Family Medicine and Community Health

Tailoring lifestyle programmes for diabetes prevention for US South Asians

Mary Beth Weber, Monique M Hennink, K M Venkat Narayan

To cite: Weber MB, Hennink MM, Narayan KMV. Tailoring lifestyle programmes for diabetes prevention for US South Asians. *Fam Med Com Health* 2020;**8**:e000295. doi:10.1136/fmch-2019-000295

Hubert Department of Global Health, Emory University, Atlanta, Georgia, USA

Correspondence to
Dr Mary Beth Weber;
mbweber@emory.edu

ABSTRACT

Objective The purpose of this study was to develop and test the feasibility of a culturally tailored Diabetes Prevention Programme (DPP) for US South Asians, a large population with high diabetes risk.

Design The South Asian Health and Prevention Education (SHAPE) study included: (1) focus group discussions with South Asian adults to understand views of lifestyle behaviours and diabetes prevention; (2) modification of the US DPP for South Asians and (3) a pilot, pre–post study to test the feasibility and impact of delivering the culturally tailored programme.

Setting The study was conducted in Atlanta, Georgia, USA. Focus group discussions and intervention classes were held at locations within the community (eg, South Asian restaurants, a public library, university classrooms, a South Asian owned physical therapy studio).

Participants The focus group discussions (n=17 with 109 individuals) included adults aged 25 years of older who self-identified as South Asian. Groups were stratified by age (25–40 years or older than 40 years) and sex. The SHAPE pilot study included 17 (76.5% male with a mean age of 46.9±12 years) South Asian adults aged 25 years or older with pre-diabetes and body mass index (BMI) >22 kg/m^2.

Results Formative data from 17 focus group discussions and a community board guided the modification of the DPP curriculum to reflect cultural food preferences and include tools to leverage social support, create a stronger foundation in exercise and overcome culturally specific barriers. The SHAPE pilot study included 17 South Asian adults with pre-diabetes and BMI >22 kg/m^2. There were positive changes in participants' weight, waist circumference, blood pressure, plasma lipids, HbA1c and other cardiometabolic markers postintervention and 55% of participants regressed to normoglycaemia.

Conclusion These results provide important information on the barriers faced by US South Asians in participating in 'standard' lifestyle change programs, indicate the feasibility of culturally tailored programmes and show positive impact of a culturally tailored programme for diabetes prevention in the South Asian population.

Key points

Tailoring Lifestyle Programs for Diabetes Prevention for US South Asians

Question:

- The South Asian Health and Prevention Education pilot study used a mixed-methods study design to develop and test a culturally tailored, lifestyle intervention for overweight or obese South Asian Americans with pre-diabetes. This population develops diabetes more often, at younger ages and lower body mass indices, and has worse outcomes if they do develop diabetes than other race/ethnic groups. Finding effective and acceptable diabetes prevention programs is key to improving the health of this population.

Finding:

- South Asian Americans report that lifestyle choices around diet and physical activity are influenced by culturally prescribed family roles, the importance of South Asian foods in their lives, and changes due to immigration to the USA. In a pilot intervention study, participating in a culturally tailored lifestyle intervention programme modelled after the US Diabetes Prevention Programme resulted in improvements in cardiometabolic risk factors including weight, waist circumference, blood pressure, plasma lipids and glycated hemoglobin (HbA1c). Over half (55%) of participants' glucose levels returned to the normal range at the end of the intervention.

Meaning:

- Diabetes prevention programmes can improve health markers in this high-risk population, but should include tools to increase and leverage social support, improve knowledge around physical activity, overcome cultural barriers and reflect cultural food preferences.

INTRODUCTION

South Asians, a rapidly growing and linguistically, religiously, and culturally diverse immigrant group in the USA,[1] have a uniquely high risk for type 2 diabetes, developing diabetes more often and at lower ages and body mass indices (BMIs) than other race/ethnic groups.[2 3] Lifestyle interventions like the US Diabetes Prevention Programme (DPP), which promote weight loss through changes in diet, activity and behaviour, decrease type 2 diabetes incidence in high-risk individuals.[4] The DPP showed that lifestyle education was

effective at preventing or delaying diabetes in all race/ethnic groups, including Asians,[4 5] but the number of South Asians was small. Furthermore, there is limited research on how to best design and implement proven DPPs like the DPP among South Asian Americans. There is a need to develop and test diabetes prevention interventions targeted specifically to South Asian Americans. To increase programme uptake and retention, and therefore effectiveness, lifestyle programs need to be culturally appropriate and address the unique barriers to lifestyle change of South Asian Americans. Herein, the authors report the results of the South Asian Health and Prevention Education Study pilot study (SHAPE, clinicaltrials.gov #NCT01084928), which aimed to: (1) describe barriers to and motivators for health lifestyle behaviours among South Asian Americans and suggestions for diabetes prevention in this community through formative focus group discussions (FGDs) and (2) test the feasibility of a culturally tailored lifestyle intervention programme, modelled after the US DPP and modified based the data collected in aim 1, in a preintervention and postintervention study.

