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**Interventions for prevention of type 2 diabetes in relatives: A systematic review**

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**Abstract**

The relatives and partners of people with type 2 diabetes are at increased risk of developing type 2 diabetes. This systematic review examines randomized controlled trials, written in English that tested an intervention, which aimed to modify behaviors known to delay or prevent type 2 diabetes, among the relatives or partners of people with type 2 diabetes. Study quality was assessed using the Cochrane Collaboration's tool for assessing risk of bias. Seven studies met the inclusion criteria. The majority of studies were at low risk of bias. Six studies tested an intervention in first-degree relatives of people with type 2 diabetes and one in partners. Intervention components and intervention intensity across studies varied, with those targeting diet and physical activity reporting the most significant changes in primary outcomes. Only one study did not observe significant changes in primary outcomes. There were three main recruitment approaches: advertising in the community, recruiting people through their relatives with diabetes, or identifying people as high risk by screening of their own health care contacts. Some evidence was found for potentially successful interventions to prevent type 2 diabetes among the relatives and partners of people with type 2 diabetes, although finding simple and effective methods to identify and recruit them remains a challenge. Future studies should explore the effect of patients' perceptions on their family members' behavior and capitalize on family relationships in order to increase intervention effectiveness.

### Introduction

First-degree relatives of people with type 2 diabetes are at increased risk of developing this condition, with offspring and siblings at a three-fold higher risk than the general population [1, 2, 3]. This increased risk has genetic and environmental components, the latter likely arising from shared risk factors such as sedentary lifestyle, physical inactivity and obesity [4]. Co-habiting partners are also at high risk from these shared risk factors [5]. Prevention studies in people at high risk provide compelling evidence that type 2 diabetes can be prevented or delayed with lifestyle modifications, such as increase in physical activity and healthy diet, and weight loss [6 -10]. Identifying and intervening in the relatives of people with type 2 diabetes is important and could therefore form part of an effective diabetes prevention strategy [11-13].

For diabetes prevention among relatives and partners of people with type 2 diabetes to form part of such an intervention strategy, the feasibility of identifying and recruiting these high-risk people needs to be established. In terms of intervention effectiveness, only one narrative review to date has synthesized evidence on interventions to reduce the risk of type 2 diabetes in people with a family history [7]. This review included studies of different designs, but it did not assess study quality and neither did it synthesize evidence relating to partners of people with this condition. The authors concluded that health promotion in people with family history of type 2 diabetes is under-researched and family history is rarely used to initiate or promote behavior change. The current systematic review therefore examines published randomized-controlled trials (RCTs) in order to identify successful recruitment and intervention strategies for type 2 diabetes prevention in relatives and partners of people with type 2 diabetes.

### Methods

#### Search strategy and information sources

The selected databases were MEDLINE, PsychINFO, CINAHL, ASSIA and ProQuest and search terms included “random\* control\* trial\*”, “RCT”, “type 2 diabetes”, “non-insulin dependent diabetes”, “NIDDM”, “family+”, “spouse\*”, “partner\*”, “sibling\*”, “parent\*” and “offspring\*”. All databases were searched from inception until August 2016. The reference lists of all included studies were then searched by hand to identify any additional relevant studies.

#### Study selection

RCTs were included if they aimed to modify behaviors known to delay or prevent type 2 diabetes (e.g. physical activity, healthy diet) that were delivered to the relatives and/or partners of people with type 2 diabetes. Studies were excluded if they were not RCTs, if they were feasibility studies or protocols, or if the participants did not have a relative/partner with type 2 diabetes (or if this was not reported). Inclusion/exclusion criteria were applied in a two-step process, screening titles and abstracts before screening full text (Figure 1). The search identified one trial, which was delivered to patients but explored the indirect intervention effect on the patients’ partners [14]. A decision was made to include the study, as partners of people with type 2 diabetes are at increased risk of type 2 diabetes and they remain understudied. The additional hand search through the reference lists of included articles identified a narrative review [12] that led to the addition of one study not identified by the initial search strategy [15-18]. Although not an RCT, this study was included as participants were randomized into treatment groups through the process of minimization [19]. Minimization is based on the principle of randomization although participants are allocated to treatment groups on the basis of specific characteristics such as gender or BMI. This method is appropriate for controlled trials with small samples because it minimizes the imbalance between different factors [19].

