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Systematic Review on Diabetes Prevention Focusing on Barriers and Facilitators to Lifestyle Changes in US South Asians

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An abstract of
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Abstract

Systematic Review on Diabetes Prevention Focusing on Barriers and Facilitators to Lifestyle Changes in US South Asians

By Lydia Stephney

Background: There is an increased risk of developing type 2 diabetes among South Asians living in the United States. Lifestyle practices, migration to the U.S., and epigenetic mechanisms could possibly explain this elevated risk. In the U.S., there is limited information on how to design intervention programs for South Asians. For successful implementation of lifestyle change, further research must be done on the South Asian culture, including their barriers and motivators. This systematic review aims to describe the previously reported barriers and facilitators to lifestyle changes in U.S. South Asians and determine how culturally tailored programs been modified to South Asian lifestyle behaviors and preferences.

Methods: PubMed was used to search for papers using the identify studies published between 2014-2022 describing barriers or facilitators to healthy diets or physical activity and diabetes prevention programs among U.S. South Asians. The PubMed database identified 7,694 articles. After removing of duplicates and ineligible article, four articles were retrieved and used for this study.

Results: Common barriers for diabetes prevention included gender roles, immigration, social context, family priorities, and the role of food.. Motivators for diet and physical activity include family, diabetes education, emphasis on monitoring and health outcomes, and an environment tailored to South Asian norms.

Interventions used in this population include culturally tailored lifestyle programs with dietary and physical activity components.

Discussion: Diabetes prevention programs tailored to the South Asian culture might be beneficial. It is important to address common barriers because diabetes is significant problem in the South Asian population. Future recommendations include developing group or family-based prevention programs to leverage motivating factors for healthy lifestyles mentioned by this population and encourage social support.

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Chapter 1: Introduction

1.1 Background and Significance

In the United States, roughly 37 million adults are currently diagnosed with diabetes (CDC, 2021b). South Asians, individuals from Pakistan, Bangladesh, India, Sri Lanka, Bhutan, Nepal, and the Maldives, are a growing population in the United States (Das et al., 2017). Globally, South Asians are at an increased risk for developing type 2 diabetes compared to any other race or ethnic group, even at lower BMIs (Narayan & Kanaya, 2020). Compared to other ethnic groups, type 2 diabetes disproportionately affects South Asians living in the United States (Ali et al., 2020). Immigration, urbanization, and lifestyle factors such as sedentary lifestyles, tobacco use, physical inactivity, dietary changes, and sleep duration contribute to the prevalence of this condition (Gujral et al., 2013; Narayan & Kanaya, 2020; Shah & Kanaya, 2014). South Asians tend to develop type 2 diabetes at a higher rate due to the Asian Indian Phenotype. Characteristics of this phenotype include increased insulin resistance (even at lower BMIs) and abdominal fat (Anjana et al., 2020). South Asians also experience greater morbidity and mortality from coronary artery disease, cerebrovascular disease, and chronic kidney disease due to diabetes complications (Shah & Kanaya, 2014).

The influx of diabetes in South Asian Americans has caused more attention to be shifted towards diabetes prevention in individuals with pre-diabetes or those at risk for the disease (Ali et al., 2020). Diabetes prevention programs were designed to prevent or delay the onset of type 2 diabetes. Although these programs focus on "promoting health-protective lifestyle changes," they need to be culturally tailored to the South Asian culture to maximize program effectiveness (Ali

et al., 2020). The large-scale U.S. Diabetes Prevention Program provided significant evidence for diabetes prevention (Kramer et al., 2009). In a pilot study modeled after the U.S. Diabetes Prevention program, found that this culturally tailored program improved cardiometabolic risk factors such as waist circumference, blood pressure, weight, and plasma lipids (Weber et al., 2020). As the need to address cultural precision in diabetes prevention increases, more research is needed to clarify the impact of existing prevention interventions on South Asian Americans (Ali et al., 2020).

The morbidity and mortality associated with diabetes in U.S. South Asians is significant (Shah & Kanaya, 2014). Compared to other racial/ethnic groups, South Asians also tend to have severe outcomes related to diabetes. Research has shown that this population develops diabetes more often, at younger ages, and at lower body mass indices (Narayan & Kanaya, 2020). Thus, developing a culturally tailored intervention to prevent or delay diabetes development is the key to improving the health of this population (Weber et al., 2020). It is also important to note that the barriers to diabetes prevention must also be addressed; first, however, there barriers must be documented by reviewing the literature in this population.

1.2 Problem Statement

Currently, there is limited information on how to design diabetes prevention programs like the diabetes prevention program among South Asian Americans (Weber et al., 2020). Before designing these programs, more research is needed on the South Asian culture including their barriers and motivators to lifestyle change for successful implementation. Given that this

population is disproportionately affected by type 2 diabetes, there is a need to design and test a culturally relevant diabetes prevention program for this population.

1.3 Purpose Statement

The purpose of this systematic review is to examine the barriers and motivators factors to diabetes prevention in U.S. South Asians.

1.4 Research Questions

This systematic review seeks to address the following questions:

1. What are the barriers for diabetes prevention in South Asians living in the United States?
2. What are the motivating factors for diet and exercise improvement in the South Asian American community?
3. How have diabetes prevention programs been culturally tailored to US South Asian lifestyle behaviors and preferences?

Knowing this information could help design better programs targeted for South Asians at risk for type 2 diabetes. Since this population is at high risk for developing the disease, more attention is needed to design culturally relevant programs to for successful outcomes. On a large scale, this would help to fill existing gaps on the South Asian population and provide insight as to how they can prevent developing the disease.

Chapter 2: Literature Review

Global Prevalence of Diabetes

Diabetes is a metabolic disorder that affects millions of people worldwide. Known as one of the top 10 causes of death globally, this condition is in dire need of public health attention. Individuals with this condition are shown to have increased mortality from stoke, cardiovascular disease, cancer, infection, and other conditions. Although progress has been made to reduce the burden of diabetes, it appears to be the second biggest factor reducing the life expectancy worldwide (Lin et al., 2020). The main types of diabetes are type 1 and type 2. Type 2 diabetes is characterized by insulin resistance, resulting from the pancreas inability to produce sufficient insulin to maintain blood glucose levels (Galicia-Garcia et al., 2020). This decline in beta-cell function prevents glucose from being stored in the liver, muscle, and fat cells, leading to abnormal blood glucose levels.