METHODS

The SHAPE study included: (1) formative FGDs; (2) intervention development based on the results of the FGDs and (3) a pre–post design trial testing the feasibility and effectiveness of the intervention. This mixed-methods study design ensured that the intervention design reflected the needs of the target community, increased acceptability of the intervention content and provided a richer evaluation of programme design and impact. Individuals provided written, informed consent before each FGD, at baseline testing, and before intervention enrolment. Deidentified data are available through the corresponding author.

A community advisory board including local leaders in the South Asian community provided guidance on recruitment and design. Participant recruitment for the FGDs and then the subsequent pilot study included advertisements in local South Asian magazines and on community organisation listservs. In-person outreach was conducted at events targeting South Asians (health fairs, diabetes education events, screening for an unrelated cardiovascular risk) and at meetings of South Asian clubs (for younger participants) and South Asian shopping centres and grocery stores (for older participants).

Formative qualitative research

The study team conducted FGDs to obtain a broad range of community beliefs[6] about lifestyle behaviours among South Asian Americans. FGDs were stratified by sex and age (25–39 or 40+ years) to create homogeneous groups of participants, minimise hierarchy development that may reduce data quality and enable structured analytical comparisons.[6] Trained moderators, matched to participants' sex, used a semistructured interview guide to elicit conversation around lifestyle behaviours, barriers and motivators for exercise and healthy eating, and feedback on possible programme components. Moderators were not South Asian to encourage more detailed discussions, as would be needed when speaking to an outsider not familiar with their community.[7] The interview guide was not based on an existing framework, but was instead based on concepts from research literature around diet and physical activity behaviours and key components of the DPP. FGDs (n=17, n=109, average group size 6.4 individuals), five with older females and four each with younger males, younger females and older males) lasted 60–90 min, were digitally recorded, and were held at locations familiar to participants (eg, Indian restaurants, temples). Meaning saturation was reached around key themes central to the research goals (see the Results section) with no new information or nuance arising during FGDs.[8] All participants took a brief demographic survey before the discussion and received refreshments, parking validations and a gift bag. Participants were not contacted to provide further feedback after the completion of the FGDs.

The recordings were transcribed verbatim, deidentified and uploaded into MAXQDA (VERBI Software, V.10, V.11). The investigators developed codes based on a close read of the transcripts, and two analysts coded a subset of data independently to assess intercoder agreement. The researchers conducted a thematic analysis[9] of the data by developing thick descriptions of core influences on diet and physical activity behaviours and diabetes prevention in the South Asian community. Structured comparisons (men vs women, younger vs older participants) identified contextual differences between subgroups. The researchers calculated means and frequency distributions for survey variables.

Intervention design

The SHAPE curriculum, like the DPP, included 16 weekly core intervention classes, followed by maintenance classes (taught weekly in SHAPE instead of monthly like the DPP), mirrored the topics covered in DPP lessons and encouraged participants to reach weight (7% wt loss) and physical activity goals (150+ min per week). Modifications to the DPP curriculum based on the FGD analysis and feedback from the community advisory board are described in the Results section.

Pilot intervention

South Asians aged ≥25 years with BMI >22 kg/m^2 (indicative of overweight/obesity in Asians[10] and pre-diabetes (fasting glucose 100–125 mg/dL (impaired fasting glucose, IFG) and/or 2 hours postload glucose of 140–199 mg/dL (impaired glucose tolerance, IGT)[11] were eligible for the pilot study. Individuals with diagnosed type 1 or type 2 diabetes or taking diabetes medication, currently pregnant or with a history of heart disease, serious illness or conditions that may impede or prohibit participation were excluded. Prescreening (n=117) was conducted in-person or over the phone and included demographic questions and the FINDRISC (Finnish Diabetes Risk

Score) screening tool, a validated diabetes risk score,[12] and at in person screenings, measures of height, weight and waist circumference. Individuals with a FINDRISC score of ≥11 were invited for baseline testing.

Baseline (n=55) and follow-up testing at months 4 and 6 were conducted at the Georgia Clinical and Translational Science Alliance Emory University Hospital Clinical Interaction Site. Testing included fasting blood draws to measure plasma lipids, insulin, glucose, A1C, complete blood count and blood chemistry; anthropometric measurements (weight, height, percentage body fat, waist and hip circumference, abdominal sagittal circumference and full body bioimpedance); blood pressure measurement; study questionnaires; a medical assessment and a 24-hour dietary recall. A 75 g oral glucose tolerance test with blood draws at 0, 30 and 120 min was done at baseline and month 6. Eligible participants (n=17) completed an exercise treadmill test[13] to identify contraindications to unsupervised exercise; none were found.

Lifestyle classes of 3–8 participants were held at two locations across Atlanta on weekend days or weeknights. Participants selected their preferred class. Classes lasted about an hour, included a weight measurement and were led by a trained health educator.

