REDUCING THE RISK OF TYPE 2 DIABETES IN SOUTH ASIAN POPULATIONS: A SYSTEMATIC REVIEW OF LITERATURE

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ABSTRACT

Background: Research has shown that physical activity and dietary interventions have the potential to reduce the risk of type 2 diabetes among the South Asian population. Nevertheless, little is known about the effectiveness of these intervention and contents of the interventions that contribute to the results attained.

Aim: This study is therefore a review of the evidence available on the effectiveness of these interventions on the risk of T2D, as well as the processes that have facilitated the conduct of the interventions.

Methods: Four databases were searched for randomized control trials published from 1900-2016. The review included interventions that comprised of both awareness creation and practical demonstrations of lifestyle changes necessary for a healthy living. After a careful search of literature and quality assessment, this review conducted a narrative synthesis of results obtained. Four studies were identified. Three focused on both dietary and physical activity interventions and one on only physical activity. All the studies were conducted outside the South Asian continent.

Results: Two of the studies reported a reduction in weight after the intervention period. One of these studies focused mainly on intensive physical exercise for male adults (p value less than 0.01 after five months). The other study focused on physical activity and home based dietician visits and consultations involving the family cook and family members (p value: 0.0076). All the four studies were culturally adapted to suit the South Asian population. Some of these adaptations helped to increase participation and retention through the intervention process. The use of the various recruitment methods, family and community involvement are some of the aspect of these interventions that have been stated to have facilitated its conduct.

Conclusion: The evidence on the effectiveness of the dietary and physical activity interventions in reducing weight among South Asians is inconclusive. The effectiveness of these interventions in reducing the risk of type 2 diabetes among South Asians is most likely possible amidst various cultural adaptations. Researchers of future lifestyle interventions for South Asians are recommended to therefore focus developing interventions that are culturally adapted from recruitment to follow up. Recruitment methods should be multifaceted, and should involve community and family members. Additional data should be provided to assess behavior change and the exact contribution of the various adaptations to the effectiveness of the interventions.
ABBREVIATIONS

T2D: Type 2 Diabetes
IDF: International Diabetes Federation
ADA: American Diabetes Association
IGT: Impaired Glucose Intolerance
MODY: Maturity-Onset Diabetes of the Young
BMI: Body Mass Index
GDM: Gestational Diabetes
UK: United Kingdom
USA: United States of America
RCT: Randomized Controlled Trial
PODOSA: Prevention of Diabetes and Obesity in South Asians
INNVANDIAB: Immigrant Diabetes
FDPS: Finish Diabetes Prevention Studies
EPOC: Cochrane Effective Practice and Organization of Care Review Group
EPHPP: Effective Public Health Practice Project
OGTT: Oral Glucose Tolerance Test
1. INTRODUCTION

1.1 Epidemiology of Diabetes
Diabetes is one of the global public health emergencies of the twenty first century\(^{(1)}\). According to the International Diabetes Federation\(^{(2)}\) (IDF) about 12% (approximately 673 billion dollars) of global health expenditure is spent on diabetes and related issues. In 2015, 415 million people were estimated to be living with diabetes globally and this is expected to increase to about 642 million in 2040\(^{(2)}\). Majority of people (about three quarters of 415 million) living with diabetes are in low and middle-income countries\(^{(2)}\).

Diabetes manifests itself in different forms depending on the cause and risk factors that lead to its development. There are about four known types of diabetes, including type 1 and type 2 diabetes (T2D), Maturity-Onset Diabetes of the Young (MODY) and gestational diabetes (GDM)\(^{(3)}\). These will be discussed in subsequent paragraphs. The risk of being diabetic among other factors increases with age, Body Mass Index (BMI), obesity and family history\(^{(3)}\). For example, studies have shown that first direct relatives have three times greater risk of developing diabetes (T2D) than unrelated individuals of a population\(^{(4)}\). In addition, some racial and ethnic groups of a population are likely to have high risk and prevalence due to genetic or environmental predispositions associated mainly to them\(^{(3)}\).

One of the ethnic groups that has been of utmost concern to researchers in recent years has been the South Asian population. The South Asians are a subgroup of people who have a special predisposition to diabetes\(^{(2)}\). The South Asian continent consists mostly of developing countries representing about one-quarter of the world’s population \(^{(5)}\). According to Mohan (2004 cited by Gujral \(^{(5)}\)), it includes countries like Pakistan, Bangladesh, India, Nepal, Sri Lanka, Bhutan and Maldives.

According to the IDF, more than 70 million individuals in the sub-continent are living with diabetes\(^{(6)}\) and about 7.9 million of its people die every year from this condition\(^{(7)}\). India has had a steady increase of the disease over the last 40 years (Mohan, 2004 cited by Gujral \(^{(5)}\)). According to ADA (2014 cited by Joseph et al\(^{(8)}\)), it is expected to lead the world with 101.2 million people living with type 2 diabetes (T2D) mellitus by the year 2030. Furthermore, Pakistan and Bangladesh were at the 12\(^{th}\) and 13\(^{th}\) positions respectively on the global list for high prevalence countries for T2D in 2015\(^{(7)}\).

The word ‘trial’ ‘studies’ and ‘intervention’ are used interchangeable in this review to mean the same thing (intervention program).
T2D among this group in some respects differ from other races because it occurs at an earlier age, at a lower BMI and complications develop earlier\(^7\). This makes the incidence of T2D among South Asians a case for urgent attention\(^7\).

1.2 Causes and symptoms of Diabetes

*Diabetes mellitus* or simply diabetes is a condition that occurs when the pancreas is unable to produce insulin or the body cells fail to recognize insulin signals being produced\(^9\). Insulin is a peptide hormone in the body responsible for the regulation of glucose intake in the blood\(^9\). Insulin controls the release, cessation of glucose flow in the blood, and maintains the blood sugar at a normal level of between 3.6-5.8 mmols/liter (for a person without diabetes)\(^10\). It is in addition responsible for the storage of glucose for later use when needed\(^10\). When insulin in the body is non-functional, it is unable to control the intake or regulation of glucose flow in the body. This then leads to high blood sugar and poor functioning of the cells resulting in a failure of many organs and tissues in the body\(^11\). High blood sugar and its related complications lead to several diseased conditions known as Diabetes mellitus. Diabetes mellitus is a condition that serves as a gateway to the destruction of several vital organs like the kidney, eyes, brain etc. that requires regulated energy flow for growth and proper functioning\(^10\).

Preceding diabetes is a condition of impaired glucose tolerance (IGT), which is determined by a blood sugar test two hours before and after a 75g glucose intake (Oral Glucose Tolerance Test (OGTT))\(^12\). If the blood sugar level is more than 11.1mmol/l then a condition of impaired glucose intolerance is determined\(^9\). At this stage, the blood sugar is higher than normal but not enough to be classified as diabetic\(^13\). IGT is one of the risk factors associated with metabolic syndrome\(^12\). Metabolic syndrome is characterized by large waist circumference, high blood pressures, central obesity among others and most often leads to the development of diabetes\(^12\).

T2D is the most prevalent form of diabetes in the world today and it is responsible for about 90% of diabetic cases\(^14\). It is a condition where the body is insensitive to the insulin (insulin resistance) or the insulin produced is not enough to regulate the amount of glucose entering into the blood\(^9\). In this condition, the body is unable to recognize the signals provided by insulin to either release or not to release glucose\(^10\). The body thus becomes completely

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insensitive to insulin and its activities. At this stage, there is constant high insulin level in the body and constant high levels of blood sugar because the body is in constant receipt of glucose from food eaten. This mostly occurs when a person is eating too much of foods that produce glucose and does not engage in physical activity. Low physical activity is known to be responsible for 27% of the cases of diabetes (Mathers et al., 2009 cited by Nicolaou et al.). T2D is often realized in the latter part of one’s life, generally between the ages of 35-64 years old. It is a dangerous condition because insulin injections most often cannot be of any help but rather a drastic management of diet and physical activity.

Research has shown T2D and obesity are significantly associated. Both conditions are increasing at significant rate with T2D been one of the primary consequence of obesity in the world today. In effect, the relative risk of being diabetic increases as a person’s BMI increases (Erkelens, 2001 cited by Yaturu). Treating IGT and obesity helps to delay the incidence of T2D.

Most T2D cases are hard to detect because symptoms develop slowly and many cases develop undiagnosed until complications start to advance. Screening for T2D is encouraged for persons who are at high risk; which include persons who are overweight or obese, persons who have first generation relatives with diabetes and those who come from ethnic background where diabetes is common.

Diabetes mellitus can be detected with a simple blood sugar test. A person is diagnosed as diabetic when fasting plasma glucose (pre-prandial) is more than or equal to 7.0 mmol/l. Fasting means that eight hours before the test, the person should not have eaten or drank anything (except water). This test is normally done first thing in the morning before any meal.

T2D is life-long and it is irreversible the moment the body sets into motion of insulin resistance. It is thus important to make efforts to prevent the onset of this condition. Regular physical activity and consumption of diet with less sugar and fat are key elements in the prevention and management of T2D. Other studies have also stated that good management of stress, sleep and less smoking also have an effect on the incidence of T2D.

Other types of diabetes mellitus include Type 1 diabetes, which is a condition that occurs when the pancreas or brain does not produce insulin because of a genetic condition. This occurs due to a destruction of the B-cells of the pancreas that produce Insulin. Type 1
diabetes represents about 10% of diabetic cases\(^4\). It is controlled by injecting insulin into the body when needed and regulating diet\(^2\). This type is often recognized at an early stage in life and patients have to live their lifetime with this condition\(^10\).

When diabetes is caused by an inherited gene mutation in young people usually before the age of 25, it is called MODY\(^9\). Young people who develop MODY often have parents with diabetes or two or more generations with diabetes\(^9\). It is developed irrespective of weight, ethnic background or diet\(^4\). MODY is a rare form of diabetes which does not necessarily require insulin treatment\(^19\). Early detection of MODY is through genetic testing. A well-balanced diet and physical activities can help reduce complications\(^19\).

Gestational diabetes mellitus (GDM) is the last type of diabetes mellitus to outlined here. GDM is defined as ‘any degree of glucose intolerance with onset or first recognition during pregnancy’\(^20\). According to the IDF\(^2\), GDM affects one in seven births worldwide. A change in diet and some physical exercise during pregnancy helps to treat GDM among most women\(^20\). Women with previous experience of gestational diabetes have a higher chance of developing T2D in like manner, their children\(^14\).

1.3 T2D and the South Asian population.

Studies are still ongoing to find out why the South Asian ethnic group has a higher prevalence compared to other groups like the Caucasians \(^5\). Some studies have gone ahead to find out that South Asians have this predisposition because of a combination of genetic and socio-cultural factors \(^5, 21\).