It is estimated that roughly 537 million people are living with type 2 diabetes worldwide (Atlas, 2021). In 2017, this disease contributed to more than 1 million deaths alone. Ranked as the ninth leading cause of mortality, diabetes cases have increased significantly over the past few years. The dramatic increase of type 2 diabetes cases is most notable when compared to the year 1990. During that year, it was ranked as the eighteenth leading cause of death. When looking at type 2 diabetes globally, socio-economic development appears to show a pattern (Khan et al., 2020) When looking at the prevalence of cases in Western Europe, the number of cases is steadily increasing (Khan et al., 2020).

Regarding sex, there is a slight difference in the prevalence of type 2 diabetes across all age groups. Data from Western European and Asian populations suggests that men have a higher prevalence than women. It is estimated that 221 million men and 204 million women worldwide had type 2 diabetes in 2017. When looking at time trends, the prevalence of diabetes has increased in men and women in the last few decades. For instance, the prevalence for men increased from 4.3% in 1980 to 9.0% in 2014. In women, the prevalence went from 5.0% in 1980 to 7.9% in 2014. Interestingly, variations in sex differences have been noted across the lifespan. In women, there appears to increase rates of type 2 diabetes in youth. In men, the prevalence is higher during midlife (Huebschmann et al., 2019).

Type 2 diabetes can lead to serious health complications if not properly treated. These complications include microvascular disorders such as nephropathy, retinopathy, and neuropathy and macrovascular disorders such as heart attack and stroke (DeFronzo et al., 2015). The leading cause of morbidity and mortality is due to macrovascular complications from cardiovascular disease (Killilea, 2002). Several studies have indicated that behavioral, lifestyle, and biological factors contribute to the development of the disease. The increase of cases globally is mostly attributed to increases in weight (obesity and overweight), consumption of unhealthy diets, and physical inactivity (WHO, n.d.). Socioeconomic disadvantages also contribute to the development of diabetes. Not having access to quality treatment and living in environmental that promote unhealthy behaviors increases a person's risk for type 2 diabetes (WHO, n.d.). Specific dietary intakes have been associated with reducing the risk of type 2 diabetes. This diet includes a high consumption of whole grains, leafy green vegetables, and nuts and coffee, with lower intakes of sugar-sweetened beverages, red and processed meats, refined grains, and moderate alcohol

consumption. Regarding behavioral factors, aerobic and resistance training are beneficial. Sedentary behaviors like watching television for long periods of time increases the risk for the disease. Short (≤ 5 hours) and long (≥ 9 hours) of sleep can also increase a person's risk for type 2 diabetes. Independent of body weight, cigarette smoking is also a major risk factor for developing the disease (DeFronzo et al., 2015).

Diabetes in South Asians

Compared to other ethnic groups, South Asians have an increased risk for developing type 2 diabetes (Gujral et al., 2013). This observation was first noted as South Asians moved to high-income countries (Narayan et al., 2021) . Although the prevalence for type 2 diabetes is high in South Asia, the prevalence appears to vary across all countries in this region. In 2011, the estimated prevalence for diabetes was 9.6% in Bangladesh, 4.9% in Bhutan, 8.31% in India, 7.6% in Maldives, 3.0% in Nepal, and 7.8% Sri Lanka. Factors such as socioeconomic development, differences in the prevalence of diagnosed versus undiagnosed cases, and lifestyle factors contribute to these variations. It is estimated that 120.9 million people will develop diabetes in South Asia by 2030. Of those 120.9 million, 90-95% of cases will be type 2 diabetes (Gujral et al., 2013).

In the United States, roughly 37 million people have type diabetes, with 90-95% of them having type 2 diabetes. Although this condition is commonly diagnosed in older adults, more cases are being observed in children and young adults (CDC, 2021b). The prevalence of diabetes varies when looking at race/ ethnic groups. In both men and women, diabetes prevalence was the highest in American Indian/Alaskan Natives (14.5%), followed by 12.1% in non-Hispanic blacks, 11.8%

in Hispanics, 9.5% in Asian Americans, and 7.4% in non-Hispanic whites (CDC, 2021a). Obesity and increased sedentary lifestyles are a major contributing factor to the development of this disease (Skyler & Oddo, 2002). The estimated prevalence of diabetes in Asian Indian Americans, the largest South Asian population, is 23% (Kanaya et al., 2014).

South Asians living in the United States are at an increased risk of developing type 2 diabetes. According to the Mediators of Atherosclerosis in South Asians Living in America (MASALA) study, South Asians are disproportionately affected by type 2 diabetes compared to other race/ethnic groups. The mechanism behind the increased risk is not fully understood. However, it is hypothesized that increased insulin resistance (with lower body mass indexes), increased impaired insulin secretion, and increased fat deposition may be contributing to the development of the disease. Lifestyle practices, migration to the United States, and epigenetic mechanisms could possibly explain this population's type 2 diabetes risk (Gujral & Kanaya, 2021). Potential risk factors for diabetes in this population include migration, physical inactivity, and diet.

Migration: Compared to non-Hispanic Whites, South Asian Immigrants (SAI) display an increased risk for cardiovascular disease (CVD) as well as CVD risk factors (obesity, type 2 diabetes, metabolic syndrome, abnormal blood lipids and glucose levels) (Kandula et al., 2019). Genetic, environmental, and behavioral lifestyle factors are the likely cause of this high prevalence (Palaniappan et al., 2011). Behavior and lifestyle factors appear to be the most significant factors contributing to CVD risks. However, it is unclear what specific practices contribute to unhealthy lifestyles in U.S. SAIs. Majority of the studies focuses on Asian Indian and Pakistani immigrants; thus, the findings cannot be generalized to all South Asian Immigrants (Kandula et al., 2019). With

this notion in mind, more research is needed to further elucidate the differences across various SAI populations.