*Insert figure 1 here*

Data extraction was carried out by ED, with included studies then checked against inclusion criteria by AM. Information was collected on author and year, population sample, recruitment methods, intervention components and mode of delivery, intervention duration and study outcomes. Intervention components were classified according to the Behavior Change Taxonomy [20]. This was done independently by two of the authors (ED and AM).

### Assessment of study quality

Study quality was assessed using the Cochrane Collaboration's tool for assessing risk of bias [21]. The tool allows the researcher to assess risk of bias across several domains and provides a systematic and transparent method of assessing the internal validity of a study [21]. Assessors are required to assign "high risk", "low risk" or "unclear risk" of bias, based on the sources of bias, which include random sequence generation, allocation concealment, blinding of participants and personnel, blinding of outcome assessment, incomplete outcome data and selective reporting. The tool also provides an opportunity to assess bias, based on other sources that assessor considers to be relevant [21].

## **Results**

### Summary of studies

Seven studies, published in 14 articles in peer-reviewed journals, were included (Table 1). The majority were published between 2000 and 2015 with only one study published prior to this (1998). The studies were carried out in various geographical locations (two in the USA [14, 22]; two in the Netherlands [23, 24-26]; and one each in Japan [27], Sweden [15-18] and the UK [28-30]). Interventions were delivered to parents and siblings of people with type 2 diabetes [24-26, 27], offspring only [22, 28-30], first degree relatives (relationships not specified) [15-18, 23] or partners [14].

### Recruitment strategies

There were three main recruitment approaches: advertising in the community, recruiting people through their relatives with diabetes, or identifying people as high risk (as defined by having a relative with diabetes) when they had a health care contact. Three of the studies provided insufficient information to assess participation rate and response [15-18, 24-26]. In the ProActive trial, only 365 (24%) relatives were recruited from a pool of 1,521 trial participants [28-30]. In the LookAHEAD trial, 357 (7%) partners were recruited from 5,145 trial participants [14]. In the other two studies, 53% [23] and 40% [27] of eligible relatives identified through their own health care contacts agreed to take part. However, one study did not state how many people needed to be screened in order to identify eligible people [27]; in the other there was an initial population screening of over 11,000 people [31].

### Intervention components and mode of delivery

The interventions generally incorporated lifestyle interventions focusing on diet and/or physical activity, and behavioral strategies (e.g. goal setting, self-monitoring) that were group and/or individually based, with one study exploring the communication of familial risk [23]. The most often used behavior change strategies [20] were “provide information on consequences”, “prompt specific goal setting” and “prompt self-monitoring of behavior”.

Studies were too heterogeneous in terms of intervention components to allow for a meta-analysis to be conducted.

Two studies delivered an intervention in a group environment that included information about diet, exercise or a combination of both [15-18, 22]. Wing et al.’s [22] trial was the most intensive intervention trial, consisting of three intervention arms and a control arm, utilizing 12 behavior change strategies and lasting two years. Participants in all intervention groups attended frequent meetings, which contained information about diet, exercise or both (depending on intervention

group). Brekke et al.'s [15-18] intervention consisted of two intervention arms and a control and incorporated 7 behavior change strategies. The intervention arms included the provision of dietary or dietary and exercise advice. Participants attended two group meetings, which were followed by unannounced phone calls every 10 days for four months.

Three studies delivered the intervention to individuals [23, 27, 28-30]. The ProActive trial [28-30] compared the efficacy of an intervention delivered either in person or over the phone, using 10 key ingredients from the behavior change taxonomy. The intervention lasted 12 months and focused on behavioral strategies such as goal setting, action planning, self-monitoring and building support from family and friends. In Pijl et al.'s [23] trial, participants attended one meeting where they were informed of their genetic risk of type 2 diabetes thus the trial used only two behavior change techniques Tokunaga-Nakawatase et al.'s [27] intervention was the least intensive intervention identified, using three key ingredients and comprising of the provision of tailored, concrete lifestyle recommendations via email in addition to a pamphlet about general diabetes prevention.