Quantitative analysis was conducted in SAS, V.9.3 (SAS Institute). Descriptive analysis was conducted for all variables and baseline and 6 months values were compared using t-tests (for continuous variables) or X^2 tests (for discrete variables).

RESULTS

Focus group discussions

Focus group participants (n=109, table 1) were from India, Pakistan and Bangladesh and were primarily Hindu, but groups also included Muslims (22.9%), Christians (4.6%), Sikhs (3.7%) and Jains (3.7%). The top five languages spoken at home were Gujarati (40.4%), English (33.9%), Hindi (25.7%), Tamil (8.3%), and Urdu and Punjabi (6.4% each).

Barriers to a healthy lifestyle

Participants cited that unhealthy lifestyle behaviours in their community, including physical inactivity, diets high in fat and refined carbohydrates, large serving sizes and stress, where common. Immigration, strongly defined gender roles and the cultural importance of food (table 2) influenced diet and exercise choices. After immigrating to the USA, the abundance of inexpensive food, reliance on convenience food products and the profusion of cars and elevators made it easier for participants to eat less healthy diets and be more sedentary. Migration was especially detrimental to the diet of South Asian men because they lacked cooking skills and therefore relied on preprepared, frozen foods or restaurant meals, food choices that are often high in fat, sodium and calories.

Culturally prescribed gender roles also affect lifestyle behaviours. Men are expected to be 'providers' and women the 'carers,' with both prioritising their family's needs above their own health. Male participants said they are expected to succeed academically, excel at work and save money, leaving little time for exercise. This emphasis on material success also manifested as valuing saving money now over saving health and healthcare dollars later; one older male said: 'You'll pay tons of dollars to the doctor, but if you say, here, to buy a gallon of milk it'll cost you two dollars extra every day, you aren't willing to do that and so we end up paying much higher value later on.' South Asian culture dictates that women prioritise caring for their family and household over their individual needs and taking time to exercise for health, pleasure or other reasons is discouraged.

Participants described the integral role of food in South Asian culture, family life, socialising and celebrating. Although women are responsible for food preparation, they find it difficult to improve their families' diet. Taste drives food choice, and 'oil is the king… to make [food] taste, uh, delicious' (Young Male). Participants in each group felt 'healthy' and 'delicious' were opposites, and people, especially men, felt that lowering the fat in South Asian food would make it less, or even unpalatable, palatable. Women report being called a 'scrooge' if they use less oil in cooking, particularly at social occasions, and attempts to lower fat or sodium were often met with resistance.

Table 1 Demographic characteristics of focus group discussion participants by age and gender

Age–gender group*	# of groups	Hindu, %	Married, %	US born, %	Mean years in the USA	Home ownership, %	History of diabetes†, %	Education level
Older males	4	62.5	94.3	0	22.1	65.7	55.6	≥Primary school
Older females	5	69.2	72.0	0	25.1	77.0	48.5	≥Primary school
Younger males	4	67.8	42.8	24.3	10.6	48.0	7.0	≥College
Younger females	4	80.3	37.8	29.0	11.8	72.3	0	≥College

*Younger age group includes participants aged 25–39 years. Older age group includes participants aged 40 years or older.
†History of diabetes includes type 2 diabetes or gestational diabetes.

Table 2 Domains affecting lifestyle behaviours in US South Asians

Domains	Behavioural impacts	How diet and physical activity choices are affected	Example quotations
Immigration	In the USA, unhealthy dietary choices and inactivity is easy.	► Prevalence of cars, elevators and climate-controlled environments in the USA make it easier to be inactive. ► Variety of foods and low cost oil, sugar, and dairy products in the USA lead to eating more and increasing fat and calorie intake. ► Lack of vegetarian options results in less healthy diets. ► Faster pace of life makes traditional, time-consuming cooking methods impractical, resulting in reliance on processed, canned and frozen foods.	'When you come to this place [US] you wanna try first of all, all these kinds of foods, not realizing that they are harming your body right now, so I would think that they are not aware of it initially, they come to know after the fact.' (Younger Woman)
Gender – Males	Men are expected to provide financially for their family, leaving little time for exercise or healthy eating.	► Men are culturally primed to focus on academic success, affecting views of exercise as adults. ► Men work long hours and skip meals during the day, making exercise difficult and resulting in overeating at night. ► Saving money is more important than investing in health. ► To secure a good marriage, a good education and job are more important than their physical appearance. ► Little need to be physically attractive to spouse after children are born	'There are a lot of issues like family, children, fee structure, planning finances, so health takes a backseat in that. It's not like we- we don't… want to be healthy, we want to look good but, uh, the emphasis is- is currently on career, family' (Younger Male).
Gender-females	Women are culturally expected to focus on family care and household duties, while personal healthcare is secondary.	► Women 'let themselves go' after having a baby. ► Exercise is viewed only a weight loss tool, not a lifestyle choice.	'We Indian people spoiled our men by giving everything in their hands, so they are lazy so they want us to pay more attention… we say, oh I am going to gym—no, no, no, I need you here. I need this thing, and I need this thing to be done' (Older Female).
Role of food	Food is central to South Asian culture. Food choice is driven by taste and 'healthy foods' are viewed as being less tasty.	► Although the South Asian diet can be healthy, South Asian Americans choose the less healthy foods more often (eg, fried snacks), add in less healthy ingredients (eg, extra cheese or oil/ghee), cook healthy foods in unhealthy ways (eg, frying or overcooking vegetables), eat large portion sizes, and rarely make trade-offs by choosing healthy foods to counterbalance the unhealthy. ► Women often provide family/guests with large servings to show affection, and people have grown accustomed to eating these large portions.	'I went to a party … and there was a layer of [oil] in a big tray … so me and my friend … we just drained the oil out. And the lady who had cooked it, she saw us take-draining oil out so she took the food back in, put the oil back in and brought it out …. there's some stubborn people like that' (Older Female).

