for incidence of diabetes)	N	Y	Y	N	N	Y	N
Per-protocol-analysis	Y	Y	N	N	Y	N	N	Y
ITT defined	Y (assuming none of the refusals had improved during the study)	NA	Y (include all participants in their randomly assigned treatment group regardless of adherence to the assigned treatment regimen)	Y (include all participants in their randomly assigned treatment group regardless of adherence to the assigned treatment regimen)	NA	N	N	NA
Missing data: last-observation-carried-forward (LOCF)	NA	NA	N	NA	NA	NA	NA	NA
Missing data: other	NA	NA	Yes (censoring)	Yes (censoring)	NA	NA	NA	NA

(Continued)

methods								
LOCF defined	NA	NA	NA	NA	NA	NA	NA	NA
[n] of screened participants (I1/ I2 / I3/ C1 / total)	1658	110660	158177 (for 4 arms, 1 treatment later discontinued)	NR	10839	NR	498	184
[n] of randomised participants (for primary endpoint)	I2:187 C1: 188 Total: 375	577	I2: 1079 I3: 1073 C1: 1082 Total: 3234	I2: 265 C1: 257 Total: 523 (one patient excluded, as- signed group unknown)	I2: 133 I3: 129 I4: 133 C1: 136 Total: 531	I2: 107 C1: 377 To- tal:484 (esti- mated by re- viewers)	I2: 39 C1:39 Total:78	I1: 37 I2: 40 I3: 37 C1: 40 Total:154
[n] of participants finishing the study	I2: 169 C1: 166 Total: 335	I1: 141 I2: 126 I3: 130 C1: 133 Total: 530	NR	I2:238 C1: 237 Total: 475	I2: 120 I3: 121 I4: 128 C1:133 Total: 502	I2: 102 C1: 356 Total: 458	At 24 months: I2: 30 C1:24 Total: 54	I1: 31 I2: 32 I3: 35 C1: 31 Total: 129
[n] of patients analysed (for primary endpoint)	I2: 169 C1: 166 Total: 335	I1: 141 I2: 126 I3: 130 C1: 133 Total: 530	I2: 1079 I3: 1073 C1: 1082 Total: 3234	I2:238 C1: 237 Total: 475	I2: 120 I3: 121 I4: 128 C1:133 Total: 502	I2: 102 C1: 356 Total: 458	I2: 37, CG: 32 at 6 month; I2: 32, CG: 30 at 12 month; I2: 30, CG: 24 at 24 month	I1: 31 I2: 32 I3: 35 C1: 31 Total: 129
Description of discontinuing participants	Y	Y	N	Y	Y	N	Y, at 6 months	N
Drop-outs (reasons explained)	Y	Y	N	Y	N	N	Y	N
Withdrawals (reasons explained)	Y	Y	N	Y	Y	N	Y	N

(Continued)

Losses-to-follow-up (reasons explained)	Y	Y	N	N	N	N	Y	N
[n] of participants who discontinued (refused to participate before starting the intervention)	I2: 18 C1: 22 (refused to participate before starting the intervention)	47	255	I2: 23 C1: 17 total: 41	I2: 13 I3: 8 I4: 5 C1: 3 total: 29	I2: 7 C1: 32 total: 39	I2: 9 C1: 15 total: 24	I1: 6 I2: 8 I3: 2 C1: 9 total: 25
[%] discontinuation rate	I2: 9.6 C1: 11.7 total: 10.7	8	8	I2: 8.7 C1: 6.6 total: 7.8	I2: 9.6 I3: 6 I4: 3.9 C1: 2.2 total: 5.5	I2: 6.5 C1: 8.5 total: 8	I2: 23 C1: 38 total: 31	I1: 16.2 I2: 20.0 I3: 5.4 C1: 22.5 total: 16.2
Discontinuation rate similar between groups	Y	NR	NR	Y	N	Y	N	N
[%] crossover between groups	NR	NR	NR	NR	NR	NR	NR	NR
Adjustment for multiple outcomes / repeated measurements	NA	NA	NA	NA	NA	NA	NA	NA
Baseline characteristics: clinically relevant differences	N	N	N	N	Family history of diabetes more prevalent in control group	N	Y: % reporting engaging in regular physical activity sufficient to get their heart thumping at least once a week (24%: 53%).	N

(Continued)