Two studies used a combination of group and individual mode of delivery [14, 24-26]. The LookAHEAD trial [14] was the only intervention that was delivered to patients with type 2 diabetes but aimed to explore its indirect effect on the patients' spouses. The intervention utilized five behavior change techniques, lasted one year and included several group and two individual meetings where participants received training in behavioral strategies (e.g. self-monitoring; goal setting) and ways to enhance social support. The intervention in the DiAlert trial [24-26] consisted of two interactive group sessions, which focused on risk factors of type 2 diabetes, the importance of lifestyle changes and behavioral strategies, utilizing eight behavior change techniques. In addition, participants were sent four newsletters, 1, 4, 19 and 28 weeks after the intervention, providing information about healthy eating and physical activity.

### Study quality

The quality of studies was assessed using the Cochrane Collaboration's tool for assessing risk of bias [21]. The results of assessment of bias are presented in Table 2.

*Insert table 2 here*

Three of the studies were at high risk of bias in one [22], two [24-26] or three domains [27], including lack of blinding, incomplete outcome data and selective reporting. While there were no obvious sources of bias in the other four studies, the presence of unclear risk in at least one domain for each of them indicates that many studies fail to provide sufficient information for bias to be adequately assessed.

### Study outcomes

The outcomes and intervention effectiveness varied across studies. Five of the seven studies reported significant changes in primary outcomes. One study reported intervention effectiveness during the duration of the intervention but not thereafter [27], and one did not report significant changes in study outcomes [28-30].

Two studies demonstrated that a combination of diet and exercise information leads to most significant sustained changes in participants' behavior [15-18, 22]. Participants in the diet group in Wing et al.'s [22] study reported significant decrease in daily calorie intake and weight, which was sustained for a year. The diet plus exercise intervention led to increased physical activity and significant weight loss, which was maintained for two years. However, the study also showed a significant difference in session attendance between groups, which may have affected the results. Brekke et al. [15-18] reported significant decrease in body weight, waist circumference and sagittal diameter in the diet plus exercise group, compared to the control group. Within group differences were observed in energy intake in the diet group and frequency of physical activity in the diet plus



exercise group. Although the strength of these changes diminished, they were maintained two years after the intervention.

Gorin et al. [14] found significant correlations between the behavior of patients and their spouses, demonstrating an indirect intervention effect on the behavior of spouses of patients with type 2 diabetes.

Participants in the intervention group in Pijl et al.'s [23] study reported increased perception of diabetes consequences and diabetes control. However, their behavioral intentions did not differ from the intentions of participants in the control group. Significantly more participants in the intervention group in the DiAlert trial [24-26] lost at least 5% of their initial body weight at 9-months follow-up. However, the intervention did not affect health behaviors, intention to change behavior, self-efficacy and outcome expectancies. In addition, the results did not show significant changes in diet, physical activity, smoking or alcohol intake. The results from the DiAlert trial [24-26] should be interpreted with caution as the study was at high risk of bias for not concealing treatment allocation and anthropometric measurements from trainers and participants, for not providing an objective assessment of intervention fidelity and for being underpowered.

One study reported intervention effectiveness during the duration of the intervention but not thereafter [27]. Although changes in total energy intake were observed between the groups at 6 months, there were no significant differences in energy intake, physical activity or biomedical factors at 12 months after the intervention. However, the results from this study should be interpreted with caution as the study was considered to be at high risk of bias for selective reporting, lack of explanation for missing data and not blinding participants to study group.

The intervention in the ProActive [28-30] did not lead to significant changes in weight, BMI, waist circumference, blood pressure or cholesterol. At 1 year follow-up, the physical activity of participants in the intervention groups did not differ from the physical activity of participants in the control group. Although both modes of intervention delivery (over the phone and face-to-face) were

considered acceptable by participants, there was no difference in study outcomes between the two intervention groups.