Physical Inactivity: Research has shown that participation in physical activity decreases the risk of CVD (Hamer & Stamatakis, 2009). In SAIs, low physical activity is a contributor to increased CVD and diabetes. This population is also the least physically active group in the United States (Thanawala et al., 2020). In the South Asian culture, cultural beliefs play a significant role in an individual's physical activity levels. In a review conducted by Daniel and Wilbur (2011), the authors examined physical activity levels in SAIs living in the United States (Daniel & Wilbur, 2011; Kandula et al., 2019). They found that cultural beliefs impacted perceptions of physical activity and its relevance to health conditions such as CVD, diabetes, and other health problems. In this culture, individual physical activity is seen as disrespect to the South Asian culture because it goes against the cultural norm of putting family before self (Daniel & Wilbur, 2011; Kandula et al., 2019). Another study found that pressure to fulfill financial and social obligations to kin (e.g., working long hours) may also be a reason why South Asians have low physical activity levels (Kandula et al., 2019; Lawton et al., 2005).

Dietary Changes: Migration to a Western country exposes South Asians to new foods and preparation methods (LeCroy & Stevens, 2017). Consumption of chips, cola, alcohol, margarine, juice, and fast food has increased with migration (Gujral et al., 2013).This exposure in addition lifestyle changes is suspected of causing new dietary changes in the South Asian population, leading to excessive weight gain. Not only does this increases their risk of obesity, but it also increases the risk of other chronic diseases (LeCroy & Stevens, 2017).

Diabetes Prevention Programs

In response to the high prevalence of diabetes, prevention programs were developed. In 1996, The U.S. Diabetes Prevention Program (DPP) was developed (Gruss et al., 2019) for a randomized controlled trial. The trial proved that at risk individuals could reduce or delay the disease by losing weight through lifestyle changes (increased physical activity and dietary changes (NIDDK, 2021). This random control trial concluded that weight loss (5-7%) and increase physical activity over a year showed a 58% reduction in type 2 diabetes, and the group that used metformin showed a 31% reduction in comparison to the placebo group (Gruss et al., 2019; Knowler et al., 2002). The subjects in this intervention were diverse with a minimum of 50% from different backgrounds across both male and females at high risk for type 2 diabetes (Gruss et al., 2019; Knowler et al., 2002). In a follow-up study, researchers found a reduction of 34% after 10 years for the lifestyle intervention group and 27% reduction with the metformin intervention group (Diabetes Prevention Program Research, 2015; Diabetes Prevention Program Research et al., 2009; Gruss et al., 2019).

In 2010, the National Diabetes Prevention Program was developed to help individuals at risk for type 2 diabetes. This was a large-scale and ongoing implementation of the U.S. DPP trial, which focused on implementation of lifestyle changes (dietary changes and increased physical activity). Known as the largest intervention program, the National DPP has reached over 324,000 individuals across 3,000 organizations (Gruss et al., 2019). This intervention also used successful key features from the U.S. DPP trail such as weight loss after one-year, 150 physical activity per week, and regular attendance in a 12-month program (Gruss et al., 2019). In addition to these key features, they also placed emphasis on self-efficacy centering on problem-solving, social support, and strategies to support change (Albright & Gregg, 2013; Gruss et al., 2019). This program is updated

every three years based on dietary, physical activity, self-efficacy, and other type 2 diabetes prevention research (Gruss et al., 2019).

Translation of Diabetes Prevention and Need to Understand Culturally Specific Barriers

There is limited information on how to design intervention programs for South Asians living in the United States (Weber et al., 2020). More research is needed on the South Asian culture including their barriers and motivators to lifestyle change for successful implementation. In one study, South Asians cited physical inactivity, unhealthy diet (high in fat and refined carbohydrates), and gender roles as barriers to achieving a healthy lifestyle (Weber et al., 2020). To create successful intervention programs, we need to understand how these barriers play a role in the health of South Asians.

Several diabetes prevention programs have utilized community settings to implement diabetes interventions. These settings include religious centers, fitness centers, non-profit organization venues, and other community spaces (Ali et al., 2020). One example of a successful program is the DEPLOY Pilot study (Ackermann et al., 2011). The aim of this study was to show that lifestyle interventions can reduce the development of type 2 diabetes. The invention was conducted at the YMCA, and researchers found that participants experienced significant reductions in cholesterol, blood pressure and weight. The findings suggest that YMCA may be a useful venue for providing diabetes prevention (Ackermann et al., 2011).

Chapter 3: Methods

General Cochrane methods were used to establish a research question, specific population, intervention, and outcome of interest. We used the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRIMSA) guidelines for reporting (see Appendix A for PRISMA checklist). The study question did not require a comparison group, so none were included. Inclusion and exclusion criteria were developed and used in this study.

A systematic search of the literature from articles published in PubMed up to February 22, 2022, were performed. This study involved a review of the literature on the barriers and facilitators to lifestyle changes in US South Asians. Articles containing information diabetes prevention in US South Asians were examined. Search terms in PubMed included MeSH terms relating to US South Asians (“South Asian” , “India” , “Nepal” , “Bhutan” , “Maldives” , “Pakistan” OR “Sri Lanka” , “Bangladesh” , “Asian American” , “India/ethnology” , “US South Asian” , “Sikh Asian Indian” , “South Asian Immigrant”, search terms relating to migration (“immigrant” , “migrate”), search terms relating to interventions (“implementation” , “intervention” , “recommendation” , “prevention” , “prevention and control” , “lifestyle modification” , “Treatment Outcome” , “Life Style” , “clinical trial” , “clinical study” , “pilot study” , “health promotion” , “peer education” , “group education” , “peer support” , “community-based participatory research” , “group support” , “peer-led intervention”, “Community Health Worker” , “healthcare worker” , “health educator” , “lay health educator” , “Community Health Education” , “community based” , “mosque based” , “church based”, “family based”, “primary prevention” , “peer based intervention” , “Culturally Competent Care” , “Community Healthcare Workers” , “diabetes prevention program” , “diabetes

prevention” , “culturally-tailored exercise intervention”), and search terms relating to type 2 diabetes (“ Diabetes Mellitus, Type 2 / ethnology)”, “DM risk factors”).