							Proportion of men is higher in the control group.	
Treatment identical (apart from intervention)	Y	Y	Y	Y	Y	Y	Y	Y
Compliance measured	Y	Y	Y	Y	Y	Y	Y	Y
Other important covariates measured (specify)	N	BMI	N	genetic factors	age, sex, family history of diabetes, baseline BMI, waist circumference, baseline 2-h and fasting plasma glucose, insulin values, hypertension and smoking	age, sex, baseline BMI, family history of diabetes, 2-h and fasting plasma glucose	age, sex	N
Co-morbidities measured	N	N	N	N	N	N	N	N
Co-mediations measured	N	N	N	N	N	N	N	N
Specific doubts about study quality	N	N	N	N	N	N	N	N
Funding: commercial		N	Y (Bristol-Myers Squibb, Parke-Davis)	N	Y (M/S US Vitamins)	N	N	N

(Continued)

Funding: non-commercial	N	Y (The World Bank, Ministry of Public Health of The People's Republic of China)	Y (NIDDK, Office of Research on Minority Health, National Institute of Child Health and Human Development, National Institute on Aging, Indian Health Service, CDCP, American Diabetes Association)	Y (Academy of Finland, Ministry of Education of Finland, novo Nordisk Foundation, Yrjö Jahns-son Foundation, Finnish Diabetes Research Foundation)	N	N	Y (British Heart Foundation, Northern & Yorkshire NHS Research and Development, Royal College of General Practitioners)	Y (NIH, Obesity/Nutrition Research Centre, General Clinical Research Center)
Publication status: peer review journal	Y	Y	Y	N	Y	Y	Y	Y
Publication status: journal supplement	N	N	N	N	N	N	N	N
Publication status: abstract	N	N	N	N	N	N	N	N
Publication status: other	N	N	N	N	N	N	N	N
Notes								
<p><i>Symbols & abbreviations:</i> Y: yes; N: no; NR: not reported; NA: non applicable; RCT: randomised controlled trial; BMI: body mass index; SBP: systolic blood pressure; DBP: diastolic blood pressure; IFG: Impaired fasting glucose</p>								

Appendix 3. Baseline characteristics

Characteristics	Bo 2007	Da Qing 1997	DPP 2002	DPS 2001	IDPP 2006	Kosaka 2005	Oldroyd 2005	Wing 1998
Intervention 1 (I1) / Intervention 2 (I2) / Control 1 (C1)	I2: Exercise+diet C1: Standard recommendations	I1: Exercise I2: Exercise+diet I3: Diet C1: Standard recommendations	I2: Exercise+diet I3: Metformin C1: Placebo+standard recommendation	I2: Exercise+diet C1: Standard recommendation	I2: Exercise+diet I3: Exercise+diet + metformin I4: Metformin C1: Standard recommendation	I2: Exercise+diet C1: Standard recommendation	I2: Exercise+diet C1: No intervention	I1: Exercise I2: Exercise + diet I3: Diet C1: Standard recommendations
[n] (I1/I2/C1/Total)	(187/188/375)	(141/126/130/133/530)	(1079/1073/1082/3234)	(265/257/523)	(133/129/133/136/531)	(107/377/483)	(39/39/78)	(37/40/37/40/154)
Sex [n] (%)	I2: female 99 (58.6); male 70 (41.4) C1: female 96 (57.8); male: 70 (42.2)	I1: female 60 (43); male 81 (57); I2: female 56 (44); male 70 (56); I3: female 71 (55); male 59 (45) C1: female 60 (45); male 73 (55)	I2: female 734 (68); male 345 (32); I3: female 710 (66); male 363 (34); C1: female 747 (69); male 335 (31)	I2: female 174 (66); male 91 (34); C1: female 176 (68); male 176 (32)	I2: female 29 (21); male 104 (79); I3: female 24 (19); male 105 (81); I4: female 26 (20); male 107 (80); C1: female 32 (24); male 104 (76)	I2: female 0 (0); male 102 (100); C1: female 0 (0); male 356 (100)	I2: female 20 (54); male 17 (46); C1: female 10 (31); male 22 (69)	I1: female 30 (81); male 7 (19) I2: female 31 (77); male 9 (23) I3: female 8 (22) male 29 (78) C1: female 32 (80); male 8 (20)
Age [years] mean (SD)	I2: 55.7 (5.7) C1: 55.7 (5.6)	I1: 44.2 (8.7); I2: 44.4 (9.2); I3: 44.7 (9.4); C1: 46.5 (9.3)	I2: 50.6 (11.3); I3: 50.9 (10.3); C1: 50.3 (10.4)	I2: 55 (7); C1: 55 (7)	I2: 46.1 (5.7); I3: 46.3 (5.7); I4: 45.9 (5.9); C1: 45.2 (5.7)	NR	I2: 58.1 (52.1) C1: 57.5 (44.7)	I1: 46.4 (4.5) I2: 46.3 (3.8) I3: 45.0 (4.7) C1: 45.3 (4.9)
Ethnic groups [%]	NR	I1: Asian 100 I2: Asian 100	I2: White 53.8; African American	NR	I2: Asian Indian 100 I3: Asian Indian 100	I2: Asian 100 C1: Asian 100	I2: White 100 C1: White 100	NR