### Discussion

This systematic review shows that there has been limited research evaluating interventions that target modifiable risk factors for type 2 diabetes in relatives and partners of people with type 2 diabetes. This is particularly true for partners. Given that theories such as Common dyadic coping [32], Communal coping [33] and Family Systems Theory [34] suggest that couples and families appraise illness as a joint problem that requires joint actions, there is a need to further explore how the relationship between the patient and their significant others can be used as a mediator for behavior change, as has been done in cancer [35]. One study in this review showed a significant correlation between the behavior of patients and their spouses, which leads to behavior changes in the untreated [14]. The study highlights the potential of utilizing communication in families as a potential tool for prevention of type 2 diabetes. Previous research shows that people with type 2 diabetes are willing to inform their relatives about familial risk of diabetes [36] and that patients often do that without formal prompting from healthcare professionals [37]. Additionally, van Esch et al. [38] found a link between patients' perceptions of type 2 diabetes and perceptions of diabetes threat in their family members. More specifically, patients who perceived type 2 diabetes as a serious and unpredictable disease were more likely to be worried about their relatives' risk of type 2 diabetes [38]. These findings outline the characteristics of patients who may be more likely to act as health educators in their families. These people can be provided with information about type 2 diabetes by healthcare professions, which they can then disseminate within their families. The potential of such an indirect diabetes prevention strategy is further supported by previous findings that relatives of people with type 2 diabetes would like to be informed about their diabetes risk [39]

and healthcare professionals see this as a feasible method for diabetes prevention [40]. However, the potential for patients to be health messengers in their families may be dependent on culture. Previous research shows that people from certain cultural backgrounds may be more likely to discuss familial risk of type 2 diabetes with their relatives [39, 41, 42]. For example, Surinamese patients expressed more concern about their relatives' risk of diabetes, compared to Dutch patients [41]. Another study showed that people from Bahrain are less likely to take responsibility to prevent type 2 diabetes and to be influenced by medical advice in comparison to people from Ireland [42].

Only one study in this review used communication of familial risk of type 2 diabetes directly to relatives as a tool for behavior change [23] and showed significant changes in some of the primary outcomes. Previous research indicates that informing people about their familial risk increases people's feelings of control over their ability to prevent type 2 diabetes [43], and their perception of personal risk [44], suggesting that such interventions are potentially simpler and cheaper, and require further investigation. One study delivered the intervention online by emailing participants tailored lifestyle recommendations (27). Although the study did not find significant long-term changes in primary outcomes, it represents an early step in the use of online interventions. A more recent study showed that an interactive web-based intervention can have a significant impact on physical activity and dietary intake for people with a metabolic syndrome [45]. Computerized, online interventions have the potential to reach a large number of people at high risk of type 2 diabetes and provide personalized feedback and ongoing support to further support sustained behavior change.

The majority of studies in this review demonstrated intervention effectiveness. The use of established behavior change techniques varied, ranging from two to 12 but there was no clear link between number of behavior change techniques and intervention effectiveness. In addition, three of the studies were at high risk of bias in one [22], two [24-26] or three [27] of the domains of the

Cochrane Collaboration's tool [21]. A combination of diet and exercise education appeared to lead to most significant changes in weight loss [15-18, 22]. However, such interventions are very costly. Moreover, only two studies reported sustained behavior change at two years follow-up [15-18, 22], raising concern over long-term sustainability.

This review also raises questions as to the practicality of recruiting people who are at high risk of type 2 diabetes by virtue of having a relative with diabetes. The potential of behavior change studies among relatives would be undermined if recruitment of participants is not successful. However, the most effective recruitment strategies remain unclear. Although the studies in this review report on their recruitment methods, they do not provide detailed information about the effectiveness of these methods. The yield of eligible people was very low when they were recruited via relatives who were taking part in larger RCTs [14, 28-30], although by definition this strategy is not translatable to the real world context. The proportions of eligible people who were recruited when they were identified through their own health care contacts was much higher and this could be a more promising approach for targeting them. However, the number of people who need to be screened in order to identify eligible people may be very high. In addition, systematic screening of family members of people with type 2 diabetes is unlikely for logistic and financial reasons, which further strengthens the argument for the potential of patients to act as health educators within their families.