Titles were reviewed to determine if diabetes prevention occurred in US South Asians. The remaining abstracts were reviewed according to the following inclusion and exclusion criteria. The inclusion criteria were:

- U.S. South Asians, immigrant or 2nd or 3rd generation, Individuals from Pakistan, Bangladesh, India, Sri Lanka, Bhutan, Nepal, and the Maldives
- Barriers to healthy diets, barriers to physical activity
- Motivating factors around diet and physical activities
- Diabetes prevention in the South Asian population
- Observational, experimental, qualitative, cross-sectional, and pilot studies
- Human subjects
- Studies published between 2014-2022
- Studies published in English
- Full text articles

The exclusion criteria were:

- People not from South Asian countries
- Case-reports or study protocols
- Animal subjects
- Articles not published in English

Articles published within the last eight years were used to provide the most timely data describing barriers, motivating factors, and interventions in this population. Articles that included people that were not from South Asian Countries or animal were not included in this review as they do not meet criteria for the study population. Articles not published in English were excluded due to the reviewer only speaking English. Case-reports or study protocols were excluded as they are not intended for this study. This review was completed independently, thus one reviewer screened abstracts and titles. A meta-analysis was not conducted for this study. Articles that met the inclusion criteria were downloaded and exported to Endnote.

This study is a systematic review and does not include human subjects, thus it did not require IRB approval.

Chapter 4: Results

The PubMed database identified 7,694 articles (see Figure 1.). Duplicate articles were excluded (n = 4). The remaining 7,690 articles went through title and abstract cleaning. Articles were removed if they did not include U.S. South Asians as the study population, did not include a diabetes prevention program, or if it was not conducted in the U.S. Full text of the remaining four articles were retrieved and used for this study. One article describes a diabetes prevention program in Atlanta, one article describes a diabetes prevention program in Houston, one article describes a diabetes prevention program in New York City, and one article describes a diabetes prevention program in Chicago.

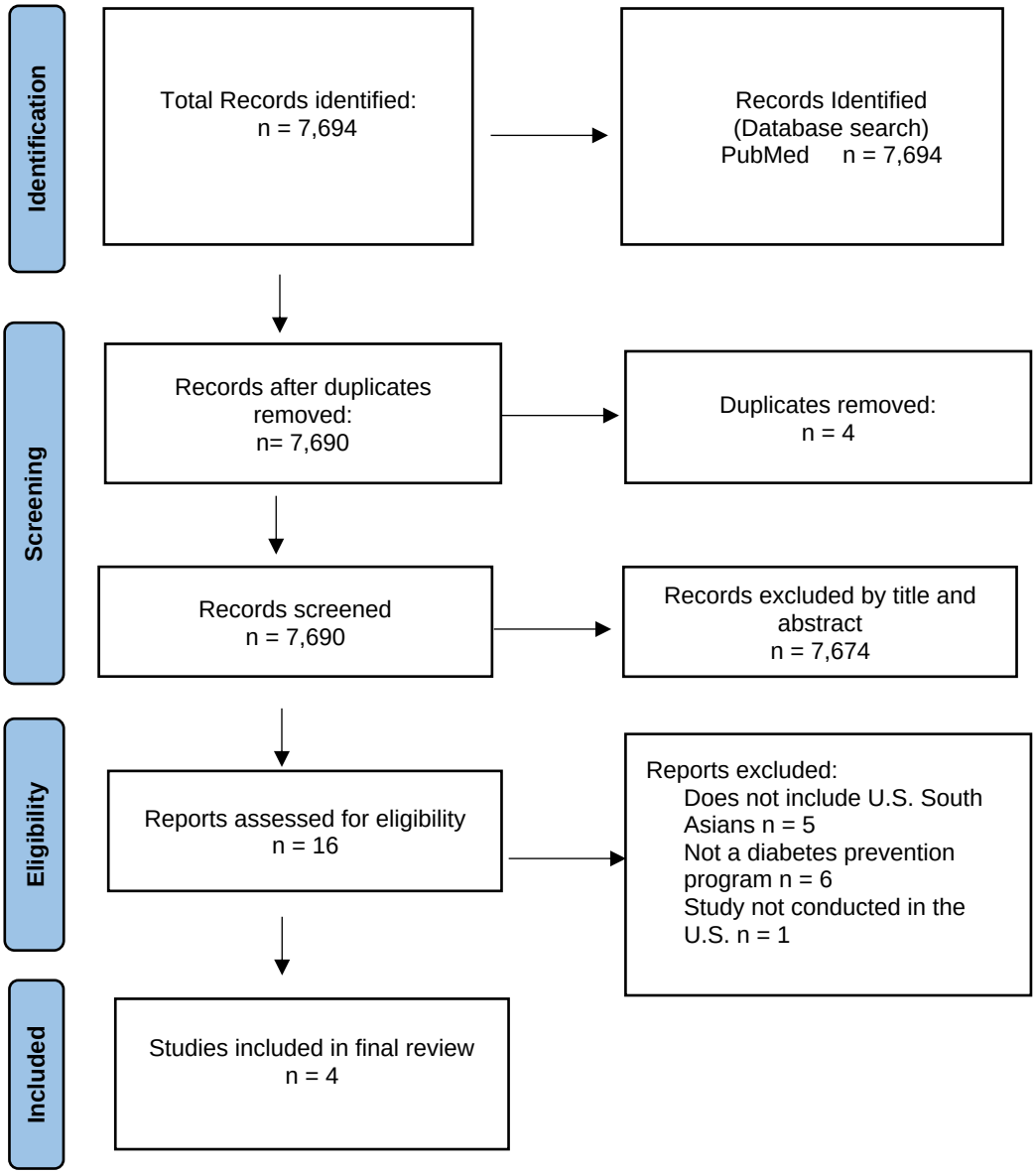

Fig 1. PRISMA flowchart of search strategy

Barriers

Most (three) of the studies described barriers to achieving a healthier lifestyle or participating in an intervention program.