(Continued)

		I3: Asian 100 C1: Asian 100	18.9; Hispanic 16.5; American Indian 5.6; Asian 5.3; I3: Caucasian 56.1; African-American 20.6; Hispanic 15.1; American Indian 4.8; Asian-American 3.4 C1: White 54.2; African American 20.3; Hispanic 15.5; American Indian 5.5; Asian 4.5		I4: Asian Indian 100 C1: Asian Indian 100			
Body mass index [kg/m ²] mean (SD)	I2: 29.7 (4.1) C1: 29.8 (4.6)	I1: 25.4 (3.7) I2: 26.3 (3.9) I3: 25.3 (3.8) C1: 26.2 (3.9)	I2: 33.9 (6.8) I3: 33.9 (6.6) C1: 34.2 (6.7)	I2: 31.3 (4.6); C1: 31.0 (4.5)	I2: 25.7 (3.3) I3: 25.6 (3.3) I4: 25.6 (3.7) C1: 26.3 (3.7)	I2: 24.0 (2.3) C1: 23.8 (2.1)	I2: 30.4 (5.6) C1: 29.9 (4.9)	I1: 36.0 (3.7) I2: 35.7 (4.1) I3: 36.1 (4.1) C1: 36.0 (5.4)
FPG [mmol/L] mean (SD)	I2: 5.8 (0.8) C1: 5.8 (0.7)	I1: 5.56 (0.83) I2: 5.67 (0.80) I3: 5.56 (0.81) C1: 5.52 (0.82)	I2: 5.90 (0.45) I3: 5.9 (0.5) C1: 5.92 (0.47)	I2: 6.05 (0.78) C1: 6.11 (0.72)	I2: 5.4 (0.7) I3: 5.4 (0.8) I4: 5.4 (0.8) C1: 5.5 (0.8)	I2: 6.27 (0.42) C1: 6.22 (0.47)	I2: 6.05 (0.89) C1: 6.16 (0.89)	I1: 6.0 (0.7) I2: 5.8 (0.5) I3: 6.0 (0.5) C1: 5.9 (0.6)
2hPG [mmol/L] mean (SD)	NR	I1: 8.83 (0.79) I2: 9.11 (0.93)	I2: 9.13 (0.93) I3: 9.16 (0.95)	I2: 8.82 (1.50) C1: 8.83 (1.44)	I2: 8.5(0.7) I3: 8.5 (0.7) I4: 8.5 (0.7) C1: 8.5(0.7)	NR	I2: 9.15 (0.89) C1: 9.22 (0.92)	NR

(Continued)

		I3: 9.03 (0.94) C1: 9.03 (0.89)	C1: 9.13 (0.95)					
Weight (Kg)	I2: 81.7 (14.9) C1: 81.3 (13.5)	NR	I2: 94 (20.8) I3: 94.3 (19.9) C1: 94.3 (20.2)	I2: 86.7 (14.0) C1: 85.5 (14.4)	NR	NR	I2: 85.3 (17.9) C1: 85.5 (14.2)	I1: 99.3 (15.3); I2: 98.7 (15.9); I3: 99.6 (13.0); C1: 97.4 (16.0)
Total cholesterol (mmol/L)	I2: 5.8 (1.1) C1: 6.0 (1.1)	NR	Total: 5.3	I2: 5.6 (1.0) C1: 5.6 (0.9)	I2: 5.2 (0.9) I3: 5.1 (0.9) I4: 5.2 (1.0) C1: 5.1 (0.9)	I2: 5.54 (1.09) C1: 5.56 (0.99)	I2: 5.6 (1.1) C1: 5.7 (1.0)	I1: 4.97 (0.69) I2: 5.01 (0.78) I3: 5.19 (0.94) C1: 4.81 (0.83)
Triglycerides (mmol/L)	I2: 1.9 (0.9) C1: 1.9 (0.9)	NR	NR	I2: 1.7 (0.8) C1: 1.7 (0.8)	I2: 2.0 (1.4) I3: 1.8 (0.9) I4: 1.7 (0.9) C1: 1.9 (1.2)	I2: 1.52 (0.56) C1: 1.51 (0.97)	I2: 1.9 (1.6-2.2) C1: 2.2 (1.9-2.5)	I1: 3.70 (2.21) I2: 3.40 (2.07) I3: 4.08 (3.11) C1: 3.02 (1.30)
HDL cholesterol (mmol/L)	I2: 1.4 (0.3) C1: 1.4 (0.3)	NR	NR	I2: 1.2 (0.3) ; C1: 1.2 (0.3)	NR	I2: 1.35 (0.36) C1: 1.33	I2: 1.2 (0.42) C1: 1.1 (0.36)	I1: 1.12 (0.23) I2: 1.22 (0.27) I3: 1.17 (0.29) C1: 1.19 (0.36)
LDL cholesterol (mmol/L)	NR	NR	Total: 3.2	NR	NR	NR	I2: 3.6 (1.1) C1: 3.6 (1.0)	I1: 3.12 (0.62) I2: 3.11 (0.81) I3: 3.35 (0.83) C1: 3.02 (0.81)