Overcoming barriers to healthy lifestyle behaviours

South Asians who make and maintain healthy lifestyle choices credit the support of friends and family. They sought out activities with social aspects (eg, group sports for young men, family walks for older participants, or exercise classes for women) to help them maintain motivation and/or had friends and family who encouraged them verbally or by example. Family was a motivator for and not a barrier to lifestyle improvement for healthy lifestyle adapters. They decided to exercise and follow a healthy diet to better care for family and prevent disease and disability to have more quality time with their loved ones. These participants were also motivated to disseminate healthy lifestyle knowledge to others in their family network. For example, one young man shared: 'When I came [to the US], and when I educated myself, I brought this rule [for when my parents visited the US]: Okay, you have to eat this in the breakfast, eat this thing in the lunch, eat this, eat this thing in the dinner. And, after when they went back [to India], they're still following it. So, if somebody is really strong in a family, they can probably bring this change.' Women overcame their family's reluctance to diet change by gradually altering foods and recipes (eg, slowing increasing spice while decreasing oil) without their family's knowledge. These women reported that their families never noticed the changes and now enjoy healthier foods.

Suggestions for lifestyle interventions in the South Asian community

In all groups, participants felt strongly that an intervention like this was needed to prevent the spread of diabetes in the South Asian community. While most participants believed the intervention would be important for all age groups, younger men often discussed the intervention in terms of its importance for older South Asians.

In terms of class logistics, most participants agreed that English language classes would be preferable, reporting that most US South Asians, except for a few older individuals, spoke English: 'Everybody knows English. We will say 99.9 percent know English and do understand what you are talking about' (Older Male). Online content could be used to support in-person classes, but the majority of participants felt in-person classes would be most effective because they build peer support and create a culture of accountability. In particular, participants felt that in-person exercise instruction was required; 'I think-I-there's always the social aspect of it, too. I mean, I'm not talking to anybody necessarily, but when you're around people, it kinda motivates you' (Younger male). All groups reported that classes should be near participants' homes at familiar locations. Young men favoured worksite-based programs, and women in both age groups stated that childcare should be provided. Class instructors could be 'anybody' as long as they were 'the best qualified person,' although some female participants suggested that a South Asian dietician might be needed to provide dietary guidance.

In terms of content, participants in all groups reported a need for nutrition information for South Asian foods. Younger participants requested that the class include information on foods from a variety of cuisines 'because our generation will eat everything' (Younger Woman). Several participants stressed that there should be specific dietary advice for vegetarians and non-vegetarians, as it was felt these diet patterns differed significantly. Although women reported an interest in cooking demonstrations and recipe books, these ideas were less appealing to the male groups. Younger men and women described the need for quick cooking Indian recipes and cooking techniques. Women reported a desire for exercise classes that taught a variety of exercise types, for example, yoga, aerobics and even sports, which they felt would appeal to younger South Asian men. Except for older women, all groups reported a need to tailor exercise classes specifically based on the participant characteristics (eg, older adults or families).

Intervention design

Based on the results of the FGD and community advisory board feedback, changes were made to the intervention protocol and the DPP curriculum. A planned control group was removed from the study design as it was deemed unnecessary given the strong evidence for the D PP and advisement that it would affect recruitment and community interest in the study. Modifications from the DPP are shown in table 3. These include adapting dietary examples and advise to be more culturally relevant, enabling social support for lifestyle changes, encouraging participants to build support for healthy changes and providing a strong foundation for exercising. The SHAPE curriculum was based on the lesson plans used in the original DPP study;[4] since that time, some of these changes have also been independently added to the National DPP (eg, classes are now all group based).

Pilot intervention trial results

Of the 55 people screened, 22 were eligible for the SHAPE pilot study (clinicaltrials.gov NCT01084928) and 17 consented to participate. Participants and non-participants were similar except participants felt they were at low risk for a serious disease (52.9% vs 28.9%, p=0.037) and presented more often with isolated IFG (iIFG, 41.2% vs 2.6%, p=0.0002) or IFG+IGT (35.3% vs 5.3%, p=0.0035). Pilot participants were 76.5% male with a mean age of 46.9±12 years and had some college or higher education. Mean BMI was 28.9+/-6.1 kg/m^2, and 41.2% had isolated IGT, 17.7% had iIFG and 35.3% had IFG+IGT (35.3%). One participant with normoglycaemia was included in the classes but not in programme assessments at his request and because he could provide valuable input on the feasibility of the programme among young men.