To conclude, this review has identified two main challenges that need to be addressed in order to optimize diabetes prevention in high-risk relatives and partners of people with type 2 diabetes: the development of effective interventions that are sustainable and not demanding on participants' time and cost; and simple and feasible methods of recruiting people who would benefit most from them.

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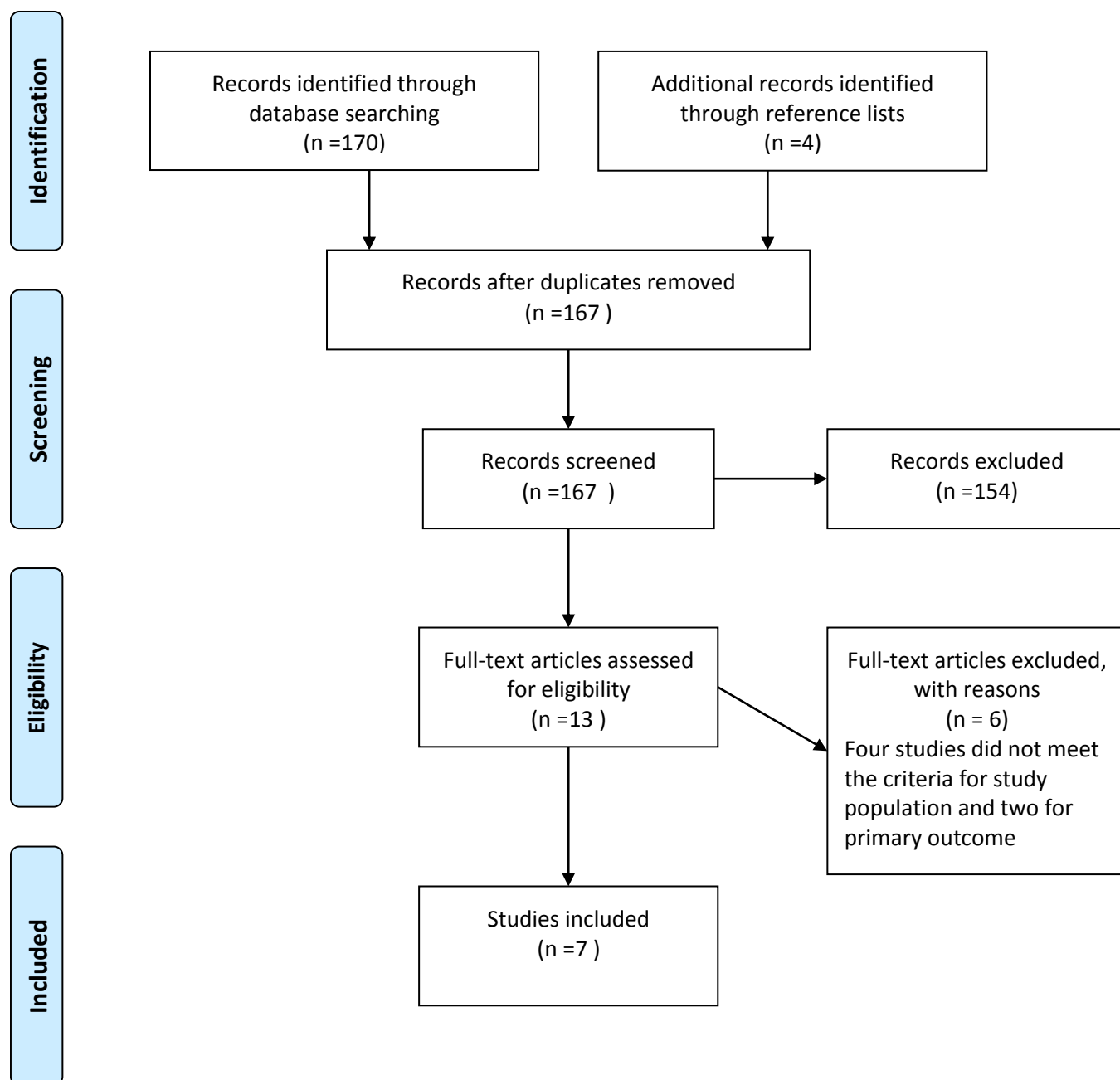
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Figure 1 Identification and selection of studies (Adapted from Moher, Liberati, Tetzlaff, Altman & The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) Group [46]).