(Continued)

Waist-to-hip ratio (WHR)	NR	NR	I2: 0.92 (0.08) I3: 0.93 (0.09) C1: 0.93 (0.09)	NR	NR	NR	I2: 0.93 (0.09) C1: 0.96 (0.08)	I1: 0.9 (0.1) I2: 0.9 (0.1) I3: 0.9 (0.1) C1: 0.9 (0.1)
Waist circumference (cm)	I2: 99.6 (11.6) C1: 99.8 (10.6)	NR	I2: 105.1 (14.8) I3: 104.9 (14.4) C1: 105.2 (14.3)	I2: 102.0 (11.0) C1: 100.5 (10.9)	NR	NR	I2: 99.0 (12.0) C1: 99.6 (11.3)	NR
Systolic blood pressure (mmHg)	I2: 142.6 (14.1) C1: 141.5 (15.2)	NR	I2: 123.7 (14.8) I3: 124.0 (14.9) C1: 123.5 (14.4)	I2: 140 (18) C1: 136 (17)	I2: 121.5 (14.4) I3: 122.4 (14.3) I4: 120.7 (15.9) C1: 124.1 (16.0)	I2: 123 (18) C1: 124 (17)	I2: 137.2 (19.9) C1: 132.8 (16.4)	I1: 116.2 (18.1) I2: 119.7 (15.0) I3: 116.4 (13.7) C1: 114 (12.1)
Diastolic blood pressure (mmHg)	I2: 88.2 (8.8) C1: 87.8 (9.5)	NR	I2: 78.6 (9.2) I3: 78.2 (9.5) C1: 78.0 (9.2)	I2: 86 (9) C1: 86 (10)	I2: 74.4 (8.1) I3: 74.9 (8.1) I4: 74.4 (9.2) C1: 76.2 (8.6)	I2: 78 (13) C1: 79 (11)	I2: 77.0 (12.6) C1: 75.5 (9.8)	I1: 75.6 (12.7) I2: 76.7 (9.3) I3: 75.1 (8.9) C1: 72.1 (9.3)
Notes								

Symbols & abbreviations:

Y: yes; N: no; NR: not reported; I: intervention; C: control; FPG: fasting plasma glucose, 2hPG: 2 hour plasma glucose

Appendix 4. Adverse events

Characteristic	Bo 2007	Da Qing	DPP	DPS	IDPP	Kosaka 2005	Oldroyd 2005	Wing 1998
Intervention 1 (I1) / intervention 2 (I2) / con-	I2: Exercise+diet C1: Stand-	I1: Exercise I2: Exercise+diet	I2: Exercise+diet I3:	I2: Exercise+diet C1: Stand-	I2: Exercise+diet I3: Ex-	I2: Exercise+diet C1: Stand-	I2: Exercise+diet C1: No in-	I1: Exercise I2: Exercise+diet

(Continued)

Control 1 (C1)	Standard recommendations	I3: Diet C1: Standard recommendations	Metformin C1: Placebo+standard recommendation	Standard recommendation	Exercise + diet+metformin I4: Metformin C1: Standard recommendation	Standard recommendation	Intervention	C1: Standard recommendation
[n] of participants who died	NR	I1: 0 I2: 5 C1: 3 total: 8	I2: 3 C1: 5 total: 8	NR	I2: 1 C1: 1 total: 2	NR	I2: 1 C1: 0 total: 1	NR
[n] adverse events (I1 / I2 / C1 / total)	NR	NR	Musculoskeletal symptoms: I2: 728 C1: 639 total: 1367 Gastrointestinal symptoms: I2: 390 C1: 930 total: 1320	NR	Cardiovascular events: I2: 4 C1: 2 total: 6	NR	NR	NR
[%] adverse events	NR	NR	Musculoskeletal symptoms: I2: 67 C1: 59 total: 63 Gastrointestinal symptoms: I2: 36 C1: 86 total: 61	NR	Cardiovascular events: I2: 3.3 C1: 1.5 total: 2.4	NR	NR	NR
[n] serious adverse events	NR	NR	NR	NR	NR	NR	NR	NR
[%] serious adverse events	NR	NR	NR	NR	NR	NR	NR	NR