Nine pilot intervention participants returned for 6-month follow-up testing. Two participants dropped out of the pilot, one for health reasons not related to the study and the other citing a lack of interest in continuing the programme. Of the remaining participants who declined attending follow-up testing visits (n=4), they cited the inconvenience of travelling to and parking at Emory University and difficulty taking time off work as reasons. Eleven participants attended more than half of the active intervention period classes, and eight participants attended at least half of the maintenance period classes.

As shown in table 4, five of the nine study participants attending 6-month testing had reverted to normoglycaemia. Mean weight, BMI, waist circumference and abdominal sagittal circumference all decreased, although none of these improvements reached statistical significance. Participants also had a slight decrease in systolic blood pressure and showed marked improvements in cholesterol, low-density lipoprotein and triglycerides. Results are similar when the analysis is restricted only to individuals with 6-month follow-up data (data not shown).

DISCUSSION

This study used mixed methods to plan, implement and test the feasibility of a lifestyle intervention programme for diabetes prevention for US South Asians. Formative qualitative research found that South Asian Americans report a high prevalence of unhealthy behaviours and felt that immigration, culturally prescribed gender roles and the role of food in their culture were significant barriers to making healthy lifestyle choices. Some participants used many of these same factors—particularly the importance of taking care of their family and the need to be healthy to fulfil this role—as motivating factors for making healthy changes. In a subsequent pilot intervention study, a lifestyle education programme based on the DPP successfully

Table 3 Modifications to the US Diabetes Prevention Programme (DPP) for the SHAPE Programme

US DPP curriculum	SHAPE curriculum	Reason for change
Individual lessons led by a trained lifestyle coach	Group-based lessons led by a trained lifestyle coach	Increase social support among participants
Diet examples in class reflected the wider US population	Examples were modified to better reflect South Asian foods and holidays	Improve cultural appropriateness
Portion size recommendations were included in one lesson	Portion sizes were discussed during several lessons and focused on foods often eaten in excess (eg, rice, breads)	Portion sizes were identified as a major contributor to overeating
Participants were taught to overcome barriers to activity, with a large focus on internally derived barriers	Discussions of barriers included several exercises to practice talking to family and friends about the programme and helping them be more supportive	Family and social support are important barriers—and motivators—for lifestyle choices
Coach and participant worked one on one to discuss the programme information, overcoming barriers, and building social support	Each class included a group activity and ample interaction and discussion time	Build social support among the class and identify and find solutions for culturally specific barriers
Only the participant attended each class	Participants were encouraged to invite family members to classes	Build social support and make family members a source of motivation (and not a barrier) for behaviour change
Lifestyle coach is the main source of programme support	Participants were divided into small groups of 4–5 participants. Groups worked together in class and were encouraged to interaction outside of class time	Build social support
Exercise (overcoming barriers, increasing amount and exertion level, safety) was discussed during sessions with lifestyle coach	Added more basic exercise training (eg, exercise safety, stretching, basic strength training and increasing level of exertion), invited an exercise trainer to come to some classes, and offered optional group walks after most lessons	Build a strong foundation for exercise within a population with less exercise experience or working knowledge

SHAPE, South Asian Health and Prevention Education.

recruited and enrolled South Asian Americans and led to positive improvements in glycaemic status, anthropometry and plasma lipids. However, on-campus testing was a barrier to attending follow-up visits.

The SHAPE study supports research from UK, Canada and US South Asians describing the important role of food in South Asian culture,[14] the prevalence of unhealthy dietary behaviours,[15–20] and how migration changes lifestyle behaviours, resulting in weight gain and increased risk of diabetes.[21–23] However, the ways that migration effects behaviour differs for South Asians in non-US settings; for example, in a study of South Asians in Australia, participants blamed poor eating habits and a move away from traditional home-cooked foods on underemployment, the necessity of dual-income households and eating cheaper, less healthy food options because of financial difficulties.[24] Conversely, SHAPE participants discussed using fast foods because of the lack of cooking skills (for men) or because of limited vegetarian choices and an increase in potentially unhealthy ingredients (eg, sugar, oil) because they lower cost in the USA allowed participants to splurge.