Gender roles were described as barriers to being active in two studies. In South Asian culture, a man's role is to be a "provider," while a woman is responsible for being a "carer" (Weber et al., 2020). These expectations place a hierarchical status on the family needs, leaving no room for prioritizing individual needs or health. Male participants stated that academic success, job success, and saving money leave little time for exercise. South Asian women are expected to take more of a familial role, compared to men. For instance, they are expected to prioritize caring for their families and household. Exercise for health, pleasure or other purposes is discouraged (Weber et al., 2020). In the article conducted by Kandula et al., 2020, gender roles also appear to be a barrier. Since the martial arts instructor was male, one participant mentioned that she could not enroll her daughter in the class. South Asian women were likely to participate in the class if it was women-only, making the class sensitive to cultural gender norms (Kandula et al., 2016).

Immigration was described as a barrier to achieving a healthy lifestyle in one of the articles. In the article by Weber et al., 2020, the authors mentioned that migrating to the United States caused many South Asians to rely on inexpensive food items. This migration also showed deleterious sex differences, especially among men. South Asian men tend to rely on convenience food items (frozen foods or restaurant foods) because they don't have sufficient cooking skills. Consequently, they consume a diet high in sodium, fat, and calories (Weber et al., 2020).

Since the role of food in South Asian culture is very important, is was described as a barrier in one of the articles (Weber et al., 2020). Food is used for socializing, family life, and celebrations. South Asian women find it challenging to improve their families' diet, as taste plays a significant role in food choice. Participants in this study felt that "healthy" and "delicious" were opposites. Men, more so than women, believed that lowering the fat content would make the food unappetizing (Weber et al., 2020).

Social context was reported as a barrier in one article conducted by Islam et al., 2014. In this six-month intervention program, six community health worker-facilitated group sessions were conducted for 2 hours on various topics (physical activity, diabetes, stress, family support, etc.). Some participants mentioned that the social context made it challenging to apply the interventions learned in the study to their daily lives. One participant commented that they came from a large family; making dietary changes within the family was more difficult (Islam et al., 2014).

In one article, family priories were cited as a barrier. In a study conducted by Kandula et al., 2016, a 16-week culturally tailored exercise intervention was assessed for South Asian immigrant mothers at risk for diabetes. Several women reported that competing family priorities prevented them from attending classes and exercising.

One of the articles did not list or describe any specific barriers to achieving a healthier lifestyle. In the Patel et al., 2017, the authors mentioned that cultural messaging and visuals were used to address barriers to adopting healthy behaviors. Specific details on these barriers were not found in this paper.

Facilitators and/or Motivating Factors

The majority of the studies (three) describe facilitators to achieving a healthier lifestyle or participating in an intervention program.

Family was described as a motivator for adopting healthy lifestyle behaviors in two articles. In the study conducted by Weber et al., 2020, family was cited as a motivator for adopting healthy lifestyle behaviors. Exercising and eating a healthy diet prevented disease and allowed them to spend time with their loved ones. Spreading healthy lifestyle knowledge to family networks was also cited as a motivator. One participant stated that they took the knowledge they learned in the intervention and shared it with their parents when they visit the United States. After telling their parents what to eat for breakfast, lunch, and dinner, the parents went back to India following the same diet. In the study conducted by Kandula et al., 2016, participants stated that the intervention allowed them to exercise with their children. One mother highlighted *"Having mother and kids together is a wonderful thing because you know, when I was exercising upstairs; my daughter was downstairs in the karate class. She talked to her doctor and she also told people in her school* (Kandula et al., 2016)*."*

Improving diabetes knowledge was cited as facilitator in one of the articles. In the study conducted by Islam et al., 2014, participants mentioned that they gained a better understanding of diabetes prevention and health behaviors. One participant stated "*I got to learn a lot and practice what I learned. I watched my diet and took care to keep diabetes away. I had borderline high sugar, but I am ok now* (Islam et al., 2014)."

Emphasis on prevention and monitoring health outcomes was also cited as a facilitator to achieving a healthy lifestyle in one article. In the article conducted by Islam et al., 2014, several participants stated that the intervention helped increase their knowledge and encourage them to make behavior changes. A few participants commented that the program's emphasis on monitoring health outcomes encouraged them change their behaviors. One participant stated *"The knowledge that we received…we were able to implement. For example, we would come to class and learn. Then we would go home and moderate our diet. Otherwise, we wouldn't pay attention and eat what's made* (Islam et al., 2014)*."*

Exercising in an environment with South Asian gender norms were described a facilitator in one article. In the study conducted by Kandula et al., 2016, a few participants mentioned that they felt comfortable attending the exercise class since it was designed to account for to South Asian gender norms and values.

One of the articles did not mention any specific facilitators or motivating factors to achieving a healthier lifestyle. However, the authors do mention that enablers to achieving their goals was discussed in one intervention sessions (Patel et al., 2017).

Characteristics of Intervention

All the studies were conducted across various states in the US. One study was in Atlanta, GA (Weber et al., 2020), one was conducted Houston, TX (Patel et al., 2017) ,one study was conducted in New York City, NY (Islam et al., 2014), and one study was conducted in Chicago, IL (Kandula et al., 2016). Half of the programs lasted for 16 weeks (Kandula et al., 2016; Weber et al., 2020).