## Interventions for prevention of type 2 diabetes in relatives: A systematic review

Table 1. Summary of included studies

	Population sample	Recruitment methods	Intervention components and mode of delivery	Intervention duration	Study outcomes	Behaviour change techniques
<b>Wing et al., 1998 (USA) [22]</b>	<p>Offspring</p> <p>Age: M=45.7 yrs</p> <p>BMI: M=35.9 kg/m<sup>2</sup></p> <p>Gender: 79% women</p> <p>Education: not reported</p> <p>Occupation: not reported</p> <p>Ethnicity: not reported</p>	<p>Newspaper adverts for overweight people aged 40-55 yrs with a parent with diabetes</p> <p>N = 154</p>	<p>3 interventions groups, 1 control.</p> <p>Diet group: Behavioral strategies to modify food intake, such as provision of plans and goals and self-monitoring</p> <p>Exercise group: A lecture on changing exercise behavior and a 50-60 minute walk with an exercise therapist plus a second supervised walk every week for the first 10 weeks of the study.</p> <p>Diet + Exercise group: A combination of components from diet and exercise groups</p> <p>Control group: A manual on healthy eating and exercise.</p>	<p>2 years: weekly meetings for 6 months followed by biweekly meetings for another 6 months. Two courses in 2<sup>nd</sup> year.</p>	<p>Body weight; daily calorie intake, physical activity.</p> <p>Most significant changes in weight loss and physical activity at 2-year follow up in diet plus exercise group.</p> <p>Weight loss led to a reduction of risk of type 2 diabetes with 31%.</p> <p>Sustained decrease in calorie intake in the diet group.</p>	<p>T4: Prompt intention formation</p> <p>T5: Prompt barrier identification</p> <p>T7: Set graded tasks</p> <p>T8: Provide instruction</p> <p>T9: Model or demonstrate the behavior</p> <p>T10: Prompt specific goal setting</p> <p>T11: Prompt review of behavioral goals</p> <p>T12: Prompt self-monitoring of behavior</p> <p>T13: Provide feedback on performance</p> <p>T17: Prompt practice</p> <p>T18: Use follow-up prompts</p> <p>T23: Relapse prevention</p>
<b>Brekke et al., 2003 (Sweden) [15-18]</b>	<p>First-degree relatives</p> <p>Age: M=42.4yrs</p> <p>BMI: M=25.8 kg/m<sup>2</sup></p> <p>Gender: 36.1% women</p> <p>Education: not reported</p>	<p>Patients at diabetes clinic completed questionnaire about diabetes in family members. Letter or phone call to those with non-diabetic relatives - asked to contact them.</p>	<p>2 intervention groups, 1 control</p> <p>Diet group: Diet advice and goal setting</p> <p>Diet + exercise group: Diet advice and discussion about physical activity</p> <p>Control: A letter with advice to maintain current lifestyle</p>	<p>Two sessions and phone calls every 10 days for 4 months</p>	<p>Body weight; waist circumference; sagittal diameter; energy intake; physical activity; diet adherence.</p> <p>Significant decrease in body weight, waist circumference and sagittal</p>	<p>T2: Provide information on consequences</p> <p>T4: Prompt intention formation</p> <p>T8: Provide instruction</p> <p>T10: Prompt specific goal setting</p> <p>T12: Prompt self-monitoring of behavior</p>