South Asian society is pluralist,[25–27] prioritising the needs of the community over self; it is perhaps unsurprising that participants reported that family responsibilities are the major barrier to increasing physical activity. Although SHAPE participants cited many of the same barriers to physical activity as other South Asian migrant studies (household or work responsibilities, little cultural focus on being active), SHAPE participants did not mention current health conditions as barriers to physical activity as has been reported elsewhere.[28–31]

Some of the differences in reported barriers and activities around lifestyle behaviours in the SHAPE population may be due to the relatively high education and socioeconomic status of participants. SHAPE focus group participants understood of the link between healthy diet, physical activity and chronic disease prevention, even if this knowledge did not translate into changed behaviours. In other studies, South Asian participants did not make the connection between lifestyle choices and disease risk or current disease status.[24 29 32]

DPPs for South Asians can use the same cultural influences that currently pose barriers to healthy lifestyle choices as forces of change. Participants in this and other studies[24 28 30 33] reported that social support, particularly from family, was vital for starting and maintaining diet change and physical activity. Family was also a primary

Table 4 Cardiometabolic risk factors at baseline to 6 months, N (%) or mean (SD)

Variable	Baseline for all participants (n=17)	Baseline for participants with follow-up data (n=9)	Six months (n=9)
Glycaemic status			
Normoglycaemia	1 (5.9%)	0 (0%)	5 (55.6%)
Isolated IGT	3 (17.7%)	3 (33.3%)	2 (22.2%)
Isolated IFG	7 (41.2%)	3 (33.3%)	1 (11.1%)
IGT+IFG	6 (35.3%)	3 (33.3%)	1 (11.1%)
Type 2 diabetes mellitus	0	0	0
HbA1c (%)*	5.8 (0.4)	5.9 (0.5)	5.7 (0.4)
Anthropometry			
Normal weight BMI	1 (5.9%)	0 (0%)	3 (33.3%)
Overweight BMI	7 (41.2%)	2 (22.2%)	2 (22.2%)
Obese BMI	9 (52.9%)	7 (77.8%)	4 (44.4%)
High waist circumference	14 (82.4%)	8 (88.9%)	5 (55.6%)
BMI (kg/m^2)	28.9 (6.1)	30.7 (5.1)	26.2 (3.9)
Weight (kg)	78.1 (13.8)	80.3 (11.2)	73.9 (14.8)
Waist circumference (cm)	97.9 (10.9)	99.7 (8.9)	92.7 (12.0)
Abdominal sagittal circumference (cm)	23.6 (6.4)	25.6 (7.6)	20.9 (5.2)
Other cardiometabolic markers			
Systolic blood pressure (mm Hg)	121.8 (9.8)	124.3 (9.4)	118.3 (14.2)
Diastolic blood pressure (mm Hg)	78.8 (8.6)	78.3 (8.8)	77.1 (9.4)
Total cholesterol (mmol/l)	4.8 (0.9)	4.9 (1.0)	4.4 (0.7)
LDL (mmol/L)	3.3 (0.6)	3.4 (0.8)	3.0 (0.7)
HDL (mmol/L)	1.0 (0.2)	1.1 (0.3)	1.0 (0.3)
Triglycerides (mmol/L)	1.7 (0.7)	1.5 (0.5)	1.2 (0.5)

*HbA1c cut-points are 5.7%–6.4%=pre-diabetes, 6.5% or greater=diabetes.
BMI, body mass index; HDL, high-density lipoprotein; IGT, impaired glucose tolerance; LDL, low-density lipoprotein.

motivating factor for healthy lifestyle changes, and families that changed their lifestyles together were particularly successful.

There is limited research applying these and similar findings for diabetes prevention in South Asians. Outside of the USA, studies delivering the DPP or the Finish Diabetes Prevention Study curriculum have reported mixed, but largely positive impacts on glycaemic status with little effects on anthropometry.[34–36] Two US studies of lifestyle programmes for reducing diabetes or cardiovascular risk reported improvements in glycaemic markers and in one study weight.[37 38]

Although the SHAPE pilot study was small and lacked good follow-up for study testing, it has promising results that support further testing of culturally tailored lifestyle intervention programs for the US South Asian population. Follow-up in study classes was good, with only two participants dropping out of the programme, and those who attended follow-up visits showed positive improvements in anthropometric markers such as body weight and more markedly, waist circumference. In the DPP, weight loss was the strongest predictor of diabetes risk reduction.[39] Perhaps even more striking is that five of the nine participants at end of study testing had regressed to normoglycaemia; within the DPP, even transient regression to normal glucose levels was associated with a 56% reduction in diabetes risk.[40]

This study has several strengths. The formative and pilot trial data add to the small but growing literature on diabetes prevention and lifestyle behaviours among US South Asians. The FGDs included a large and diverse population of South Asian adults, including men and women with and without diabetes from various countries and regions of South Asia, of different religious traditions, and with a range of education levels. The results varied little between age and sex groups indicating that the barriers and motivating factors for diet and physical activity change are not patterned by standard demographic variables, but rather are stronger cultural issues seen in a diverse population of South Asian Americans. The pilot trial adds important information on the feasibility of translating proven DPPs to the South Asian Americas. This was the first study to our knowledge to report regression to normoglycaemia among South Asians

enrolled in a diabetes prevention study, and SHAPE is one of the few studies of diabetes prevention among South Asians, enrolled participants across the pre-diabetes spectrum, and specifically targeted overweight and obese South Asians.