The phenotype of South Asians makes them more susceptible to T2D than other populations\(^22\). Some of the genetic factors include fetal programming, insulin resistance, pancreatic beta cell capacity, capacity for safe fat storage, lean body mass among others\(^5\). Even though these genetic factors play a role in the development of the disease, unhealthy lifestyles (i.e. unhealthy diet and physical inactivity) contribute immensely to its development\(^23\). The diets of South Asians vary across the continent and are generally made up of vegetables, high fat and fried foods; in addition, there has been a parallel increase in urbanization and caloric consumption in this population\(^24\). As the continent urbanizes, the consumption of meals with fat and high calorie content increases\(^24\). Despite the knowledge that South Asian diets are different from that of other populations, it is not independently
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1.4 Interventions to reduce the risk of T2D among South Asians

Several interventions have been administered among South Asians abroad and in their home countries. Most of the interventions have been aimed at encouraging South Asians to engage in activities that require the use of physical strength and also to improve upon their diet. These interventions are either designed for the general population or adapted to suit the South Asian culture\(^{(22)}\).

These interventions are administered in several forms. Some are presented as educational programs or awareness programs where advice is given to participants to encourage a change in behavior. For example in a study conducted by Yates \textit{et al} \(^{(29)}\), participants were provided with leaflets and attended structured educational programs that provided them with detailed advice on healthy living. Other interventions also provide practical sessions to facilitate the change. In a study conducted by Singh \textit{et al} \(^{(30)}\) fruits and vegetables were given directly to the participants for a certain period of time after which measurements of change were taken. Participants are also sometimes engaged in physical exercise for a designation period\(^{(31)}\). In addition, some interventions combine both education and practical sessions as a form of intervention \(^{(32)}\). In whatever form they come, most of these interventions aim at improving diet and increasing physical activity for the long term, which in turn should help reduce the risk of T2D among this group.

The culture and traditions of South Asians are taken into consideration by some project organizers. Culture amongst any group forms a strong foundation for behavior change and influences diet and physical activity\(^{(33)}\). Considerations are made through adaptation of these interventions to suit the population been studied. Some interventions have been adapted to suit the South Asian population by using local South Asian languages which enables participants to speak freely and express themselves in the best ways possible\(^{(33)}\). In addition, recommendations on healthy diets are made from the local ingredients and meals in line with the culture of the group\(^{(33)}\). According to Admiraal \textit{et al} \(^{(34)}\), cultural adaptation are likely to promote effectiveness of interventions among specific ethnic population. Telle-Hjellset \textit{et al}\(^{(22)}\) in their study also acknowledged the idea that ethnic groups make lifestyle changes that are mostly in line with their culture, social and family situations and as such providers of interventions should focus on strategies that can be adjusted in the everyday dietary and physical activity habits of South Asians.
In addition, intervention programs sometimes include the involvement of family members. Social support within already existing social networks has been found to be a strong determinant of behavior (Pinelli et al., 2011 cited by Nicolaou et al.15). Sharing of food is a common feature among South Asian gatherings15. One way of involving families is by using the homes of participants as trial centers as in the PODOSA Scotland trial33 so as to indirectly involve their families in the process. Family members can also be directly invited to join the intervention26. Actively involving the family members and the local community of the recruited participants encourages attendance; increases follow up rate, retention and adherence during the intervention period26.

South Asian communities both at home and abroad have been involved in the interventions that have been culturally adapted, included family members and constituted both awareness creation and practical sessions, all with the ultimate aim of reducing their risk to T2D. The contents and effectiveness of these interventions on the South Asian population are reviewed in this study.

1.5 Rationale of the Study
A couple of reviews have been done on issues related to lifestyle modifications among South Asians, both among the immigrants and indigenous people of South Asian continent. Obesity and weight reduction as outcomes have been addressed by two systematic reviews (23, 35). One study conducted a narrative synthesis of both published and non-published quantitative and qualitative studies among South Asian immigrants up to 2012 (23). The other study conducted a meta-analysis of quantitative studies on prevention and control of obesity among South Asian (adults and children) immigrants and native residents of South Asia up to 2005 (35). A third systematic review has been conducted among south Asians immigrants using quantitative data of both practical and awareness creating interventions (36). The review measured the effects of lifestyle intervention on the components of metabolic syndrome. These reviews aimed at measuring the effectiveness of dietary and physical activity interventions using different methods, nevertheless little is known about the appropriateness of the interventions for this group and the characteristics of the interventions that make it effective or not.

This current review is therefore a narrative synthesis of interventions that have included both educational and practical sessions of dietary and/or physical activity interventions aimed at

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reducing the risk of weight among South Asians. It includes an analysis of the elements of each study that made the intervention effective or not, including its adaptions, if any, to the population of study. This study focuses on the process of intervention program and not just the results attained at the end. This is an important element because it sheds light on the characteristics in the relationships between the provider and the recipient of this interventions, which in turn affects adherence and success of the process\textsuperscript{(22)}. This review assesses interventions that go beyond providing pieces of information for awareness creation among participants. It reviews interventions that include sessions of observational learning on how to adjust one’s everyday life. The provision of pieces information about diet and physical activity has been found by studies to produce little or no change in behavior thus risk to T2D\textsuperscript{(26)}. Therefore, an intervention that incorporates observational learning is likely to provide a complete package and better contents that can be assessed for effectiveness.

This study reviews published studies from 1900 up to 2016 and therefore serves as an update of the previous studies. It is a review of Randomized Control Trials (RCT) studies because they are most often considered the best research design for effectiveness studies\textsuperscript{(37)}. The search is for interventions conducted on the South Asian continent and abroad.

Completion of this review would benefit policy makers and host countries who are continuously trying to develop effective interventions to prevent the incidence of T2D among South Asians. It may also provide answers to why some interventions are not generating the desired outcomes while others are. In addition, it will address the call for more analysis on the efficacy of dietary and physical activity intervention to convince the South Asian population of their effectiveness so as to encourage participation in future interventions\textsuperscript{(15)}. This could also serve as guidelines for interventions developed for other similar ethnic groups. This systematic review is therefore carried out with focus on the outlined objectives below.

1.6 Research Aim

The purpose of this study is to review the evidence available on the different interventions aimed at reducing the risk of T2D and their effectiveness among adult South Asians.

The specific research question is:
• What are the effects of behavioral (mainly dietary therapies and physical exercise) interventions on the reduction of weight among South Asians?

• In addition, report is given on the factors that may have facilitated the conduct of the intervention or contributed to the effectiveness or not of the intervention.

The word ‘trial’ ‘studies’ and ‘intervention’ are used interchangeable in this review to mean the same thing (intervention program).
2. RESEARCH METHODOLOGY

2.1 Databases and Search words
A PubMed, Central Cochrane, Embase and a Web of Science internet search was conducted for this review. Articles were also retrieved from reference lists of selected systematic reviews on similar topics \(^{8, 23, 35}\). In addition, a subscription was made to all the databases to receive notifications on new articles published on South Asians. These databases were chosen because they are relevant to the topic and have been recommended under the Centre for Research and Dissemination\(^{37}\) guidelines for conducting systematic review in public health studies. The years of publication were from 1900-2016. The search period was between the 29/06/2016-29/11/16.

The search words for the review included South Asians (Indians, Sri Lankans, Pakistanis, Bangladeshis, Nepalese and Bhutan), Type 2 diabetes, prevention, obesity, weight reduction, diet therapy, physical exercise, intervention and adults. These keywords were built around themes on the population, the intervention undertaken and outcome of the review. In addition, these keywords have been diversely used in studies such as Gujral et al\(^{5}\) and Joseph et al\(^{8}\) addressing issues related generally to T2D prevention and South Asians. Search words for this review were combined to form sentences according to the format required in each database. See appendix 1.

2.2 Inclusion Criteria
The search included studies among healthy adult South Asians residing in countries in and outside the South Asian continent. It also included:

- Intervention studies that investigated the prevention of T2D using dietary and or physical exercise therapies among South Asian.
- Interventions with research design as RCTs.
- Full intervention studies that were administered among population groups of Indians, Sri Lankans, Pakistanis, Bangladeshis, Nepalese and Bhutan separately or together.
- Studies where primary and secondary outcomes were specified. The primary outcome for this review is weight reduction. It therefore included studies with a primary objective of T2D risk prevention with data on weight reduction and or other risks.

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factors of T2D. Studies with secondary and unintended outcomes including (if available) changes in oral glucose tolerance test, BMI, waist and hip circumference, blood pressure, cholesterol, behavioral changes etc. were also included.

- This search comprised of studies published only in English for lack of time and resources needed for translation of non-English articles.
- In addition, this search included only published articles, other unpublished sources like interim results were excluded because of the difficulty in accessing full reports from authors. Abstracts were excluded because they provided limited data needed for the review.

2.3 Exclusion Criteria

- Editorial papers, letters, news, comments, historical articles or anecdotes, reviews of literature were excluded.
- The search also excluded protocols and other systematic reviews on similar issues among South Asians.
- It excluded studies of mixed populations unless the population size was made up of more than 50% South Asians.
- Studies of animals, children, and those addressing management, control, causes and risk factors of T2D were excluded.
- Studies among diabetic patients (all types).
- Finally, the search excluded studies with medicinal and pharmacological interventions to prevent T2D and studies with purely educational interventions.

These inclusion and exclusion criteria helped shape the focus of the data search, analysis and conclusions drawn from this review. Preventable steps were taken to minimize biases and errors likely to arise during the data extraction process. Nevertheless, there is a possibility of language and publication bias in this review.

2.4 Study Selection

A search was done in selected databases for titles, followed by a text analysis of the titles of articles. Articles were then selected and exported to EndNote where duplicates where
automatically removed. The second step involved reading of abstracts of selected articles to determine which to include.

Full text articles of selected abstracts were read to select potential, eligible, relevant and appropriate articles for the review. At this stage attention was given to the methodology and results of each study and the reasons for rejecting each article were also documented so as to increase transparency of the selection process (see figure 1 in appendix 3). Selected articles were further analyzed for the review based on their various quality assessments.

In case of missing or inadequate information, authors were not contacted because of time and resource constraints and thus those articles were excluded. In addition, when there was confusion on whether to include or not to include a study, a meeting was held with both supervisors to discuss this.

2.5 Quality Assessment
The quality assessment was conducted for this review using assessment tools provided by Effective Public Health Practice Project (EPHPP)(38) (appendix 2 and table 4). Studies were rated as strong, moderate and weak as shown in table 4. Some of the issues considered include the following: selection bias, study design, confounders, blinding, data collection methods, withdrawals and dropouts, intervention integrity and analyses. A report of the quality assessment is provided in the results section.