One intervention lasted for 12 weeks (Patel et al., 2017) and the other program lasted for 6 months (Islam et al., 2014). All studies utilized community settings to implement diabetes interventions. These community setting include South Asian restaurants, public libraries, Hindu temples, university classrooms, parks that are hubs for South Asian immigrants, and South Asian owned studios, and fitness facilities. All intervention programs were culturally tailored to the South Asian community. In the Weber et al. 2020 study, researchers adapted the US Diabetes Prevention Programme (DPP) to the South Asian culture, the Patel et. al., 2017 study modified the Power to Prevent (P2P): A Family Lifestyle Approach to Diabetes Prevention program, the Islam et. al., used existing curriculum from the P2P, DPP, National Heart, Lung, and Blood Institute's Healthy Heart Healthy Family (NHLBI), and Road to Health, and the Kandula et. al., 2016 used community partners to develop an intervention. One of the programs were linguistically tailored using oral or written materials (Islam et al., 2014). Majority of the studies used A1C as a blood glucose indicator (Islam et al., 2014; Patel et al., 2017; Weber et al., 2020). In addition to using A1C, one study also used 2-hour fasting glucose as an indicator (Islam et al., 2014), while the other study also used normoglycemia, isolated IGT, and isolated IFT (Weber et al., 2020).

In terms of nutrition and diet, all studies included some aspect of culturally tailored eating. Limiting salt and fat intake was common in most of the interventions (Islam et al., 2014; Kandula et al., 2016; Patel et al., 2017). One of the studies used group classes provide examples on South Asian foods (Weber et al., 2020). The promotion of consuming a healthier diet, eating more fruit and vegetables was used in the study by Patel et al., 2017. They also provided sessions that included grocery store tours, cooking demos, and recipe makeovers. Islam et al., 2014, provided session on adapting South Asian cooking by incorporating healthfulness.

The use of physical activity varied across all studies. Most interventions held weekly group sessions lasting from 45 minutes to 2 hours (Islam et al., 2014; Kandula et al., 2016; Patel et al., 2017). Weber et al. 2020 incorporated group classes that focused on basic exercise training. A trainer would also lead some classes and the intervention also included optional group walks. In addition to increasing physical activity to 150- minutes per week, the Patel et al., 2017 study also included 20-minute group workout sessions during 8 of the 12 sessions. Home-based activities and session that discussed the importance of physical activity was used in the Islam et al., 2014 study. Moderate-intensity Zumba and aerobics sessions were used in the Kandula et al. 2016 study.

Effectiveness of Intervention

All studies appear to have favorable effects on diabetes risk using a culturally tailored program. Across all studies, researchers noted reductions in weight. However, statistically significant improvements were observed for weight at 6-months in the Islam et al., 2014 study and significant reductions by 3.2 lbs. in the Kandula et al., 2016 study. Weight change was -4.8 lbs. in women who attended at least 80% of classes (Kandula et al., 2016). Reductions in BMI were cited in the Weber et al., 2020 study and were statistically significant in the intervention conducted by Islam et al., 2014. In addition to reducing BMI, participants also had reductions in their waist circumference (Patel et al., 2017; Weber et al., 2020).

When looking at blood glucose indicators, improvements were noted across most studies. Roughly 55% of participants achieved normoglycemia (Weber et al., 2020). Participants in the intervention groups had significant decreases in HbA1c (Patel et al., 2017) and glucose (Islam et al., 2014).

69.2% of individuals in the intervention group had normal HbA1c levels after six months (Patel et al., 2017). In the study by Kandula et al., 2016, a small statistically significant increase in hemoglobin A1c was observed.

In terms of blood pressure, two studies reported decreases in blood pressure (Islam et al., 2014; Weber et al., 2020). However, Islam et al., 2014, reported significant reductions in both treatment and control groups, with 96% of the individuals in both groups having controlled blood pressure. No changes in blood pressure reported in the study conducted by Kandula et al., 2016. Changes in blood pressure was not reported in the study by Patel et al., 2017.

When looking at physical activity, increased physical activity was noted in two studies (Islam et al., 2014; Patel et al., 2017). In the study Patel et al., 2017, increased physical activity was noted in all groups. In the study by Islam et al., 2014, 88.7% of participants in the treatment group reported some activity at 6 months, compared with 3.8% at baseline. In the control group, physical activity was not significant. Although both groups reported an increase in social interaction related to physical activity, the effect was much greater among the treatment group. Change in physical activity was not significant in the study by Kandula et al., 2016.

Lipids and other cardiometabolic markers decreased in participants in the study by Weber et al., 2020.

When observing food related behaviors, researchers noted some differences in portion control in the study conducted by Islam et al., 2016 study. For instance, the intervention group achieved a

statistically significant increase from baseline to six months. On the other hand, not significant changes were observed in the control group. Both groups gained significant knowledge on diabetes.

Chapter 5: Discussion

This review shows that community-based programs may be successful for at risk South Asians living in the United States. The majority of the studies included used cultural adaptations to improve program success such incorporating sessions on how to make healthy adjustments to the South Asian diet was successful. Overall, these programs had favorable effects on weight loss, waist circumference, and physical activity levels.

In this review, gender roles, immigration, social context, family priorities, and the role of food were described as barriers to achieving a healthier lifestyle. The most common barrier cited was gender roles. When examining the barrier and facilitators in South Asians across various countries, there appear to be similarities and differences.

In a study conducted by Beune et al., 2022, researchers conducted a culturally tailored dance intervention to promote physical activity for South Asian women at risk for diabetes in the Netherlands. This study's objective was to test whether culturally tailored dance is acceptable to women of South Asian descent and whether it affects physical activity and social-cognitive determinants. Family-related circumstances were cited as barriers to attending the dance class. Maintaining an organized personal life was also described as a barrier which played a role in attendance in the program (Beune et al., 2022).

The objective of a study conducted in Edinburgh, Scotland, was to determine how South Asians (Pakistanis and Indians) perceive and experience physical activity as part of their diabetes care (Lawton et al., 2005). One barrier mentioned in this article was a lack of time due to a busy life. Participants in the study noted that they often work long hours, preventing them from incorporating physical activity (walking and swimming) into their daily lives. Another barrier described in this study was prioritizing familial obligations, which was also cited as a barrier by US South Asians. In the South Asian culture, it is perceived as selfish to take out time for yourself to go and exercise. As a South Asian, it is expected that one helps with family businesses or childcare over personal interests. Female participants also mentioned the lack of time barrier. Married women are supposed to stay indoors, taking care of domestic chores and responsibilities. As one participant stated "women cannot go out…. You have to cook and provide meals at the right time, so because of that there is a restriction." US South Asian women also described this as a barrier. The lack of culturally sensitive facilities was also described as a barrier. Although participants were willing to increase their physical activity levels, they were often unable to due to the culturally insensitive facilities. Some of the participants (women) stated that they were unable to follow recommendations to exercise because of cultural taboos about exposing their bodies to people of the opposite sex and the lack of single-sex facilities with same-sex instructors. Participants (women) stated that cultural taboos about exposure to people of the opposite sex and the lack of single-sex facilities with same-sex instructors prevented some of them from following recommendations to exercise. Lastly, weather conditions were cited as a barrier by both men and women since they disliked being outside in cold or extreme conditions (Lawton et al., 2005).