Nevertheless, this study has several limitations. The pilot study too small to enable significance testing of results and there was loss of participants at follow-up testing visits. The goal of the SHAPE intervention was to assess programme feasibility, however, and even with these significant hurdles, the study provided a better understanding of barriers to participation and possible effects of the programme on health outcomes. Recruitment logistics for FGDs made it impossible to recruit younger participants quickly enough to host separate groups for first and second-generation South Asians resulting in an inability to capture differences that place of birth might have on lifestyle behaviours. The results of this study may not apply to non-English-speaking South Asians. The researchers believe that this is not the case, since focus group participants described behaviours of the South Asian community more broadly and requested the programme in English, and the research team was able to recruit a sizeable population of older South Asians where English skills might be lowest. However, acculturation affects lifestyle behaviours such as diet and physical activity, and the researchers cannot rule out the possibility that English-speaking participants are more acculturated than other members of the South Asian community and that different interventions might be needed for South Asians with low-English proficiency.

Despite these limitations, the SHAPE study provides important information on the current behaviours, beliefs and feelings around diabetes prevention, diet change and physical activity, as well as pilot data showing the feasibility of a DPP-like intervention among South Asian Americans. Future work should focus on testing the SHAPE intervention in a larger trial, collecting more formalised feedback on programme acceptability and considering additional intervention models, a family-based programme, for instance, to address the high risk of diabetes in this community.

CONCLUSION

In the USA, where food is plentiful, portions are large, unhealthy ingredients are cheap and readily available, and the environment supports sedentary activity over active lifestyle choices, South Asians, with their focus on family, society and food, are at a uniquely high risk for weight gain and developing cardiometabolic diseases like diabetes. This study showed that, although immigration and traditional gender roles can act as barriers to following a healthy lifestyle, they could also motivate South Asians to change their diet and physical activity behaviours. Lifestyle interventions, based on the US DPP, can be an effective tool for reducing weight, improving glycaemia and engaging South Asian adults in diabetes prevention.

Contributors MBW designed and managed the SHAPE study, conducted data analysis and was the primary author of the manuscript. MMH provided guidance on the development and implementation of the qualitative components of SHAPE. All authors contributed to the design of the SHAPE study, assisted in data interpretation and provided substantive feedback on the manuscript.

Funding As requested, we deidentified the manuscript. The information removed was Emory as the institution in several places (currently 'UNIVERSITY') and the initials and grant information in the funding statement. The full statement is: This work was supported by the National Institute of Diabetes and Digestive and Kidney Diseases of the National Institutes of Health (NIDDK/NIH) (grant number R34 DK081723), the Clinical and Translational Science Award programme, NIH, National Center for Research Resources (grant number UL1 RR025008), the Emory University Coalition of University-Community Partnerships, and the American Diabetes Association. Further support was provided for MBW by additional grants from the NIDDK/NIH (grant numbers T32 DK007298, T32 DK007734) and both MBW and KMVN receive support from a NIDDK/NIH-funded Centre grant (grant number and P30 DK111024).

Competing interests None declared.

Patient consent for publication Not required.

Ethics approval The Emory University Institutional Review Board approved the FGDs (#IRB00019630) and the intervention (#IRB00035893).

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data are available on reasonable request. Deidentified data are available through the corresponding author.

ORCID iD

Mary Beth Weber http://orcid.org/0000-0002-2804-3948

REFERENCES

1 The United States Census, 2000 and 2010 [Internet]. Available: www.census.gov
2 Gujral UP, Pradeepa R, Weber MB, *et al*. Type 2 diabetes in South Asians: similarities and differences with white Caucasian and other populations. *Ann N Y Acad Sci* 2013;1281:51–63.
3 Gujral UP, Weber MB, Staimez LR, *et al*. Diabetes among Non-Overweight individuals: an emerging public health challenge. *Curr Diab Rep* 2018;18:60.
4 Knowler WC, Barrett-Connor E, Fowler SE, *et al*. Reduction in the incidence of type 2 diabetes with lifestyle intervention or metformin. *N Engl J Med* 2002;346:393–403.
5 Haw JS, Galaviz KI, Straus AN, *et al*. Long-Term sustainability of diabetes prevention approaches: a systematic review and meta-analysis of randomized clinical trials. *JAMA Intern Med* 2017;177:1808–17.
6 Hennink MM. *International focus group research: a Handbook for the health and social sciences*. Cambridge, U.K.: Cambridge University Press, 2007.
7 Green J, Thorogood N. *Qualitative methods for health research*. London: Sage Publications, 2004.
8 Hennink MM, Kaiser BN, Marconi VC. Code saturation versus meaning saturation: how many interviews are enough? *Qual Health Res* 2017;27:591–608.
9 Guest G, MacQueen KM, Namey EE. *Applied thematic analysis*. Thousand Oaks, CA: Sage Publications, 2012.
10 WHO Expert Consultation. Appropriate body-mass index for Asian populations and its implications for policy and intervention strategies. *Lancet* 2004;363:157–63.
11 American Diabetes Association. 2. classification and diagnosis of diabetes. *Diabetes Care* 2015;38:S8–16.
12 Lindström J, Tuomilehto J. The diabetes risk score: a practical tool to predict type 2 diabetes risk. *Diabetes Care* 2003;26:725–31.