(Continued)

[n] drop-outs due to adverse events	NR	I1: 0 I2: 0 C1: 0 total: 0	NR	NR	NR	NR	NR	NR
[%] drop-outs due to adverse events	NR	I1: 0 I2: 0 C1: 0 total: 0	NR	NR	NR	NR	NR	NR
<i>Symbols & abbreviations:</i> NR: not reported; I: intervention; C: control								

Appendix 5. Primary outcome data

Study	Diabetes incidence	Morbidity
Bo 2007 I2: exercise + diet, n/N (%) C1: control, n/N (%)	1 year of follow-up: I2: 3/169 (1.8) C1: 12/166 (7.2)	Not investigated
Da Qing 1997 I1: exercise, n/N (%) I2: exercise + diet, n/N (%) C1: control, n/N (%)	6 years of follow-up: I1: 58/144 (40) I2: 58/126 (46) I3: 62/130 (48) C1: 89/133 (67)	Not investigated
DPP 2002 I2: diet + exercise, n/N (%) C1: control, n/N (%)	Mean 2.8 years of follow-up: I2: 155/1079 (14) C1: 313/1082 (29)	3 years of follow-up: Death because of CVD: I2: 2/1079 (0.2) C1: 4/1082 (0.4) Nonfatal CVD events: I2: 24/1079 (2.2) (n estimated by the authors) C1: 18/1082 (1.7)
DPS 2001 I2: exercise + diet, n/N (%) C1: control, n/N (%)	Mean 3.2 years of follow-up (end of intervention): I2: 44/241 (18) C1: 72/239 (30) Median 7 years of follow-up: I2: 75/238 (32) C1: 110/237 (46)	Not investigated

(Continued)

IDPP 2006 I2: diet + exercise, n/N (%) C1: control, n/N (%)	1 year of follow-up: I2: 20/120 (17)* C1: 34/133 (26)* 2 years of follow-up: I2: 29/120 (24)* C1: 52/133 (39)* 3 years of follow-up: I2: 47/120 (39) C1: 73/133 (55)	Not investigated
Kosaka 2005 I2: diet + exercise, n/N (%) C1: control, n/N (%)	4 years of follow-up: I2: 3/102 (3) C1: 33/356 (9)	Not investigated
Oldroyd 2005 I2: diet + exercise, n/N (%) C1: control, n/N (%)	1 year of follow-up: I2: 4/37 (11)* C1: 6/32 (19)* 2 years of follow-up: I2: 7/37 (19) C1: 8/32 (25)	Not investigated
Wing 1998 I1: exercise, n/N (%) I2: exercise + diet, n/N (%) C1: control, n/N (%)	2 years of follow-up: I1: 4/31 (13) I2: 5/32 (16) I3: 10/35 (31) C1: 2/31 (6)	Not investigated
Notes		
<i>Symbols & abbreviations:</i> I: intervention; C: control; *non published data		

Appendix 6. Secondary outcome data

Characteristic	Bo 2007	Da Qing 1997	DPP 2002	DPS 2001	IDPP 2006	Kosaka 2005	Oldroyd 2005	Wing 1998
Fasting plasma glucose (mmol/L)	1 year of follow-up: I2: -0.26 (0.66)	6 years of follow-up: I1: 1.27 (3.84)	1 year of follow-up: I2: -0.27 (0.66)	1 year of follow-up: I2: -0.22 (0.67)	1 year of follow-up: I2: 0.04 (0.92)*	NR	1 year of follow-up: I2: 0.03 (0.6)	1 year of follow-up: I1: 0.1 (0.7) I2: 0.0 (0.5)

(Continued)