Family, improving diabetes knowledge, emphasis on diabetes prevention and health monitoring, and exercising in an environment that's culturally sensitive to South Asian gender norms were described as motivating factors in this review, with family being the most common motivator. In the study conducted by Beune et al., 2022, participants mentioned that the intervention included songs and dances native to the South Asian culture. Another motivating factor of this intervention is that it was culturally sensitive to South Asian gender norms. Participants said the female-only classes made dance classes more attractive and acceptable to South Asian women. As one participant described, "It was a group of SA women, about the same age, you feel comfortable in that group, there is no competition." Exercising in a group-based program was also a motivator because it promoted a sense of belonging and kept them motivated to attend the classes.

Maintaining familial priorities/obligations was described as a barrier in the United States, Netherlands, and Scotland. Gender roles, specifically women maintaining the home was a barrier in Scotland and the United States. Immigration, the role of food, and social context were not described as barriers in Scotland or the Netherlands. In terms of facilitators, exercising in an environment that's culturally sensitive to South Asian gender norms was cited as a motivating factor in the United States and Netherlands. Family, improving diabetes knowledge, and emphasis on diabetes prevention and health monitoring was not cited in the study conducted in the Netherlands. In the Netherlands, working in a group-based program and utilizing South Asian songs and dances were mentioned as a facilitator.

Although the included studies in this review discussed barriers and facilitators for diabetes prevention, they were not mapped onto behavioral theories. The study by Beune et al., 2022, was

designed to measure behavioral social cognitive determinants of physical activity (PA), identified by evidence synthesis and Delphi expert consensus. Changes in these PA-behavioral social cognitive determinants were measured, and some specific models of change were supported, while others did not. The findings agree with existing literature, and the results demonstrate the usefulness of Ajzen's theory of planned behavior (social norms) and Bandura's Social Cognitive Theory (self-efficacy) when designing PA interventions. The data, however, did not support the assumption that active participation in the dance sessions would lead to a greater readiness for change towards PA as proposed by Prochaska and DiClemente's Transtheoretical Model.

When examining diabetes prevention programs designed for other minority groups in the US, there appear to be a few similar barriers to studies in other countries. In a study conducted by Ockene et al., 2012, Spanish-speaking Latinos at increased diabetes risk were subjected to a community-based, literacy-sensitive, and culturally tailored lifestyle intervention to reduce weight and diabetes risk. Participants in the study mentioned that barriers to dietary change included stress, lack of will power, knowledge, and a home healthy food environment. Regarding exercise, participants described lack of motivation, time constraints, bad weather, fatigue, and physical illness or disability as barriers. Lack of time and inclement weather were also cited as barriers by participants in the study conducted in the Netherlands. None of the barriers mentioned in this study were similar to the barriers expressed by US South Asians. Motivating factors were not described in this study (Ockene et al., 2012).

This review will help to inform public health practice by bringing more awareness to the health complications in US South Asians. For instance, health care providers can focus on implementing

group or family style interventions for South Asians. South Asians appear to do well in social groups with either family or other individuals from the culture. Further, by including the family in the diabetes prevention program, individuals can prioritize their family obligations rather than neglecting their own health. Thus, family members are also able to improve their health.

There is limited information on how to design intervention programs for South Asians living in the United States (Weber et al., 2020). More research is needed on the South Asian culture including their barriers and motivators to lifestyle change for successful implementation. Compared to other ethnic groups, South Asians have an increased risk for developing type 2 diabetes (Gujral et al., 2013). Lifestyle practices, migration to the United States, and epigenetic mechanisms could possibly explain this population's type 2 diabetes risk (Gujral & Kanaya, 2021). Public health professionals could develop culturally tailored intervention programs to reduce this burden. Developing a culturally tailored dance class as described in the article by Beune et al., 2022, would be a great intervention for South Asians. Incorporating songs and dances of the South Asian culture was a great way to encourage this population to get physical active to become healthy.

Since this population is often understudied and at increased risk for type 2 diabetes, more research on culturally tailored programs in US South Asians should be completed. Considering that mechanisms contributing to the increase are not fully understood (Gujral & Kanaya, 2021), we must address this burden to improve their health. Research has shown that migration, physical inactivity, and diet are potential risk factors for the disease. Although the study points to important barriers, more research is needed understand how it plays a role in type 2 diabetes. Until we fully

elucidate the barriers and motivators for South Asians achieving a healthier lifestyle, diabetes will remain prevalent in this group.

One strength of this review is that it included recently published articles (from 2014-to 2022). This provided the most up-to-date information on the barriers and facilitators in US South Asians. Another strength of this review is that it conducted a review on an understudied population. Hopefully, providing insight into the barriers and motivating factors to diabetes prevention will bring more attention and awareness.

This review had several limitations. One limitation is that this review only included four articles. With a limited number of articles used in this study, it is hard to make sufficient recommendations for public health practice. Another limitation of this review is that only one reviewer conducted title and abstract cleaning. Two people usually complete this process, thus there may be selection bias. Furthermore, having two reviewers increases the validity of the number of articles selected for review and decreases errors.