2.6 Data Extraction
The aim is to extract data needed to assess the overall effectiveness and appropriateness of selected interventions among the South Asian population. The variables extracted included study title, country of study, eligibility criteria, exclusion criteria, characteristics of participants (gender, age), method of recruitment (allocation), number of participants recruited, number of participants at final follow up, type of intervention (intervention and control groups), outcomes measured, the characteristics of the various interventions and the results obtained at the end of the interventions. The data extracted was based on the research questions and the inclusion and exclusion criteria used in this study. The data extraction form was adopted from the Cochrane Effective Practice and Organization of Care Review Group.
The word ‘trial’ ‘studies’ and ‘intervention’ are used interchangeable in this review to mean the same thing (intervention program).

2.7 Data Synthesis

A narrative synthesis was the selected method of analysis/compilation chosen for this review because of time constraint and statistical data needed to conduct a meta-analysis. The information sought after in this review includes reduction in weight as an outcome, details on the process of intervention, characteristics of the intervention influencing outcomes, differences and similarities of interventions. The synthesis of the data is in line with the framework outlined and explained in the CRD guideline\(^{(37)}\).

This consists of four elements:

- Developing a concept of how the intervention works, why and for whom
- Developing a preliminary synthesis of findings of included studies
- Exploring relationships within and between studies
- Assessing the strength of the synthesis process

(EPOC) \(^{(39)}\) (Table 1). The author did the data extraction, and both supervisors evaluated the process.
3. RESULTS

3.1 Search Results

The review assesses dietary and physical activity interventions undertaken among South Asian. 440 papers were retrieved through database searches and also screening through reference lists of selected articles (8, 23, 35). After screening through the titles, removing review papers, duplicates, non-randomized controlled and non-South Asian papers, 73 papers remained. Based on the contents of the abstracts, 13 were selected. Six articles met the inclusion criteria and the research questions after the full text was read. Finally, four articles were assessed for quality and eligibility and were included in the review for this study as shown in figure 1 in appendix 3.

3.2 Study Characteristics

Details of the study characteristics and intervention undertaken are summarized in the tables 1 and 2. The studies were from United Kingdom (26), Norway (22, 31) and Netherlands (34). Studies were organized among the South Asian population, which included Pakistani women and men respectively (22, 31). Admiraal et al (34) study targeted Hindustani Surinamese living (both men and women) in The Hague. The trial by Bhopal et al (26) was among Indian and Pakistani men and women. The overarching objective of all four studies were to undertake interventions that will help reduce the risk of T2D by including physical activity and or dietary change as part of a one to one or group intervention program. These intervention programs included lifestyle counselling, cooking classes or dietician visits and exercise programs.

All the interventions involved a comparison to a control group who received minimal contact and few practical demonstrations. In Admiraal et al (34) study, the control group received two group sessions of lifestyle advice while the intervention group received six to eight sessions of lifestyle counselling in addition to a 20-week physical activity program. In the study by Andersen et al (31), the intervention group were offered group exercise sessions, two group lectures, one individual counselling session, written material and a phone call, while participants in the control group were offered one group lecture, organized exercised and written material. The control group in Bhopal et al (26) study were provided with four dietician visits throughout the program while the intervention group received 15 consultations with a dietician, food shopping tour and organized exercise. Finally, participants in intervention

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group in Telle-Hjellset \textit{et al}\textsuperscript{(22)} study were offered six group sessions of teaching and two session a week of organized exercise. The control group on the other hand received one session of teaching. After these interventions were provided, facilitators measured outcomes of interest to their study.

3.3 Study Design

All the studies included in this review were randomized controlled trails. One study\textsuperscript{(26)} used the family cluster method for allocation of participants. The other three studies \textsuperscript{(22, 31, 34)} allocated individuals (not families) into either the intervention or the control group after been screened for eligibility. Nevertheless, one of the three studies invited family members of selected individuals after the allocations for social support \textsuperscript{(34)}. The intervention periods lasted for at least five months\textsuperscript{(31)}, 12 months \textsuperscript{(34)}, seven months\textsuperscript{(22)} and three years\textsuperscript{(26)} of active engagement with participants in varying sessions over this period. All the studies employed different ways of culturally adapting the recruitment and intervention to suit the South Asian population in the study. Some of the adaptations included involving volunteers in the design of the intervention, culturally adapting language, pictures and questionnaires and finally providing advice in line with South Asian lifestyle. Andersen \textit{et al}\textsuperscript{(31)} however, conducted the study in Norwegian, which is the language of the host nation, Norway. Further details of the cultural adaptations are provided in the next chapter.

The following three studies based the design or foundation of the intervention on a theoretical framework. One study reported that the intervention was designed in line with the Social Cognitive theory which helped to explain and predict behavior changes among participants\textsuperscript{(31)}. Admiraal \textit{et al}\textsuperscript{(34)} also used the theory of motivational interviewing to gather information from participants. They argue that, this method was preferred for the one to one dietician counselling sessions. This is because unlike other methods behavior change was elicited from the individual and not imparted by the health worker. Finally, Telle-Hjellset \textit{et al}\textsuperscript{(22)} adapted the intervention to recent health promotion ideology which placed emphasis on process of the intervention as much as the results attained. Emphasis was thus placed on the relationship between behavior and health.
Table 1. Characteristics of Included Studies

<table>
<thead>
<tr>
<th>Author</th>
<th>Study Title</th>
<th>Country of Study</th>
<th>Eligibility criteria</th>
<th>Exclusion criteria</th>
<th>Characteristics of participants (gender, age)</th>
<th>Method of recruitment (allocation)</th>
<th>Number of participants randomized</th>
<th>Number of participants at final follow up</th>
<th>Type of intervention (intervention group)</th>
<th>Type of intervention (control group)</th>
<th>Outcomes measured</th>
</tr>
</thead>
<tbody>
<tr>
<td>Admira al et al (34)</td>
<td>Intensive Lifestyle Interventio n in General Practice to Prevent T2D among 18 to 60-Year-Old South Asians; 1-Year Effects on the Weight Status and</td>
<td>The Hague, Netherlands</td>
<td>Hindustani-Surinamese, Impaired fasting glucose, Impaired glucose intolerance, 18-60 year old.</td>
<td>Already on a lifestyle program, Pregnant, Diagnosed T2D, A chronic disease that made participation impossible, On drugs that interfered with glucose</td>
<td>18-60 years, 50.7% men and 49.3% women.</td>
<td>Invitation letter with reply card through a list from 48 general practitioner, Phone calls.</td>
<td>642</td>
<td>335</td>
<td>Lifestyle counselling, Cooking classes, Physical activity program.</td>
<td>2 group lectures and two flyers with simple generic lifestyle advice.</td>
<td>Weight change, Glucose metabolism, Blood pressure, Lipid profile.</td>
</tr>
</tbody>
</table>
The word ‘trial’ ‘studies’ and ‘intervention’ are used interchangeable in this review to mean the same thing (intervention program).
| Bhopal et al (26) | Effect of a lifestyle intervention on weight change in south Asian individuals in the UK at high risk of T2D: a family-cluster randomized controlled trial | Scotland, UK | Indian or Pakistani, Waist circumference measured 90cm or greater in men or 80cm or greater for women, Men and Women 35 years or older. | Participants receiving long-term oral corticosteroid, weight-loss medication, health disorders, pregnant, living outside UK within the period. | 35-80 years | National Health Service (NHS), Community (Local South Asians organizations and individuals), Participants’ referrals. | 171 participants in 156 families | 167 participants in 152 families | 15 Consultation with dietician, Food shopping tour, Brisk walking. | 4 dietitian visits. | Weight change, BMI, waist circumference, Glucose tolerance (Fasting plasma glucose), |
Table 2. Characteristics of the interventions

<table>
<thead>
<tr>
<th>Nature of cultural adaption</th>
<th>Admiraal et al(^{34})</th>
<th>Andersen et al(^{31})</th>
<th>Bhopal et al(^{26})</th>
<th>Telle-Hjellset et al(^{22})</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oslo, Norway</td>
<td>Women living in Norway,</td>
<td>Women 25-62 years old</td>
<td>Visit to local Mosques,</td>
<td>Six Group session of teaching and twice a week walking sessions.</td>
</tr>
<tr>
<td></td>
<td>Born in Pakistan,</td>
<td></td>
<td>language centers,</td>
<td>One group session of teaching.</td>
</tr>
<tr>
<td></td>
<td>Born to two Pakistani parents, 25 years or older.</td>
<td></td>
<td>visit to local community, word of mouth and telephone calls.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Known T2D,</td>
<td></td>
<td></td>
<td>Glucose tolerance,</td>
</tr>
<tr>
<td></td>
<td>Close relative already included,</td>
<td></td>
<td></td>
<td>Waist circumference (cm),</td>
</tr>
<tr>
<td></td>
<td>Pregnancy,</td>
<td></td>
<td></td>
<td>Systolic Blood pressure,</td>
</tr>
<tr>
<td></td>
<td>Heart disease,</td>
<td></td>
<td></td>
<td>Diastolic Blood pressure (mmHg),</td>
</tr>
<tr>
<td></td>
<td>Lack of interest.</td>
<td></td>
<td></td>
<td>BMI,</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>HbA1c (%)</td>
</tr>
<tr>
<td></td>
<td>198</td>
<td>157</td>
<td>6 Group session of teaching</td>
<td></td>
</tr>
<tr>
<td></td>
<td>198</td>
<td>157</td>
<td>One group session of teaching</td>
<td></td>
</tr>
</tbody>
</table>

Table 2. Characteristics of the interventions

Source: Author\(^{40}\)

The word ‘trial’ ‘studies’ and ‘intervention’ are used interchangeable in this review to mean the same thing (intervention program).
The word ‘trial’ ‘studies’ and ‘intervention’ are used interchangeable in this review to mean the same thing (intervention program).

<table>
<thead>
<tr>
<th>Adaptations</th>
<th>Culturally adapted to suit the Hindustani-Surinamese population. Involving family and family cook.</th>
<th>Intervention was developed with representatives from the male Pakistani immigrant group</th>
<th>Culturally Adapted language, pictures, figures, questionnaires</th>
<th>Culturally adapted: language, Pictures and Figures, advice in line with Pakistani diet.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nature of desired change (aim of study)</td>
<td>To access the effect of 1- year. Intervention on weight status and metabolic profile.</td>
<td>To increase physical activity levels Promoting weight loss and increasing physical activity</td>
<td>Improve blood –glucose physiology, Reduce risk factors of T2D by physical activity and nutrition</td>
<td></td>
</tr>
<tr>
<td>Intervention based on clear recommendations for practice</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Theoretical foundation of intervention</td>
<td>Motivational Interviewing</td>
<td>Social Cognitive theory</td>
<td>None stated</td>
<td>Health Promotion Ideology</td>
</tr>
<tr>
<td>Recipient (individual or groups)</td>
<td>Individuals and their families</td>
<td>Individuals in group sessions</td>
<td>Individuals and their families</td>
<td>Individuals in group sessions</td>
</tr>
<tr>
<td>Deliverer</td>
<td>Dieticians, Trained coaches</td>
<td>Exercise psychologist, Norwegian of Sports Science, Authors.</td>
<td>Dieticians</td>
<td>Norwegian project leader</td>
</tr>
<tr>
<td>Frequency/number of intervention events</td>
<td>8-10 sessions in 12 months</td>
<td>Four sets of interventions. Five Months</td>
<td>15 visits over three years</td>
<td>Six group sessions for Seven months</td>
</tr>
</tbody>
</table>
The word ‘trial’ ‘studies’ and ‘intervention’ are used interchangeable in this review to mean the same thing (intervention program).