	C1: 0.07 (0.59)	I2: 1.48 (2.42) I3: 1.38 (4.14) C1: 2.07 (2.29)	C1: 0.03 (0.66)	C1: 0.06 (0.67) 2 years of follow-up: I2: -0.1 (0.7) C1: 0.2 (0.8) 3 years of follow-up: I2: 0.0 (0.7) C1: 0.1 (0.7)	C1: 0.29 (1.34)* 2 years of follow-up: I2: 0.33 (1.24)* C1: 0.68 (1.53)* 3 years of follow-up: I2: 0.72 (1.35)* C1: 1.00 (1.65)*		C1: 0.08 (0.97) 2 years of follow-up: I2: 0.25 (0.77) C1: 0.12 (1.00)	I3: 0.2 (0.8) C1: 0.0 (0.6) 2 years of follow-up: I1: 0.4 (0.9) I2: 0.5 (1.3) I3: 0.3 (1.0) C1: 0.2 (0.4)
2-h plasma glucose (mmol/L)	NR	6 years of follow-up: I1: 1.68 (3.60) I2: 1.65 (3.98) I3: 1.48 (4.49) C1: 3.96 (3.82)	NR	1 year of follow-up: I2: -0.84 (1.9) C1: -0.28 (2.24) 2 years of follow-up: I2: -0.8 (2.1) C1: 0.0 (2.5) 3 years of follow-up: I2: -0.50 (2.40) C1: -0.1 (2.20)	1 year of follow-up: I2: 0.06 (2.02)* C1: 0.81 (3.25)* 2 years of follow-up: I2: 0.36 (2.65)* C1: 1.48 (3.22)* 3 years of follow-up: I2: 1.00 (2.78)* C1: 2.00 (3.95)*	NR	1 year of follow-up: I2: -0.63 (1.6) C1: 0.22 (1.9) 2 years of follow-up: I2: 0.23 (1.60) C1: -0.52 (1.90)	NR
Body mass index (BMI-kg/m ²)	1 year of follow-up: I2: -0.29 (1.79) C1: 0.61 (1.97)	NR	1 year of follow-up: I2: -2.42 (1.97) C1: -0.15 (1.97)	1 year of follow-up: I2: -1.6 (1.8) C1: -0.4 (1.3) 3 years of follow-up: I2: -1.3 (1.9) C1: -0.3 (2.7)*	1 year of follow-up: I2: 0.08 (1.14)* C1: 0.25 (1.08)* 2 years of follow-up: I2: 0.19 (1.7)*	NR	1 year of follow-up: I2: -0.36 (1.6)* C1: 0.59 (1.2)* 2 years of follow-up: I2: -0.69 (2.7)	1 year of follow-up: I1: -0.1 (1.8) I2: -2.7 (3.4) I3: -2.0 (2.5) C1: -0.2 (1.7)

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				0)	C1: 0.35 (1.14)* 3 years of follow-up: I2: 0.20 (1.33)* C1: 0.36 (1.13)*		3)* C1: 0.91 (1.70)*	2 years of follow-up: I1: 0.4 (1.7) I2: -0.80 (3.0) I3: -0.8 (2.8) C1: -0.1 (1.7)
Weight (kg)	1 year of follow-up: I2: -0.75 (4.93) C1: 1.63 (5.23)	NR	1 year of follow-up: I2: -6.76 (5.58) C1: -0.42 (5.59)	1 year of follow-up: I2: -4.2 (5.1) C1: -0.8 (3.7) 2 years of follow-up: I2: -3.5 (5.5) C1: -0.8 (4.4) 3 years of follow-up: I2: -3.5 (5.1) C1: -0.9 (5.4)	1 year of follow-up: I2: 0.24 (2.99)* C1: 0.64 (2.71)* 2 years of follow-up: I2: 0.43 (4.6)* C1: 0.71 (2.7)* 3 years of follow-up: I2: 0.54 (3.62)* C1: 0.87 (2.8)*	4 years of follow-up: I2: -2.18 (1.63) C1: -0.39 (1.42)	1 year of follow-up: I2: -1.1 (3.4) C1: 1.5 (2.6) 2 years of follow-up: I2: -1.8 (5.9) C1: 1.5 (2.6)	1 year of follow-up: I1: -0.4 (4.8) I2: -7.4 (9.7) I3: -5.5 (6.9) C1: -0.3 (4.5) 2 years of follow-up: I1: 1.0 (4.7) I2: -2.5 (8.4) I3: -2.1 (7.6) C1: -0.3 (4.5)
Waist-to-hip ratio (WHR)	NR	NR	1 year of follow-up: I2: -0.021 (0.033) C1: -0.002 (0.033)	NR	1 year of follow-up: I2: -0.01 (0.07)* C1: -0.01 (0.05)* 2 years of follow-up: I2: -0.002 (0.07)* C1: -0.01 (0.07)* 3 years of follow-up:	NR	1 year of follow-up: I2: 0.01 (0.07)* C1: -0.03 (0.15)* 2 years of follow-up: I2: 0.01 (0.07)* C1: 0.01 (0.04)*	2 years of follow-up: I1: -0.02 (0.05) I2: -0.03 (0.05) I3: -0.03 (0.06) C1: -0.02 (0.05)