In conclusion, this review showed that diabetes prevention programs tailored to the South Asian culture might be beneficial. Common barriers for diabetes prevention in US South Asians included gender roles, immigration, social context, family priorities, and the role of food, making it difficult to achieve a healthy lifestyle. It is important to address these barriers because diabetes is significant problem in the South Asian population. Furthermore, South Asians experience greater morbidity and mortality from coronary artery disease, cerebrovascular disease, and chronic kidney disease due to diabetes complications (Shah & Kanaya, 2014). Future recommendations include

developing group or family-based prevention programs. As described in this review, South Asians mentioned that working with family was a motivating factor to adopting healthy lifestyle behaviors and encourages social support. It also removes the barrier of prioritizing familial obligations, preventing individuals from neglecting their health.

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Appendix A

Section and Topic	Item #	Checklist item	Location where item is reported
TITLE			
Title	1	Identify the report as a systematic review.	Title page
ABSTRACT			
Abstract	2	See the PRISMA 2020 for Abstracts checklist.	Abstract page
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of existing knowledge.	1-3
Objectives	4	Provide an explicit statement of the objective(s) or question(s) the review addresses.	3
METHODS			
Eligibility criteria	5	Specify the inclusion and exclusion criteria for the review and how studies were grouped for the syntheses.	12
Information sources	6	Specify all databases, registers, websites, organisations, reference lists and other sources searched or consulted to identify studies. Specify the date when each source was last searched or consulted.	11
Search strategy	7	Present the full search strategies for all databases, registers and websites, including any filters and limits used.	11
Selection process	8	Specify the methods used to decide whether a study met the inclusion criteria of the review, including how many reviewers screened each record and each report retrieved, whether they worked independently, and if applicable, details of automation tools used in the process.	12-13
Data collection process	9	Specify the methods used to collect data from reports, including how many reviewers collected data from each report, whether they worked independently, any processes for obtaining or confirming data from study investigators, and if applicable, details of automation tools used in the process.	13
Data items	10a	List and define all outcomes for which data were sought. Specify whether all results that were compatible with each outcome domain in each study were sought (e.g. for all measures, time points, analyses), and if not, the methods used to decide which results to collect.	N/A
	10b	List and define all other variables for which data were sought (e.g. participant and intervention characteristics, funding sources). Describe any assumptions made about any missing or unclear information.	N/A
Study risk of bias assessment	11	Specify the methods used to assess risk of bias in the included studies, including details of the tool(s) used, how many reviewers assessed each study and whether they worked independently, and if applicable, details of automation tools used in the process.	N/A
Effect measures	12	Specify for each outcome the effect measure(s) (e.g. risk ratio, mean difference) used in the synthesis or presentation of results.	N/A
Synthesis methods	13a	Describe the processes used to decide which studies were eligible for each synthesis (e.g. tabulating the study intervention characteristics and comparing against the planned groups for each synthesis (item #5)).	N/A
	13b	Describe any methods required to prepare the data for presentation or synthesis, such as handling of missing summary statistics, or data conversions.	N/A
	13c	Describe any methods used to tabulate or visually display results of individual studies and syntheses.	N/A
	13d	Describe any methods used to synthesize results and provide a rationale for the	N/A

Section and Topic	Item #	Checklist item	Location where item is reported
		choice(s). If meta-analysis was performed, describe the model(s), method(s) to identify the presence and extent of statistical heterogeneity, and software package(s) used.	
	13e	Describe any methods used to explore possible causes of heterogeneity among study results (e.g. subgroup analysis, meta-regression).	N/A
	13f	Describe any sensitivity analyses conducted to assess robustness of the synthesized results.	N/A
Reporting bias assessment	14	Describe any methods used to assess risk of bias due to missing results in a synthesis (arising from reporting biases).	N/A
Certainty assessment	15	Describe any methods used to assess certainty (or confidence) in the body of evidence for an outcome.	N/A
RESULTS			
Study selection	16a	Describe the results of the search and selection process, from the number of records identified in the search to the number of studies included in the review, ideally using a flow diagram.	13
	16b	Cite studies that might appear to meet the inclusion criteria, but which were excluded, and explain why they were excluded.	13
Study characteristics	17	Cite each included study and present its characteristics.	18-20
Risk of bias in studies	18	Present assessments of risk of bias for each included study.	N/A
Results of individual studies	19	For all outcomes, present, for each study: (a) summary statistics for each group (where appropriate) and (b) an effect estimate and its precision (e.g. confidence/credible interval), ideally using structured tables or plots.	N/A
Results of syntheses	20a	For each synthesis, briefly summarise the characteristics and risk of bias among contributing studies.	N/A
	20b	Present results of all statistical syntheses conducted. If meta-analysis was done, present for each the summary estimate and its precision (e.g. confidence/credible interval) and measures of statistical heterogeneity. If comparing groups, describe the direction of the effect.	N/A
	20c	Present results of all investigations of possible causes of heterogeneity among study results.	N/A
	20d	Present results of all sensitivity analyses conducted to assess the robustness of the synthesized results.	N/A
Reporting biases	21	Present assessments of risk of bias due to missing results (arising from reporting biases) for each synthesis assessed.	N/A
Certainty of evidence	22	Present assessments of certainty (or confidence) in the body of evidence for each outcome assessed.	N/A
DISCUSSION			
Discussion	23a	Provide a general interpretation of the results in the context of other evidence.	22
	23b	Discuss any limitations of the evidence included in the review.	27
	23c	Discuss any limitations of the review processes used.	27
	23d	Discuss implications of the results for practice, policy, and future research.	27-28
OTHER INFORMATION			
Registration and protocol	24a	Provide registration information for the review, including register name and registration number, or state that the review was not registered.	N/A
	24b	Indicate where the review protocol can be accessed, or state that a protocol was	N/A

Section and Topic	Item #	Checklist item	Location where item is reported
		not prepared.	
	24c	Describe and explain any amendments to information provided at registration or in the protocol.	N/A
Support	25	Describe sources of financial or non-financial support for the review, and the role of the funders or sponsors in the review.	N/A
Competing interests	26	Declare any competing interests of review authors.	N/A
Availability of data, code and other materials	27	Report which of the following are publicly available and where they can be found: template data collection forms; data extracted from included studies; data used for all analyses; analytic code; any other materials used in the review.	N/A

From: Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ 2021;372:n71. doi: 10.1136/bmj.n71

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