## Interventions for prevention of type 2 diabetes in relatives: A systematic review

	Occupation: not reported Ethnicity: not reported	Newspaper adverts N = 77			diameter in the diet plus exercise group.  Significant changes in diet adherence for both intervention groups at 1- and 2-year follow-up.  Weight loss was sustained in the diet plus exercise group at 2-year follow-up.  No significant changes in physical activity.	T13: Provide feedback on performance T18: Use follow-up prompts
<b>Gorin et al., 2008 (USA) [14]</b>	Partners Age: M=59.2 yrs BMI: M=30.6 kg/m <sup>2</sup> Gender: 57% women Education: 68.3% attending college or more Occupation: not reported Ethnicity: 91.5% Caucasian	Among 5,145 overweight people with type 2 diabetes in LookAHEAD RCT in 16 centers, there were 607 married or living with significant other, 357 partners agreed to take part N=357	1 intervention, 1 control group  Intervention group: Combination of group and individual meetings; training in self-monitoring, problem solving, goal setting, relapse prevention and enhancing social support; information on controlling physical cues (e.g. storing food out of sight) and social cues (e.g. avoid temptation.  Control group: Enhanced usual care-three information group meetings per year that provided information on diabetes, nutrition and physical activity.	Four meetings per month for 6 months followed by 3 sessions per month for another 6 months.	Body weight; energy intake; behavioral control strategies; physical activity.  Partners of intervention participants were more likely to adopt strategies for behavior control and lost significantly more weight and reduced energy intake at 1-year follow-up, compared to partners of control group participants.  No significant changes in physical activity.	T5: Prompt barrier identification T10: Prompt specific goal setting T12: Prompt self-monitoring of behavior T20: Plan social support or social change T23: Relapse prevention

## Interventions for prevention of type 2 diabetes in relatives: A systematic review

<b>Proactive trial, 2004 (UK) [28-30]</b>	<p>(Sedentary) offspring</p> <p>Age: M=40.4 yrs</p> <p>BMI: M=27.8 kg/m<sup>2</sup></p> <p>Gender: 62% women</p> <p>Education: Mean age when they finished education- 17.9</p> <p>Occupation: 55.3% in managerial or professional job</p> <p>Other SES information: 89% owned a home; 98% had a car</p> <p>Ethnicity: Predominantly white</p>	<p>1,521 potentially eligible offspring of people with type 2 diabetes were recruited by searching primary care records and sent questionnaire. 1,123 were returned and 465 eligible people contacted. 399 agreed to take part. 365 were randomized.</p> <p>N = 365</p>	<p>2 intervention groups, 1 control</p> <p>Intervention groups: Individual lifestyle intervention over the phone or in person; behavioral strategies such as goal setting, action planning, self-monitoring and building support from family and friends.</p> <p>Control group: An advice leaflet</p>	<p>Phone intervention: 6 phone calls over 5 months then monthly postal contact for 7 months.</p> <p>Home intervention: 4 visits and 2 phone calls for 5 months then monthly phone calls for 7 months</p>	<p>Body weight; BMI; waist circumference; blood pressure; cholesterol; physical activity.</p> <p>No significant changes in study outcomes.</p>	<p>T2: Provide information on consequences</p> <p>T4: Prompt intention formation</p> <p>T7: Set graded tasks</p> <p>T10: Prompt specific goal setting</p> <p>T11: Prompt review of behavioral goals</p> <p>T12: Prompt self-monitoring of behavior</p> <p>T15: Teach to use prompts or cues</p> <p>T18: Use follow-up prompts</p> <p>T20: Plan social support or social change</p> <p>T23: Relapse prevention</p>
<b>Pijl et al., 2009 (The Netherlands) [23]</b>	<p>First-degree relatives</p> <p>Age: M=67.1 yrs</p> <p>BMI: M=28.3 kg/m<sup>2</sup></p> <p>Gender: 57% women</p> <p>Education: 5% completed higher</p>	<p>233 participants of a diabetes screening program 5 years previously who had family history invited to RCT. 118 participated.</p> <p>N = 118</p>	<p>1 intervention, 1 control group</p> <p>Intervention group: Communication of genetic risk by constructing a family tree; discussion on familial risk and information on prevention.</p> <p>Control group: A five-year risk estimate, based on general risk factors.</p>	<p>One session</p>	<p>Healthy eating; physical activity; behavioral intentions.</p> <p>Significant increase in healthy eating in the intervention group.</p>	<p>T1: Provide information about behavior-health link</p> <p>T2: Provide information on consequences</p>