<table>
<thead>
<tr>
<th>Setting of intervention</th>
<th>Home</th>
<th>Exercise facilities</th>
<th>Home</th>
<th>Local mother and baby health center (Adapted to suit feminine preferences)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Norwegian of Sports Science</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Setting of intervention</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Setting of intervention</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Source of funding</td>
<td>The Netherlands Organization for Health Research and Development (ZonMw) funded the trial with grant</td>
<td>Funded by Norwegian ExtraFoundation for Health and Rehabilitation</td>
<td>National Prevention Research Initiative</td>
<td>Norwegian Research Council, the Throne Holst foundation, the Jahre Foundation and Reebok</td>
</tr>
<tr>
<td>Ethical approval</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Unit of analysis (individual/group)</td>
<td>Individual</td>
<td>Individual</td>
<td>Individual</td>
<td>Individual</td>
</tr>
<tr>
<td>Type of targeted behavior (advice and practice)</td>
<td>Practice and Advice</td>
<td>Practice and Advice</td>
<td>Practice and Advice</td>
<td>Practice and Advice</td>
</tr>
</tbody>
</table>

Source: Author\(^{(40)}\)
3.4 Excluded studies

Seven articles were excluded after reading the full papers. Three were protocols (29, 41, 42) whose full article papers were not available during the search period. One study did not report results on the intervention (43). Three of the papers were conference papers with no success in finding the actual reports (44, 45) & Williams et al (46), included 80% Caucasian population and 20% South Asian and this did not satisfy the inclusion criteria of the study. Out the six studies that moved on to the next stage. Two were excluded. One because it was not a controlled trial (30) and the other (47) was the same intervention as Andersen et al (31) and was reporting on other outcomes.

3.5 Participants

All four studies in this review included participants from either Indian or Pakistani ethnic group living outside the South Asian continent. The number of participants at baseline varied from 150-642 involving adults above the age of 18 years. One study reported that the participants included more men than women (50.7%: 49.7%) (34), another conducted the intervention amongst only men (31), while one focused on only women (22) (refer to table 1). All studies targeted participants who were at high risk of getting T2D. Three of the studies included participants with impaired glucose intolerance and the final study (31) targeted men who were not physically active on a daily basis.

All studies provided detailed information on their inclusion and exclusion criteria, which included any condition that could interfere with the measurement of the outcomes. Details are outlined in the data extraction table. The study by Telle-Hjellset et al (22) specifically targeted participants of a particular socio-economic group as a way of following recent health promotion ideology which draws a correlation between low socio-economic status, stress and T2D. They purposively targeted women who were of a low socio-economic status, low education and illiteracy, since the providers believed that they were mostly at risk of T2D. Randomization was thus conducted in a sub-urban area in order to capture this group of participants. Two of the interventions (22, 26) engaged the family cook (women) in the intervention since they are the ones assumed to be making dietary choices or ingredient choices for the entire family.

The word ‘trial’ ‘studies’ and ‘intervention’ are used interchangeable in this review to mean the same thing (intervention program).
3.6 Quality Assessment of individual studies

After assessing the quality of the studies, all four selected studies were included for the review. The definitions for the various parameters for assessment are outlined in the dictionary for Quality Assessment Tool for quantitative studies (48).

Selection bias: Selection bias in this context refers to how likely the participants are to be representative of the target population and also the percentage of participants that agreed to participate in the study before allocation into control and intervention groups (38). Two of the studies (22, 31) reported to have selected participants who were totally representative of the population they were studying. This means that all their participants were first of all of South Asian origin and were at high risk of developing T2D. The latter was verified through screening tests. In addition, recruitments were made from South Asian communities, where South Asians are likely to be found. All the participants were selected through a randomized process. These two studies had more than 80% (80.8 % & 82.4 % respectively) of selected participants agreeing to participate in the study.

Some participants in the study by Bhopal et al (26) were recruited from direct referrals by health professionals and also by written invitation to potential participants through general practice. To avoid missing other potential participants who do not visit their general practitioners, they used other methods of recruitments to support this. About 5% of the participants were recruited through health professionals. In addition, 770 potential participants were excluded before screening in the study. This was because they were either not eligible, available or disagreed to participate. It is however unclear how many of these participants purely disagreed to participate in the study. Furthermore, only 63% (1319/2089) of the contacted participants were screened for allocation. For this reason, the study by Bhopal et al (26), scored moderate on selection bias. Admiraal et al (34) scored weak for selection bias because potential participants were selected from a 48 general practice list through written invitation (15). This was not backed up by any additional methods of recruitment. It most likely means that potential participants who did not visit their general practitioners will not have a chance be included in the study. In addition, only 56% (2307/4111) of contacted participants agreed to participate and were screened for eligibility. According to the assessment tool, this reduces representativeness to the target population and thus a potential selection bias.

Study design: All the studies were assessed to have a strong score in the kind of study design used for the intervention program. All the studies were classified as RCTs. The methods of
randomization were described in the study and were deemed appropriate. For example, individual participants in Telle-Hjellset\(^{(22)}\) study were randomized using a computer generated list of numbers. Participants were allocated on a 1:1 ratio using random block sizes. According to the study, the allocation sequence was concealed from all personnel, including the researchers and assistants in charge of enrolling and assessing participants.

**Blinding:** All the studies scored strong for the blinding process, meaning that neither the outcome assessors nor researchers were aware of the intervention status of the participants. In addition, participants of the studies were not aware of the research questions for the intervention program. Bhopal *et al*\(^{(26)}\) in their study allocated families and not individuals into either the intervention or control group. The allocation into either groups were concealed from both the researchers and the participants. Nevertheless, they stated in their study that there was no masking of group status during the data collection process except for year 3. The status of the groups were hidden from the independent nursing who collected data in the third year, therefore the results from the third year were used for the analysis.

**Confounders:** It was stated in writing and tables in two studies \(^{(22, 34)}\) that there were no important differences between the groups prior to implementation of the intervention. However, in Bhopal *et al*\(^{(26)}\) study, the individual variables were almost the same except for physical activity and cholesterol lowering medication. These variables are associated with the intervention and the outcome of interest, which is weight change. These variables were nevertheless controlled in the analysis of the outcome measurement and therefore did not influence results obtained. It was rated as ‘strong’. In like manner, the participants in the intervention group in Andersen *et al*\(^{(31)}\) study had a significantly higher level of physical activity at baseline compared with the control group. This study was scored as ‘strong’ since adjustments were adequately made to avoid bias. It was however stated in the study that this most likely reduced the intervention effect of the study compared to a situation where both groups were similar.

**Data collection methods:** Methods used in the data collection by all the four interventions received a high score. This was attained because studies provided details of the sources of data, which included assessments by experts, self-reported data and from vital medical records. Details of the process and tools used in the data collection were explicitly documented. The data collection tools seemed to be valid and reliable.

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The word ‘trial’ ‘studies’ and ‘intervention’ are used interchangeable in this review to mean the same thing (intervention program).
Withdrawal and dropouts: The number of participants that dropped out at the beginning and during the study were documented. In addition, the various reasons for withdrawals during the study were also documented. Three of the studies retained between 94-100% of enrolled participants to the end of the intervention program\(^{(31)}\). This means that data was available for these percentage of participants for the analysis. However, in Admiraal \textit{et al}\(^{(34)}\) study, data was available for only 63% of the randomized participants, almost equally distributed in the control and intervention groups. The characteristics of the dropouts were reported to be similar thus, this most likely did not introduce biases in the results obtained from both groups. This study was therefore scored as moderate for the required withdrawal and drop out expectation.

Intervention integrity: The integrity of the intervention as defined in the dictionary\(^{(48)}\) varied across studies. In Telle-Hjellset \textit{et al}\(^{(22)}\) study only 20% of the participants received the full intervention which included attendance to all six group sessions. The number of sessions received by participants were stated in the study and were included in the final analysis of the results. The intervention was administered in the same manner for all participants in the intervention and control groups as required. There was no likely contamination in the intervention since the control group did not receive program intended for the intervention group. It is unlikely from the data provided in Telle-Hjellset \textit{et al}\(^{(22)}\) study that participants received an unintended intervention likely to influence the results obtained. In Andersen \textit{et al}\(^{(31)}\) study, all participants enrolled, participated in three out of four of the interventions. One of the interventions was however attended by 60% of the participants enrolled. None of the participants in the control or intervention groups received programs intended for the other. No unintended intervention were administered that could have most likely influenced the results of the intervention. Bhopal \textit{et al}\(^{(26)}\) stated that the mean number of visits for the intervention group was 13.7 out of 15 visits, which is about 91%. In addition, dietician’s visits is stated to be completed as planned for participants. Similar to the other studies, there was no unintended intervention and participants received the programs intended for them. 46 out of 131 (35\%) participants in Admiraal \textit{et al}\(^{(34)}\) study received the complete intervention. The intervention was consistently in line with the initial plan. There is no record of any likely contamination likely to have been caused by an unintended intervention to either the control or the intervention group.
In conclusion, the quality of the studies may have been compromised in one way or the other but not strong enough for exclusion from the review. The risk assessment of these studies was graded as strong for Telle-Hjellset et al(22), Andersen et al(31) and Bhopal et al(26) and moderate for Admiraal et al(34) as shown in table 3.
The word ‘trial’ ‘studies’ and ‘intervention’ are used interchangeable in this review to mean the same thing (intervention program).