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					I2: 0.004 (0.063)* C1: -0.01 (0.06)*			
Waist circumference (cm)	1 year of follow-up: I2: -2.55 (5.21) C1: 1.96 (6.67)	NR	1 year of follow-up: I2: -6.36 (6.24) C1: -0.69 (6.25)	1 year of follow-up: I2: -4.4 (5.2) C1: -1.3 (4.8) 3 years of follow-up: I2: -3.3 (5.7) C1: -1.2 (5.9)	NR	NR	1 year of follow-up: I2: 0.45 (4.8) C1: -0.23 (5.5) 2 years of follow-up: I2: 2.5 (4.5) C1: -0.35 (6.9)	NR
Total cholesterol (mmol/L)	1 year of follow-up: I2: -0.0006 (0.86) C1: 0.06 (0.89)	NR	NR	1 year of follow-up: I2: -0.13 (0.73) C1: -0.1 (0.73) 3 years of follow-up: I2: -0.1 (0.9) C1: 0.1 (0.8)	1 year of follow-up: I2: -0.02 (0.98)* C1: -0.06 (0.73)* 2 years of follow-up: I2: -0.21 (0.92)* C1: 0.04 (0.86)* 3 years of follow-up: I2: 0.19 (1.05)* C1: 0.17 (0.91)*	NR	1 year of follow-up: I2: -0.12 (0.62) C1: -0.12 (0.63) 2 years of follow-up: I2: 0.04 (0.79) C1: -0.06 (0.59)	1 year of follow-up: I1: 0.36 (0.82) I2: 0.32 (0.64) I3: 0.26 (0.76) C1: 0.39 (0.70) 2 years of follow-up: I1: 0.33 (0.64) I2: 0.09 (0.67) I3: -0.12 (0.61) C1: 0.18 (0.53)
HDL cholesterol (mmol/L)	1 year of follow-up: I2: 0.02 (0.14) C1: -0.07 (0.16)	NR	NR	1 year of follow-up: I2: 0.05 (0.18) C1: 0.03 (0.16) 3 years of follow-up:	1 year of follow-up: I2: 0.02 (0.19)* C1: 0.04 (0.19)* 2 years of	NR	1 year of follow-up: I2: 0.60 (0.21)* C1: 0.08 (0.25)* 2 years of	1 year of follow-up: I1: 0.16 (0.18) I2: 0.12 (0.20) I3: 0.10 (0.16)

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				I2: 0.14 (0.2) C1: 0.11 (0.19)	follow-up: I2: 0.04 (0.21)* C1: 0.06 (0.17)* 3 years of follow-up: I2: 0.09 (0.26)* C1: 0.09 (0.22)*		follow-up: I2: 0.14 (0.20)* C1: 0.04 (0.25)*	C1: 0.08 (0.16) 2 years of follow-up: I1: 0.05 (0.17) I2: 0.02 (0.21) I3: 0.02 (0.20) C1: 0.04 (0.24)
LDL cholesterol (mmol/L)	NR	NR	NR	NR	1 year of follow-up: I2: 0.07233 (0.87)* C1: -0.0562 (0.59)* 2 years of follow-up: I2: -0.19 (0.89)* C1: -0.12 (0.68)* 3 years of follow-up: I2: -0.027 (0.84)* C1: -0.0035 (0.82)*	NR	1 year of follow-up: I2: -0.11 (0.58) C1: -0.13 (0.69) 2 years of follow-up: I2: -0.09 (0.71) C1: -0.14 (0.56)	1 year of follow-up: I1: 0.15 (0.54) I2: 0.14 (0.54) I3: 0.12 (0.73) C1: 0.24 (0.66) 2 years of follow-up: I1: 0.22 (0.61) I2: 0.12 (0.52) I3: -0.16 (0.63) C1: 0.03 (0.46)
Triglycerides (mmol/L)	1 year of follow-up: I2: -0.3 (0.6) C1: -0.1 (0.62)	NR	NR	1 year of follow-up: I2: -0.2 (0.56) C1: -0.01 (0.66) 3 years of follow-up: I2: -0.1 (0.6) C1: 0.0 (0.8)	1 year of follow-up: I2: -0.22 (1.39)* C1: -0.03 (1.32)* 2 years of follow-up: I2: -0.18 (1.39)* C1: 0.28 (2.27)*	NR	1 year of follow-up: I2: -0.2 (1.15)* C1: -0.1 (1.33)* 2 years of follow-up: I2: 0.05 (0.84)* C1: 0.15 (1.27)*	NR

(Continued)