## Interventions for prevention of type 2 diabetes in relatives: A systematic review

	vocational training Occupation: not reported Ethnicity: Dutch Caucasian				Marginally significant changes in physical activity between groups.  No change in behavioral intentions.	
<b>Heideman et al., 2011 (The Netherlands) [24-26]</b>	Parents and/or siblings  Age: M=55 yrs BMI: M=30.5 kg/m <sup>2</sup> Gender: 67.7% women Education: 49.5% low, 18.9% middle, 31.6% high Occupation: not reported Ethnicity: 80% Dutch, 4.2% Surinamese, 4.2% Netherlands East Indies, 2.1% Antilles	Letter from GP to potentially eligible people from primary care records.  Adverts in community.  Women from gestational diabetes clinics.  N = 482	1 intervention, 1 control group  Intervention group: Discussion about risk factors for type 2 diabetes, health benefits of lifestyle changes, self-monitoring and physical activity diaries; nutrition and exercise balance, benefits and barriers of lifestyle change and setting personal action plans; newsletters about healthy eating and physical activity.  Control group: A brochure about heredity and general risk factors for type 2 diabetes.	Two sessions over a 2 week period	Waist circumference; blood pressure; intention to change; diet; physical activity; smoking; alcohol intake.  Sustained decrease in waist circumference and improved systolic blood pressure in the intervention group.  No significant changes in intention to change, diet, physical activity, smoking or alcohol intake.	T1: Provide information about behavior-health link T2: Provide information on consequences T4: Prompt intention T5: Prompt barrier identification T10: Prompt specific goal setting T12: Prompt self-monitoring of behavior T17: Prompt practice T23: Relapse prevention
<b>Tokunaga-Nakawata se et al., 2012 (Japan) [27]</b>	Parents and/or siblings  Age: M=44.9 yrs BMI: M=22.7 kg/m <sup>2</sup> Gender: 67.1% men	Recruited at a medical check-up. 216/538 eligible individuals consented to be randomized. 141 were enrolled.  N = 141	1 intervention, 1 control group  Intervention group: Tailored, concrete lifestyle recommendations via email in addition to a pamphlet about general diabetes prevention.	Three emails over 6 months	Energy intake; physical activity; biomedical factors.  Intervention effectiveness for all primary outcomes was observed during the	T1: Provide information about behavior-health link T2: Provide information on consequences T8: Provide instruction

## Interventions for prevention of type 2 diabetes in relatives: A systematic review

	<p>Education: 3 less than high school, 28 high school, 29 technical school, 75 university/college, 6 graduate school</p> <p>Occupation: 122 full-time, 16 part-time, 2 housekeeping</p> <p>Ethnicity: not reported</p>		<p>Control group: The same pamphlet and conventional routine care.</p> <p>Individual lifestyle intervention via email and a pamphlet</p>		<p>intervention but not thereafter.</p>	
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Table 2 Risk of bias assessments of included studies

	Random sequence generation.	Allocation concealment.	Blinding of participants and personnel.	Blinding of outcome assessment.	Incomplete outcome data.	Selective reporting.	Other sources of bias.
Wing et al., 1998	L	U	L	L	U	L	H <sup>1</sup>
Brekke et al., 2003	L	U	U	U	L	L	L
Gorin et al., 2008	L	L	U	L	U	L	L
Proactive trial, 2004	L	L	U	L	L	L	L
Pijl et al., 2009	L	L	U	U	L	L	L
Tokunaga - Nakawata se et al., 2012	L	L	H	L	H	H	L
Heideman et al., 2011	L	L	H	L	L	L	H <sup>2</sup>

1. High risk of other bias because there was a significant difference in session attendance between groups.
2. High risk of other bias because Study was underpowered; anthropometric measurements were not blinded to treatment allocation; intervention fidelity was not objectively measured.