<table>
<thead>
<tr>
<th>Author</th>
<th>Selection Bias</th>
<th>Study Design</th>
<th>Confounders</th>
<th>Blinding</th>
<th>Data Collection Methods</th>
<th>Withdrawals and Dropouts</th>
<th>Intervention Integrity</th>
<th>Analyses</th>
<th>Overall Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Telle-Hjellset et al(^{(22)})</td>
<td>Strong</td>
<td>Strong</td>
<td>Strong</td>
<td>Strong</td>
<td>Strong</td>
<td>Strong</td>
<td>Strong</td>
<td>Strong</td>
<td>Strong</td>
</tr>
<tr>
<td>Bhopal et al(^{(26)})</td>
<td>Moderate</td>
<td>Strong</td>
<td>Strong</td>
<td>Strong</td>
<td>Strong</td>
<td>Strong</td>
<td>Strong</td>
<td>Strong</td>
<td>Strong</td>
</tr>
<tr>
<td>Admiraal et al(^{(34)})</td>
<td>Weak</td>
<td>Strong</td>
<td>Strong</td>
<td>Strong</td>
<td>Moderate</td>
<td>Strong</td>
<td>Strong</td>
<td>Strong</td>
<td>Moderate</td>
</tr>
<tr>
<td>Andersen et al(^{(31)})</td>
<td>Strong</td>
<td>Strong</td>
<td>Strong</td>
<td>Strong</td>
<td>Strong</td>
<td>Strong</td>
<td>Strong</td>
<td>Strong</td>
<td>Strong</td>
</tr>
</tbody>
</table>

Source: Author\(^{(40)}\)
4. INTERVENTION EFFECTS

4.1 How the intervention works; why and for whom; the importance of practical demonstrations

It first starts with information dissemination, then demonstration of intervention, which may lead to understanding, empowerment and hopefully lifestyle change. In the intervention groups, all the reviewed interventions provided information to participants with the aim of increasing awareness on the need to reduce the risk of T2D by making changes to their dietary and physical activity habits. These pieces of information were given in the form of counselling to individuals or groups. Intervention coordinators provided insights on healthy lifestyle while trying to convince participants to make personal decisions to live healthily.

Most of the authors agreed that the provision of information is inadequate unless accompanied by some practical teaching. Bhopal et al.(26) stated that the simple provision of information about diet and physical activity in their intervention did not stop or reduce the risk of T2D but rather a moderate intensity intervention incorporating diet and physical exercise led to positive results. Advice was therefore given, not just as doctrine of dos and don’ts but rather involved practical demonstrations of how to adjust one’s lifestyle(22). It was done by showing participants how these pieces of advice can be utilized on a daily basis. As participants were exposed to the right products or ingredients, how to use them as well as the kind of physical exercise to engage in, they most likely developed an understanding and thus a personal will to do as demonstrated.

In addition, through participation in these demonstrations, participants get firsthand information on the effects of the choices they made during the study period. The reduction or increase of the risk of T2D during this period most likely empowers participants to follow intervention guidelines during and after the intervention. A follow up study conducted by Andersen et al.(49) six months after the end of the intervention evaluated physical activity levels. In this study, they found that the intervention yielded both short term and long term habitual physical activity. Råberg et al.(32), also stated in their article on Telle-Hjellset et al.(22) intervention that intention to change behavior increased with the number of attendances in the intervention period. The more participants are exposed to information and how to use it, the most likely their behavior or an intention to change behavior could be affected.
The point in this explanation of behavior change is that, as seen from the interventions, participants are likely to have a higher probability of reducing their risk as well as changing their behavior in the long and short term as they participate in interventions that provide both information and demonstrations on lifestyle change. This is seen in the difference in outcomes in the interventions groups compared to the control groups. This method in addition to various cultural adaptions for South Asians may have contributed to the positive effects in at least three of the four studies reviewed in this study.

4.2 Study Outcomes (Effects)

The primary outcome for this review is change in weight after the intervention. It also assesses other outcomes that led to the reduction in the risk of T2D. Details of effects from each study are outlined in table 4.

Three of the interventions measured weight change \(^{(22, 26, 34)}\). Bhopal et al\(^{(26)}\) found a significant change (p=0.0076) in weight in the intervention group compared with the control group. At baseline, the intervention group had a mean weight of 79.77 kg compared with the control group of 80.36 kg. At the end of the intervention, the control group had gain more weight (80.99 kg) compared to its baseline and compared to the intervention group. They concluded that the intervention resulted in at least a 2.5 kg reduction in weight over the period of three years in the intervention group. This meant that three years of providing 15 dietician visits and physical activity was likely to lead to weight reduction in this population compared to annual contact and simple lifestyle advice received by the control group. In another study, Admiraal et al\(^{(34)}\) measured weight change after the one year intervention period. They found no significant change in weight between the intervention and the control group. The difference in weight between the intervention and control group was 0.6 kg. The intervention group however lost 0.2 kg weight after one year whereas those in the control group gain weight (0.4 kg) after the intervention period. The change in weight between the groups was however not significant. They found out that attendance and maintenance of the lifestyle counselling did not in any way influence the change in weight among participants. They however concluded that the one-year intensive lifestyle intervention in general practice did not effectively change the weight of the population in study. Andersen et al\(^{(31)}\) recorded an adjusted mean difference of -1.9 kg (p value less than 0.01) between the intervention and the
control group at the end of the intervention. This means that the intervention group lost weight of 1.9kg less compared with the control group in the study.

*Waist circumference* is one of the secondary outcomes for this review and it was measured in all four studies. An increase in waist circumference (above 90cm for men and 80cm for women)\(^{(26)}\) is an indication of an increased risk of metabolic syndrome which is a risk factor of T2D. Bhopal *et al*\(^{(26)}\) observed a significant reduction of 1.89cm (p value of 0.0072) in waist circumference among the intervention group after three years compared with the control group. In their study both the intervention and control group had a reduction in waist circumference compared with their baseline results but this difference was significant in light of the intervention effect between the intervention and control groups. Admiraal *et al*\(^{(34)}\) recorded no significant reduction in waist circumference in the intervention group and compared to the control group (p value 0.50). The intervention group at one year had a mean waist circumference of 95cm whereas the control group had 94cm. This means that the intervention in Admiraal *et al*\(^{(34)}\) study had negative effect on the waist circumference of the intervention group compared with the control group. There is not enough data needed to provide reasons why this occurred between the groups. After the five-month intervention by Andersen *et al*\(^{(31)}\), they recorded a significant reduction of 3.4 cm in waist circumference among participants in the intervention group compared with the control group (p value less than 0.01). There was a mean difference of 1.7cm in waist circumference between the intervention and control group in Telle-Hjellset *et al*\(^{(22)}\) study. This difference was however not a significant effect of the intervention (p value 0.184). BMI reductions followed the same trend as change in waist circumference in the various interventions.

*Blood pressure* was measured in three\(^{(34)}\) of the studies except the study by Andersen *et al*\(^{(31)}\). There was no significant difference found in the blood pressure response (systolic and diastolic measurements) between the intervention and the control groups.
The word ‘trial’ ‘studies’ and ‘intervention’ are used interchangeable in this review to mean the same thing (intervention program).

Table 4. Outcome measurements

<table>
<thead>
<tr>
<th>Study</th>
<th>Intended results</th>
<th>Variable measured</th>
<th>Mean change in intervention group compared to baseline measurements</th>
<th>Mean change in control group compared to baseline measurements</th>
<th>Overall effect between intervention and control groups (P value)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Andersen et al[31]</td>
<td>Increased physical activity, cardiorespiratory fitness and reduced insulin concentration in the intervention group than the control group.</td>
<td>Waist circumference (cm)</td>
<td>-1.9</td>
<td>+1.7</td>
<td>Less than 0.01</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Glucose 2h (mmol/L)</td>
<td>-0.6</td>
<td>-0.6</td>
<td>0.4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Weight change (kg)</td>
<td>-1.7</td>
<td>+0.3</td>
<td>Less than 0.01</td>
</tr>
<tr>
<td></td>
<td></td>
<td>BMI (kg/m²)</td>
<td>-0.5</td>
<td>+0.3</td>
<td>Less than 0.01</td>
</tr>
<tr>
<td>Admiraal et al[34]</td>
<td>Intervention group lost weight but not significant. Small changes in waist circumference, fat mass, blood pressure in both groups.</td>
<td>Weight change (kg)</td>
<td>-0.2</td>
<td>+0.4</td>
<td>0.08</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Waist circumference (cm)</td>
<td>+1</td>
<td>+2</td>
<td>0.50</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Systolic Blood Pressure (mm Hg)</td>
<td>+2</td>
<td>0</td>
<td>0.18</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Diastolic Blood Pressure (mm Hg)</td>
<td>-2</td>
<td>-2</td>
<td>0.51</td>
</tr>
<tr>
<td></td>
<td></td>
<td>BMI (kg/m²)</td>
<td>-0.1</td>
<td>+0.1</td>
<td>0.09</td>
</tr>
<tr>
<td>Bhopal et al[26]</td>
<td>Higher level of Weight reduction in the intervention group than the control group compared with baseline results. Intervention group had a lower though not significant progress to</td>
<td>Weight change (kg)</td>
<td>-1.01</td>
<td>+0.31</td>
<td>0.0076</td>
</tr>
<tr>
<td></td>
<td></td>
<td>BMI (kg/m²)</td>
<td>-2.28</td>
<td>0.08</td>
<td>0.0112</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Waist circumference (cm)</td>
<td>-2.18</td>
<td>-0.41</td>
<td>0.0072</td>
</tr>
</tbody>
</table>
The word ‘trial’ ‘studies’ and ‘intervention’ are used interchangeable in this review to mean the same thing (intervention program).

<table>
<thead>
<tr>
<th>Source</th>
<th>Effect</th>
<th>Parameter</th>
<th>Change</th>
<th>t-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Telle-Hjellset et al (22)</td>
<td>T2D compared to the control group</td>
<td>Glucose tolerance (2-h plasma glucose in mmol/l)</td>
<td>-0.83</td>
<td>-0.28</td>
<td>0.1428</td>
</tr>
<tr>
<td></td>
<td>Change in fasting blood glucose, fasting insulin. Regression of metabolic syndrome, More attendance better effect.</td>
<td>Waist circumference (cm)</td>
<td>-0.14</td>
<td>+0.58</td>
<td>0.184</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Systolic Blood Pressure</td>
<td>-1.2</td>
<td>-1.6</td>
<td>0.795</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Diastolic Blood Pressure (mmHg)</td>
<td>-1.5</td>
<td>-0.7</td>
<td>0.393</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Glucose level after 2 hours (mmol/l)</td>
<td>-0.01</td>
<td>-0.191</td>
<td>0.186</td>
</tr>
<tr>
<td></td>
<td></td>
<td>BMI</td>
<td>-0.28</td>
<td>-0.08</td>
<td>0.183</td>
</tr>
</tbody>
</table>

- ‘-‘ sign indicates a reduction in the measurement and ‘+’ sign indicates an increase in measurement.