					3 years of follow-up: I2: 0.09 (0.77)* C1: 0.16 (0.84)*		02)*	
Systolic blood pressure (mmHg)	1 year of follow-up: I2: -1.99 (18.77) C1: 4.79 (16.99)	NR	1 year of follow-up: I2: -3.4 (12.81) C1: -0.9 (12.82) 2 years of follow-up: I2: -3.4 (12.65) C1: -0.52 (12.74) 3 years of follow-up: I2: -3.27 (12.63) C1: -0.57 (12.82)	1 year of follow-up: I2: -5 (14) C1: -1 (15)	1 year of follow-up: I2: 1.28 (15.98)* C1: -1.95 (15.15)* 2 years of follow-up: I2: -1.57 (15.41)* C1: -2.56 (16.22)* 3 years of follow-up: I2: -0.82 (15.48)* C1: -3.99 (15.81)*	NR	1 year of follow-up: I2: -6.5 (18.9)* C1: 2.3 (12.5)* 2 years of follow-up: I2: -5.9 (16.3)* C1: -0.92 (13.5)*	1 year of follow-up: I1: 1.1 (15.8) I2: -2.9 (14.2) I3: 1.3 (8.3) C1: 1.1 (9.6) 2 years of follow-up: I1: 0.9 (13.9) I2: -4.8 (15.0) I3: -0.8 (9.4) C1: -1.5 (12.0)
Diastolic blood pressure (mmHg)	1 year of follow-up: I2: -2.57 (9.32) C1: -0.28 (9.99)	NR	1 year of follow-up: I2: -3.6 (6.41) C1: -0.89 (6.41) 2 years of follow-up: I2: -3.33 (6.32) C1: -1.07 (6.37) 3 years of follow-up: I2: -3.82 (7.58) C1: -1.88 (7.69)	1 year of follow-up: I2: -5 (9) C1: -3 (9)	1 year of follow-up: I2: -0.92 (11.35)* C1: -2.48 (9.33)* 2 years of follow-up: I2: 3.33 (11.76)* C1: 1.28 (12.15)* 3 years of follow-up: I2: 8.08 (10.64)* C1: 7.14 (11.12)*	NR	1 year of follow-up: I2: -2.9 (9.9)* C1: 1.9 (9.0)* 2 years of follow-up: I2: -0.77 (12.7)* C1: -0.10 (5.7)*	1 year of follow-up: I1: 0.9 (9.7) I2: -1.0 (10.2) I3: 3.4 (8.1) C1: 4.9 (8.2) 2 years of follow-up: I1: 2.0 (8.0) I2: -0.2 (10.5) I3: 3.0 (7.8) C1: 2.0 (8.0)

(Continued)

Notes
<i>Symbols & abbreviations:</i> NR: not reported; I: intervention; C: control; *non published data

WHAT'S NEW

Last assessed as up-to-date: 29 February 2008.

Date	Event	Description
13 March 2008	Amended	Converted to new review format.

HISTORY

Protocol first published: Issue 2, 2001

Review first published: Issue 3, 2008

CONTRIBUTIONS OF AUTHORS

OROZCO LJ: searching for trials, quality assessment of trials, data extraction, data analysis.

BUCHLEITNER AM: searching for trials, quality assessment of trials, data extraction, data analysis, review development.

GIMENEZ-PEREZ G: protocol development, searching for trials, review development.

ROQUE M: quality assessment of trials, data extraction, data analysis, review development.

RICHTER B: protocol development, quality assessment of trials, data analysis, review development.

MAURICIO D: protocol development, searching for trials, quality assessment of trials, data analysis, review development.

DECLARATIONS OF INTEREST

None known.

SOURCES OF SUPPORT

Internal sources

- Corporacio Parc Taulí, Spain.
- Hospital de la Santa Creu i Sant Pau, Spain.
- Hopital Universitari Arnau de Vilanova, Spain.
- Institut de Recerca Biomèdica de Lleida, Spain.

External sources

- Agència d'Avaluació de Tecnologia i Recerca Mèdiques, Departament de Salut de la Generalitat de Catalunya, Spain.
- The review was supported by Grant No. 075/23/06

DIFFERENCES BETWEEN PROTOCOL AND REVIEW

Background has been updated significantly.

Risk of bias of studies assessment has substituted the quality of studies assessment defined in the protocol. This was done for adapting the review to RevMan 5 and the *Cochrane Handbook for Systematic Reviews of Interventions Version 5.0.0* ([Higgins 2008](#)).

INDEX TERMS

Medical Subject Headings (MeSH)

*Diet; *Exercise; Combined Modality Therapy [methods]; Diabetes Mellitus, Type 2 [*prevention & control]; Diabetic Diet; Randomized Controlled Trials as Topic

MeSH check words

Humans