Source: Author(40)
All four studies measured glucose tolerance. Even though there was a reduction in 2-h plasma glucose measurements (from 8.21-7.38mmol/l) within the intervention group in Bhopal et al\textsuperscript{(26)} study, there was no significant difference (p value 0.1428) between the intervention and control group. The intervention thus did not have a positive effect on the 2-h plasma glucose with reference to the two groups. Likewise in the study by Admiraal et al\textsuperscript{(34)} no significant difference in fasting glucose (p value 0.66) and 2-h glucose (p value 0.44) was found between the intervention and control group. In the study by Andersen et al\textsuperscript{(31)} they recorded a fasting and postprandial glucose levels that were within normal range in the intervention and control group. There was no significant difference between the intervention and the control group measurements after five months. There was significant reduction of 0.53 within the intervention group with respect to 2-h plasma glucose in the Telle-Hjellset et al\textsuperscript{(22)} study. Nevertheless, the intervention had no significant effect in reducing the 2-h plasma glucose between the intervention and the control group (p value: 0.186) as shown in table 4.

4.3 Strengths and weaknesses in the conduct of interventions.

The strengths and weaknesses identified in the review process did not necessarily lead to effectiveness of the intervention. It is hard to conclude from the data provided in the studies what factors might have led to the intervention effects obtained. However, the various modes of conduct are methods that can be adapted by other intervention coordinators to either increase participation, retain participants or familiarize themselves with the target population. These are outlined in the following paragraphs.

4.3.1 Recruitment strategy

Recruitment procedures varied among the various studies and these were listed as strengths in these studies. Telle-Hjellset et al\textsuperscript{(22)} adopted the use of a multi-recruitment method where participants were sought for from various places and through various means. They stated that from previous experience, the use of this method gained more participants that using just one method of recruitment. Their multi-recruitment method included visits to the mosque where majority of the target group were to be found. A visit to the language school because most of the Pakistani women they were targeting were likely to be enrolled in these Norwegian language classes. Visiting and recruiting participants in their local communities also proved successful. This success was also realized by Bhopal et al\textsuperscript{(26)} as they combined community
The word ‘trial’ ‘studies’ and ‘intervention’ are used interchangeable in this review to mean the same thing (intervention program).

recruitments, personal approaches and record data from the National Health Service. Bhopal \textit{et al}\textsuperscript{(26)} also stated that, community involvement in combination with personal approaches (responsible for 83\% of the recruited participants) for recruitment purposes were the most successful compared with recruitment through the National Health Service (General practice). Most of the target population recruited in the Andersen \textit{et al}\textsuperscript{(31)} were Pakistani who are mostly Muslims thus six visits to mosque and to Muslim festivals in Oslo was also a way of recruiting from this ethnic population. Islam is the state religion in Pakistan, with about 95\% of the citizens identifying as Muslims\textsuperscript{(50)}. It is thus important to identify with the target population on a personal, social and even religious level throughout the intervention process in order to ensure familiarity and gain trust among the people.

One of the reasons likely to have contributed to the huge drop out in Admiraal \textit{et al} \textsuperscript{(34)} study was their method of recruitment which was less individualized than that of those discussed. In this study, potential participants were recruited through letters of invitation and follow up phone calls. Even though these letters were structured in a way that suited the South Asian community by the use of their national flag, a celebrity note and a detailed description of their risk to T2D, it still resulted in a low turn up of participants during the screening and the main intervention program. In a South Asian community where strong personal and family relationships are a reflection of belongingness, the use of personal approaches have been shown to be more effective than other multimedia methods\textsuperscript{(26)}.

\textbf{4.3.2 Length of time for recruitment and intervention}

Enough time should be allocated to the screening and recruitment process depending on the funds available and the outlined objectives of a study. Planning and allocating enough time to the screening and recruitment process provided some advantage in some of the studies as compared with others. For example, the design and execution of Bhopal \textit{et al}\textsuperscript{(26)} and Admiraal \textit{et al}\textsuperscript{(34)} study are similar nevertheless, Admiraal \textit{et al}\textsuperscript{(34)} had less success with recruitment and retention of participants compared with Bhopal \textit{et al}\textsuperscript{(26)}. This is most likely because of the time needed to recruit and follow up participants. It is unclear from Admiraal \textit{et al} \textsuperscript{(34)} study whether shortage of time in the intervention process was most likely responsibly for the results attained in outcomes and dropouts. In addition, setting realistic objectives from the start of the study is important so as to prevent problems that might arise when objectives are to be changed in the middle of the study as seen with Bhopal \textit{et al}\textsuperscript{(26)} and Admiraal \textit{et al}\textsuperscript{(34)}. 

\textsuperscript{41}
4.3.3 Family involvement

Bhopal et al\textsuperscript{26} reported in their study that family involvement, eating together and hospitality are important aspects of the socio-cultural life of the South Asian individual. Even though it was hard to tell from their report how much of the effect size was contributed by family involvement, it is most likely important when it comes to recruitment and retention of participants in the intervention process. Admiraal et al\textsuperscript{34}, also emphasized the need to involve families in the intervention process since for the Surinamese people, eating is regarded as a social interaction involving mostly family or friends. Food plays an important role on the daily basis and during party which are organized often\textsuperscript{15}. Preparation of large amounts of foods and snacks is a necessity so as to account for unexpected guests\textsuperscript{15}. In addition, eating in their gatherings are often regarded as obligatory or act of kindness\textsuperscript{15}. In order to encourage a person from such a social-cultural background to alter their lifestyle, it is important to understand what that lifestyle is, the foundations of the lifestyle and the people that help build that lifestyle. They therefore recommended that families should be included in the intervention process as this provides social support for the participants.

4.3.4 Cultural adaptations made in the interventions

The interventions made adaptations in line with the South Asian culture as well as provided additional support with the daily responsibilities of participants. This might have facilitated in the smooth conduct of the study. Nevertheless, there is little data available in the articles to make strong conclusions concerning this.

These adaptations were made by been culturally sensitive to the target population. According to Resnicow et al\textsuperscript{51}, cultural sensitivity is defined as ‘the extent to which ethnic/cultural characteristics, experiences, norms, values, behavioral patterns and beliefs of a target population as well as relevant historical, environmental and social forces are incorporated in the design, delivery and evaluation of targeted health promotion interventions’. Thus adaptations are done through an understanding of the behavior, experiences etc. of the target population and how this is likely to influence the impact of the intervention.

Through the involvement of community members most of the studies made adaptations to the South Asian population in which they conducted their study. These collaborations provided

The word ‘trial’ ‘studies’ and ‘intervention’ are used interchangeable in this review to mean the same thing (intervention program).
insights into the challenges South Asians face in trying to live healthy, and the various recommendations appropriate for them.

Telle-Hjellset et al\textsuperscript{(22)} employed surface adaptations by culturally adapting the language, pictures, figures and advice given during the intervention program. The main goal in Telle-Hjellset et al\textsuperscript{(22)} study was to provide the Pakistani immigrant women with knowledge and tools needed to make adjustment to their everyday life (diet and physical activity) in order to reduce their risk of getting T2D. Through consultations with community members, it is most likely they understood the content of the everyday life of the Pakistani woman. Access to this information most likely helped in the adjustments made in the health recommendations for to this group. They stated that the lifestyle changes they recommended were meant to fit the culture, social and family situation of the South Asian (Pakistani) woman. Telle Hjellset et al\textsuperscript{(22)} acknowledge that, before a lifestyle change could be made, there is a need for empowerment and a personal will to make such changes. Recommendations for specific lifestyle changes were made from a place of understanding of what the needs and challenges of this target group was. In addition, Telle-Hjellset et al were sensitive to the gender roles of their participants\textsuperscript{(22)}. They therefore provided childcare facilities for women who had children so they could actively participate in the intervention without disruptions from the children. All the research personnel in the study were female thus creating a common ground for the Pakistani women. Adaptations in Telle-Hjellset et al\textsuperscript{(22)} study were also sensitive to participants’ length of stay in Norway and their command of the Norwegian language. Interventions were thus administered in the preferred language of the participants with an interpreter when needed. This study concludes by stating that these cultural adaptations seems to have been successful. This is because there was no difference in for example blood parameters with length of stay in Norway and with command of the Norwegian language. In addition, they stated that cultural adaptations made through empowerment of participants seems to have been successful by providing participants with appropriate ways to adjust their everyday lives to reduce their risk to T2D.

Admiraal et al\textsuperscript{(34)} through focus group discussions with the target population also made both surface and deep cultural adaptations to the design and implementation of the study. Surface adaptations were made through alteration of interventions material while the deep adaptations focus on the socio-cultural beliefs that influenced behavior. For example during the intervention\textsuperscript{(34)}, questions were drafted and asked in relation to the eating of masala and

The word ‘trial’ ‘studies’ and ‘intervention’ are used interchangeable in this review to mean the same thing (intervention program).
getting T2D as well as eating bitter leaves and preventing diabetes\textsuperscript{(15)}. This was all in a quest to shed light on the underlying cultural beliefs that influence behavior change concerning diet and physical activity. Through these discussions, they gained insight into the personal and social determinants of health among the Hindu-Surinamese people.

Likewise, through two focus group discussions with representatives from male Pakistani group, Andersen \textit{et al}\textsuperscript{(31)} gained understanding of some aspects of the Pakistani lifestyle and were thus able to amend the key concepts underlying their intervention. They therefore decided to target concepts focusing on how the environment, an individual’s behavioral capability, self-control, self-efficacy, expectations and expectancies can promote physical activity. They discovered from the discussions that the men had little knowledge about physical activity and how it is linked to healthy living. Furthermore, they gained insights into the barriers (e.g. time management) that prevented these men from engaging in as much physical exercise as required. It is unclear from the study the degree of contribution these adaptations added to success of the intervention. The authors however believe that the use of a participatory approach in the development and planning of the intervention seems to have been essential in ensuring success of the intervention.

The intervention by Bhopal \textit{et al}\textsuperscript{(26)} was developed from the Finish Diabetes Prevention Studies (FDPS), which was implemented in a largely white Northern European population\textsuperscript{(33)}. In order to implement this intervention among the South Asians living in Scotland UK, major cultural adaptations were therefore necessary. These adaptations were mainly influenced by experiences from the trial staff and coordinators of the interventions who had relevant insights into the language, religion, customs and lifestyle of the South Asian population\textsuperscript{(33)}. For example, it is stated that the homes of participants were used as intervention centers mainly to encourage family involvement, appointment keeping and retention during the trial period\textsuperscript{(33)}. In addition, age criteria for the trial was lower than that of the FDPS mainly because the South Asian population are at risk of T2D at a younger age than the European population. Necessary adaptations were also made to the language used by dieticians and research personnel. Data collection material like questionnaires were also translated from English to Urdu and Gurmukhi and adapted to suit the South Asian dietary and physical activity habits\textsuperscript{(33)}. It is stated at the end of the trail that one of the strengths of the intervention program was its ability to adequately adapt the trial to the South Asian population. Nevertheless it is
unclear from the report\(^{(26)}\), the direct contribution made by these adaptations to the overall effectiveness of the trial.

It is important to note that there is little data available in the various interventions to make conclusions about the effect of these adaptations on the overall effectiveness of the interventions among the South Asian population. Nevertheless, these adaptations may have contributed in one way or the other to the success of the conduct of the intervention in terms of participation, retention and follow up.

The word ‘trial’ ‘studies’ and ‘intervention’ are used interchangeable in this review to mean the same thing (intervention program).
5. DISCUSSIONS

5.1 Summary of main results
This review has examined published studies on the effectiveness of dietary and/or physical activity intervention programs among the South Asian population with the aim of reducing the risk of T2D among at-risk individuals. It also reviewed the various procedures used in the conduct of the intervention. The case of the South Asian and T2D risk is one of urgent concern. It is therefore important that preventive measures be put in place to control the onset of this condition. The measures (interventions) put in place should first of all suit the South Asian population and also aim at reducing their risk to T2D. This review therefore sought to shed light on effectiveness and suitability of these interventions among this population.

Three of the studies found that a dietary and physical activity intervention that include education and practical demonstrations generated significant effects in reducing the risk of T2D among South Asians. Bhopal et al(26) found that actively involving participants through dietician visits, food shopping and organized physical activity sessions generated significant results. This intervention resulted in more people in the intervention group loosing 2.5kg compared with those in the control group. In addition, they found significant results in reductions in BMI and waist circumference in the intervention compared with the control group. Furthermore, involving South Asian women in a seven-month intervention involving educational sessions on the importance of proper dieting and physical activity, as well as actively involving participants in physical exercise generated significant results(22). Telle-Hjellset et al found that this intervention was able to improve blood glucose and blood pressure though non-significant with respect to waist circumference and BMI(22). Finally, an intensive physical activity for five months was effective in reducing weight, improving insulin concentration and increasing the total physical activity level(31). Presumably, these changes would imply a reduction in the risk of T2D among participants.

Concerning weight reduction, which is the main objective of this study, the evidence is inconclusive. Two of the interventions showed significant changes in weight reduction among participants (26, 31). One of these two (Andersen et al(31)), however conducted the study among participants who could speak the language of the host country (Norwegian) and also among Men. There is therefore the likelihood of missing potential participants who do not speak Norwegian language. In addition, the intervention focused exclusively on the effectiveness of

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physical activity. It is therefore unknown how effective this intervention would have been among non-men and South Asians who do not speak Norwegian. Conclusions on effectiveness of this intervention can be made only in reference to Norwegian speaking South Asian men. Overall judgement of the effectiveness of the interventions on weight reduction among South Asian is therefore inconclusive.

All the studies highlighted the need and importance of culturally adapting interventions to suit the South Asian community. Through adaptation of intervention material to the conceptual framework of the intervention, they were able to delve deeper into the South Asian dietary culture and barriers that hindered physical activity. This information provided insights into proper ways of administering intervention to achieve a good response from the South Asian population. Some of these adaptations especially ones that focused on the social-cultural values of the population most likely influenced the effectiveness of the intervention even though the extent of this effect is not known. A proper understanding of the life of participants (as well as their family conditions) helps in drafting an appropriate lifestyle intervention most likely to generate the needed effects.

Three of the studies discussed the need for applying a personal approach to the recruitment process, as this is helpful in the South Asian community. South Asians are social people who place importance on belongingness and respect for each other\(^\text{(26)}\). Therefore, inviting this group of people for an intervention should be done on a personal level (in person), as this is most likely seen a sign of recognition and respect to them. Telle-Hjellset et al reported that their recruitment method was regarded as successful\(^\text{(22)}\). They retained 80.8% even after exclusion before the trial and retained 100% of the participants that were present for the intervention for the follow up. Their recruitment process involved personal visits to the mosque, language center etc. to inform and invite participants. Even though it not clear from the study how much of this process influenced the effectiveness of the study, it did help in reaching the target group and retaining them until the end. On the contrary the use of invitation letters and phone calls did not yield much in the case of Admiraal et al\(^\text{(34)}\). Out of the 10,583 persons invited for initial eligibility screening, 8276 were included, of which 1804 actively decline, 298 did not show up and 4467 were not reachable. The point here is not to say that their approach is what resulted in the outcomes attained in the study but at least it influenced the recruitment process. Interestingly, Bhopal et al\(^\text{(26)}\) admit to the idea that their approaches to recruitment involving personal approaches yielded more results (83%) than

\[^{26}\text{The word ‘trial’ ‘studies’ and ‘intervention’ are used interchangeable in this review to mean the same thing (intervention program).}\]
those that involved no facial contact. In effect, recruitment in this community is likely to yield better results if conducted through community members or any other approach that involves facial appearance.

5.2 Assessment of the evidence
The overall quality of reviewed articles was assessed as ranging from moderate to strong score using guided quality assessment tools\(^{(38)}\). It was accessed as strong \((22, 26, 31)\) and moderate \((34)\). In addition, the synthesis process was done in a systematic manner, following guidelines provided by CRD\(^{(37)}\). The synthesis process was transparent and clear, highlighting the strengths and limitations of included studies. The evidence provided in this review is therefore most likely of a good quality and there is credibility in the synthesis process.

5.3 Potential limitations in the review
All the interventions were conducted in the diaspora that is outside the South Asian continent, therefore not reflecting the effectiveness of these interventions among South Asia in general. There is also the possibility of missing information that was not published since most of the studies were sort after from databases of published studies and reference list of published articles. Articles selected were also in only English language raising a concern for language bias. One final limitation was the lack of adequate information in the articles needed to make strong conclusions on behavior change and the exact contribution of the cultural adaptations and other procedural methods to the effectiveness of the studies.

5.4 Comparison with results from other similar reviews
There are still on-going studies accessing the effectiveness of interventions among South Asians with some overlapping results among the ones that have been published. These overlapping results are in line with observations made in this review. Martin \(\text{et al}^{(36)}\) & Chapman \(\text{et al}^{(23)}\) mention in their review the importance of cultural adaptations and like this review agree that it is unclear the exact effect these cultural adaptations have on the overall effectiveness of the dietary and physical activity interventions.

The word ‘trial’ ‘studies’ and ‘intervention’ are used interchangeable in this review to mean the same thing (intervention program).
It was also observed that programs that incorporated community members in the planning and recruitment of participants yielded more positive results with regards to the number of dropouts recorded in various studies. Chapman et al \(^{(23)}\), also stated in their review that positive effects were realized more with interventions that involved community members. In Martin et al\(^{(36)}\) study, they agreed that involving community and family members in an intervention helps to examine the barriers to lifestyle change in South Asians. Similar to this review, the inclusion of trained intervention coordinators who spoke the local language appeared to have contributed to the acceptability and retention of participants during the intervention program for some of the studies in Chapman et al\(^{(23)}\) review.

Three of the studies in this review similar to studies in Chapman et al\(^{(23)}\), appear to have also acknowledged the importance of undertaking qualitative studies among the target population prior to the intervention in order to gain an understanding of the population under study. This throws more light to the idea that interventions among South Asians designed and recruited with the help of the community and family members are likely to generate better results than those planned, organized and executed through formal arrangements. This is likely to create trust among the people concerning the safety of the program since recommendations to participate are made from their own people.

Allocating enough time for recruitment and implementation as well as follow up is important as it allows enough time for acceptance and understanding of the intervention, thus participation. Martin et al\(^{(36)}\) similarly reports that the time allocated for the intervention program affects recruitment and drop outs and might lead to alteration in the study objective.

Finally, the inconclusive report on the effect of dietary and physical activity interventions in reducing weight among the South Asian population is similar with conclusions made in Martin et al\(^{(36)}\) and Chapman et al\(^{(23)}\).

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The word ‘trial’ ‘studies’ and ‘intervention’ are used interchangeable in this review to mean the same thing (intervention program).
6. CONCLUSION

It is inconclusive from the available evidence the effectiveness of the intervention in reducing weight among the South Asian population. Nevertheless, there is an increase likelihood of success when efforts are made to culturally adapt the interventions to suit the South Asian population. Interventions that are organized for South Asians should therefore be culturally adapted to suit the South Asian population. A proper adaptation can be done in consultation with community members prior to the design and implementation of the intervention. Recruitments in the South Asian community can yield better results if it involves personal or facial contact with potential participants. Involving family members in the intervention process could provide social support for South Asian participants during the intervention. Recommendations from this review can be useful for other population bearing in mind the respective cultural adaptations suitable for that ethnic group. Further investigation is also needed on the exact contribution of family involvement to the effectiveness of the intervention. Behavior change in the short and long term should be monitored after the intervention to estimate the sustainability of these interventions among South Asians. In addition future researchers should provide adequate information needed to assess the factors that have led to the effectiveness or otherwise of the interventions. Finally, further research is needed to shed more light into the effectiveness of dietary and physical activity interventions on weight loss and the risk of T2D among this population.

7. DECLARATION OF CONFLICTING INTERESTS AND FUNDING

The author declares no potential conflicts of interests with respect to the design, execution and publication of this review. The author received no financial support for the research and publication of this review.

The word ‘trial’ ‘studies’ and ‘intervention’ are used interchangeable in this review to mean the same thing (intervention program).
APPENDICES

APPENDIX 1: Procedure for Data Collection

Below is a table of sentence-structures used in the search of databases for this review

<table>
<thead>
<tr>
<th>Search Combination</th>
<th>Number of Hits</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Type 2 diabetes AND prevention AND South Asians</td>
<td>9</td>
</tr>
<tr>
<td>2. Prevention OR Control AND overweight AND South Asians</td>
<td>5</td>
</tr>
<tr>
<td>3. Diet therapy AND type 2 diabetes AND South Asians</td>
<td>6</td>
</tr>
<tr>
<td>4. Primary Prevention AND type 2 diabetes AND South Asians</td>
<td>5</td>
</tr>
<tr>
<td>5. Weight reduction AND South Asians</td>
<td>5</td>
</tr>
<tr>
<td>6. Intervention AND type 2 diabetes AND South Asians</td>
<td>10</td>
</tr>
<tr>
<td>7. Type 2 diabetes AND South Asians</td>
<td>22</td>
</tr>
<tr>
<td>8. Lifestyle Modification AND type 2 diabetes AND South Asians</td>
<td>0</td>
</tr>
<tr>
<td>9. Physical exercise OR therapy AND intervention AND South Asians</td>
<td>10</td>
</tr>
<tr>
<td>10. Obesity AND Control AND South Asians</td>
<td>5</td>
</tr>
<tr>
<td>11. Lifestyle intervention AND type 2 diabetes AND South Asians</td>
<td>3</td>
</tr>
<tr>
<td>12. Lifestyle change AND type 2 diabetes AND South Asians</td>
<td>2</td>
</tr>
<tr>
<td>13. Dietary modification AND type 2 diabetes AND South Asians</td>
<td>0</td>
</tr>
<tr>
<td>14. Obesity AND prevention AND South Asians</td>
<td>3</td>
</tr>
</tbody>
</table>

These searches were combined with the algorithm ‘OR’ and produced = 27 Hits (58 duplicates within itself= 85 hits)

The word ‘trial’ ‘studies’ and ‘intervention’ are used interchangeable in this review to mean the same thing (intervention program).
The word ‘trial’ ‘studies’ and ‘intervention’ are used interchangeable in this review to mean the same thing (intervention program).

**COCHRANE**

First the filters were activated: Cochrane Central: check for Trials. Publications of all years.

**Search combinations COCHRANE DATABASE:**

1. Diabetes intervention AND South Asians = 18
2. Type 2 diabetes AND South Asians = 21
3. Prevention AND Control AND Overweight AND South Asians = 3
4. Primary prevention AND type 2 diabetes AND South Asians = 5
5. Lifestyle modification AND type 2 diabetes AND South Asians= 0
6. Primary prevention AND obesity AND South Asians =3
7. Physical exercise AND type 2 diabetes AND South Asians= 2
8. Weight reduction AND South Asians =8
9. Type 2 diabetes AND Prevention AND South Asians = 12
10. Prevention AND overweight AND South Asians = 3
11. Control AND Overweight AND South Asians = 5
12. Physical Therapy AND type 2 diabetes AND South Asians = 5
13. Lifestyle AND intervention AND type 2 diabetes AND South Asians =8

Exported individually to endnote 105 Hits …76 duplicates… After duplicates automatically removed in endnote = remaining 29 Hits

**EMBASE**

Multi-field search. Filters: Check for Randomized Control Trials, Humans and Adults 18-64 Years and English.

**Search combinations EMBASE**

1. Prevention AND type 2 diabetes AND South Asians = 2
2. Lifestyle modification AND South Asians= 7
3. Primary Prevention AND type 2 diabetes AND South Asians =2
4. Prevention AND obesity AND South Asians = 3
5. Intervention AND Type 2 diabetes AND South Asians = 9
6. Dietary therapy AND Type 2 diabetes AND South Asians = 0
7. Dietary change AND Type 2 diabetes AND South Asians = 0
8. Dietary modification AND Type 2 diabetes AND South Asians = 0
9. Physical exercise AND Type 2 diabetes AND South Asians = 0
10. Physical exercise AND prevention AND Type 2 diabetes AND South Asians = 0
11. Physical exercise AND South Asians = 1
12. Physical therapy AND South Asians = 2
13. Prevention AND overweight AND South Asians = 1
14. Control AND overweight AND South Asians = 1
15. Control AND obesity AND South Asians = 4
16. Weight reduction AND type 2 diabetes AND South Asians = 1
17. Weight reduction AND South Asians = 4
18. Type 2 diabetes AND South Asians = 12

These searches were combined with the algorithm ‘OR’ and produced = 17 Hits. Seven DUPLICATES in endnote (Ten remaining)

Phrases: Embase first searches for the first word in a phrase and then searches for a combination of the word. The use of ‘AND’ and ‘OR’ are the same as in the other databases as explained above.

WEB OF SCIENCE 30/06/2016

It was also filtered for document type: Article AND NOT Proceedings Paper and Review

Search combinations WEB OF SCIENCE (TS)

1. TS= (Prevention* AND Overweight* AND Type 2 diabetes AND South Asians*) = 2
2. TS= (Prevention* AND Overweight* AND South Asians*) = 13
3. TS= (Dietary change* AND Intervention* AND South Asians*) = 10
4. TS= (Control* AND Obesity* AND South Asians*) = 67
5. TS=(prevention* AND intervention* AND Type 2 diabetes* AND South Asians*)=18
6. TS= (Primary prevention* AND Type 2 diabetes* AND South Asians*)) = 17
7. TS= (Lifestyle modification* AND Type 2 diabetes* AND South Asians*)) = 3
8. TS= (Prevention* AND Type 2 diabetes* AND South Asians*)) = 48
9. TS= (Weight reduction* AND Intervention* AND South Asians*))=6
10. TS= (Weight reduction* AND South Asians*)) = 13
11. TS= (weight reduction* AND Type 2 diabetes* AND South Asians*)) = 3
12. TS= (Physical therapy* AND Intervention* AND South Asians*)) = 0
13. TS= (Physical therapy* AND Type 2 diabetes* AND South Asians*)) = 1

The word ‘trial’ ‘studies’ and ‘intervention’ are used interchangeable in this review to mean the same thing (intervention program).
The word ‘trial’ ‘studies’ and ‘intervention’ are used interchangeable in this review to mean the same thing (intervention program).

14. TS= (Diabetes Intervention* AND South Asians*)) =99
15. Dietary Therapy* AND Intervention* AND South Asians*)) = 1
16. TS= (Dietary Therapy* AND Type 2 diabetes* AND South Asians*)) =0
17. TS= (Obesity* AND Intervention* AND Type 2 diabetes* AND South Asians*)) =9
18. TS= (Obesity* AND Intervention* AND South Asians*)) =33
19. TS= (Physical exercise* AND type 2 diabetes* AND South Asians*)) =6
20. TS=(intervention* AND type 2 diabetes* AND South Asians*)=48

These searches were combined with the algorithm ‘OR’ and produced = 213 Hits

Duplicates removed in endnote nine articles. 204 remaining.

REFERENCES FROM ARTICLES

20 references were manually extracted from the reference list of three systematic reviews. These include:


8 of these references were duplicates, leaving a list of 12 articles.

CONCLUSION

73 abstracts were read and selection was made according to the research questions for the study

- 73 articles selected based on their titles. This is done in reference to the research question and articles were selected if titles
  1. Made reference to South Asians as separate ethnic groups or together.
2. Made reference to T2D
3. Any intervention methods for diet and or physical exercise
4. Mentioned Weight reduction or obesity and overweight control

The final results are produced in a flowchart in appendix 3.

APPENDIX 2: EPHPP Quality Assessment Tool for Quantitative Studies

COMPONENT RATINGS

A) Selection bias

(Q1) Are the individuals selected to participate in the study likely to be representative of the target population?

- Very likely
- Somewhat likely
- Not likely
- Can’t tell

(Q2) What percentage of selected individuals agreed to participate?

- 80 - 100% agreement
- 60 – 79% agreement
- less than 60% agreement
- Not applicable
- Can’t tell

RATE THIS SECTION | STRONG | MODERATE | WEAK
--- | --- | --- | ---
See dictionary | 1 | 2 | 3

B) Study Design

Indicate the study design

- Randomized controlled trial
- Controlled clinical trial
- Cohort analytic (two group pre + post)
- Case-control
- Cohort (one group pre + post (before and after))
- Interrupted time series

The word ‘trial’ ‘studies’ and ‘intervention’ are used interchangeable in this review to mean the same thing (intervention program).
- Other specify ____________________________
- Can’t tell

Was the study described as randomized? If NO, go to Component C.
- No
- Yes

If Yes, was the method of randomization described? (See dictionary)
- No
- Yes

If Yes, was the method appropriate? (See dictionary)

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C) Confounders

(Q1) Were there important differences between groups prior to the intervention?
- Yes
- No
- Can’t tell

The following are examples of confounders:
- Race
- Sex
- Marital status/family
- Age
- SES (income or class)
- Education
- Health status
- Pre-intervention score on outcome measure

(Q2) If yes, indicate the percentage of relevant confounders that were controlled (either in the design (e.g. stratification, matching) or analysis)?
- 80 – 100% (most)
- 60 – 79% (some)
- Less than 60% (few or none)
- Can’t Tell

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D) Blinding

(Q1) Was (were) the outcome assessor(s) aware of the intervention or exposure status of participants?
- Yes
- No
- Can’t tell

(Q2) Were the study participants aware of the research question?
- Yes
- No
- Can’t tell

E) Data Collection Methods

(Q1) Were data collection tools shown to be valid?
- Yes
- No
- Can’t tell

(Q2) Were data collection tools shown to be reliable?
- Yes
- No
- Can’t tell

F) Withdrawals and Drop-Outs

(Q1) Were withdrawals and dropouts reported in terms of numbers and/or reasons per group?
- Yes
- No
- Can’t tell
- Not Applicable (i.e. one time surveys or interviews)
(Q2) Indicate the percentage of participants completing the study. (If the percentage differs by groups, record the lowest).
   - 80 - 100%
   - 60 - 79%
   - less than 60%
   - Can’t tell
   - Not Applicable (i.e. Retrospective case-control)

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G) Intervention Integrity

(Q1) What percentage of participants received the allocated intervention or exposure of interest?
   - 80 - 100%
   - 60 - 79%
   - less than 60%
   - Can’t tell

(Q2) Was the consistency of the intervention measured?
   - Yes
   - No
   - Can’t tell

(Q3) Is it likely that subjects received an unintended intervention (contamination or co-intervention) that may influence the results?
   - Yes
   - No
   - Can’t tell

H) Analyses

(Q1) Indicate the unit of allocation (circle one)
   - Community organization/institution practice/office individual

(Q2) Indicate the unit of analysis (circle one)
   - community organization/institution practice/office individual

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(Q3) Are the statistical methods appropriate for the study design?
- Yes
- No
- Can’t tell

(Q4) Is the analysis performed by intervention allocation status (i.e. intention to treat) rather than the actual intervention received?
- Yes
- No
- Can’t tell

GLOBAL RATING
- Component Ratings:

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- Not Applicable

- Please transcribe the information from the boxes on pages 1-4 onto this page. See dictionary on how to rate this section.

Global Rating for This Paper (Circle One):

1 STRONG (no WEAK ratings)
2 MODERATE (one WEAK rating)
3 WEAK (two or more WEAK ratings)
With both reviewers discussing the ratings:
Is there a discrepancy between the two reviewers with respect to the component (A-F) ratings? No Yes

If yes, indicate the reason for the discrepancy

1 Oversight

2 Differences in interpretation of criteria

3 Differences in interpretation of study

Final decision of both reviewers (circle one):

1 STRONG
2 MODERATE
3 WEAK
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34. Admiraal WM, Vlaar EM, Nierkens V, Holleman F, Middelkoop BJC, Stronks K, et al. Intensive Lifestyle Intervention in General Practice to Prevent Type 2 Diabetes among 18 to 60-Year-Old South Asians: 1-Year Effects on the Weight Status and

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