13 Gibbons RJ, Balady GJ, Bricker JT, *et al*. ACC/AHA 2002 guideline update for exercise testing: a report of the American College of Cardiology/American heart association Task force on practice guidelines (Committee on exercise testing), 2002. American College of cardiology American heart association. Available: www.acc.org/clinical/guidelines/exercise/dirIndex.htm
14 Mukherjea A, Underwood KC, Stewart AL, *et al*. Asian Indian views on diet and health in the United States: importance of understanding cultural and social factors to address disparities. *Fam Community Health* 2013;36:311–23.
15 Varghese S, Moore-Orr R. Dietary acculturation and health-related issues of Indian immigrant families in Newfoundland. *Can J Diet Pract Res* 2002;63:72–9.
16 Fleming E, Gillibrand W. An exploration of culture, diabetes, and nursing in the South Asian community: a metasynthesis of qualitative studies. *J Transcult Nurs* 2009;20:146–55.
17 Kalra P, Srinivasan S, Ivey S, *et al*. Knowledge and practice: the risk of cardiovascular disease among Asian Indians. results from focus groups conducted in Asian Indian communities in northern California. *Ethn Dis* 2004;14:497–504.
18 Lawton J, Ahmad N, Hanna L, *et al*. 'We should change ourselves, but we can't': accounts of food and eating practices amongst British Pakistanis and Indians with type 2 diabetes. *Ethn Health* 2008;13:305–19.
19 Misra R, Patel TG, Davies D, *et al*. Health promotion behaviors of Gujurati Asian Indian immigrants in the United States. *J Immigr Health* 2000;2:223–30.
20 Walker GJ, Caperchione CM, Mummery WK, *et al*. Examining the role of acculturation in the leisure-time physical activity of South Asians living in Canada. *J Sci Med Sport* 2015;18:156–60.
21 Patel JV, Vyas A, Cruickshank JK, *et al*. Impact of migration on coronary heart disease risk factors: comparison of Gujaratis in Britain and their contemporaries in villages of origin in India. *Atherosclerosis* 2006;185:297–306.
22 Misra A, Ganda OP. Migration and its impact on adiposity and type 2 diabetes. *Nutrition* 2007;23:696–708.
23 Ramachandran A, Ma RCW, Snehalatha C. Diabetes in Asia.. *Lancet* 2010;375:408–18.
24 Fernandez R, Rolley JX, Rajaratnam R, *et al*. Reducing the risk of heart disease among Indian Australians: knowledge, attitudes, and beliefs regarding food practices - a focus group study. *Food Nutr Res* 2015;59:25770.
25 Ahmad F, Shik A, Vanza R, *et al*. Popular health promotion strategies among Chinese and East Indian immigrant women. *Women Health* 2004;40:21–40.
26 Choudhry UK. Health promotion among immigrant women from India living in Canada. *Image J Nurs Sch* 1998;30:269–74.
27 Dugsin R. Conflict and healing in family experience of second-generation emigrants from India living in North America. *Fam Process* 2001;40:233–41.
28 Jepson R, Harris FM, Bowes A, *et al*. Physical activity in South Asians: an in-depth qualitative study to explore motivations and facilitators. *PLoS One* 2012;7:e45333.
29 Lucas A, Murray E, Kinra S. Heath beliefs of UK South Asians related to lifestyle diseases: a review of qualitative literature. *J Obes* 2013;2013:1–13.
30 Daniel M, Wilbur J. Physical activity among South Asian Indian immigrants: an integrative review. *Public Health Nurs* 2011;28:no–401.
31 Dave SS, Craft LL, Mehta P, *et al*. Life stage influences on U.S. South Asian women's physical activity. *Am J Health Promot* 2015;29:e100–8.
32 Tang JW, Mason M, Kushner RF, *et al*. South Asian American perspectives on overweight, obesity, and the relationship between weight and health. *Prev Chronic Dis* 2012;9:E107.
33 Jayaprakash M, Puri-Taneja A, Kandula NR, *et al*. Qualitative process evaluation of a community-based culturally tailored lifestyle intervention for underserved South Asians. *Health Promot Pract* 2016;17:802–13.
34 Admiraal WM, Vlaar EM, Nierkens V, *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 metabolic profile of participants in a randomized controlled trial. *PLoS One* 2013;8:e68605.
35 Weber MB, Ranjani H, Staimez LR, *et al*. The stepwise approach to diabetes prevention: results from the D-CLIP randomized controlled trial. *Diabetes Care* 2016;39:1760–7.
36 Thankappan KR, Sathish T, Tapp RJ, *et al*. A peer-support lifestyle intervention for preventing type 2 diabetes in India: a cluster-randomized controlled trial of the Kerala diabetes prevention program. *PLoS Med* 2018;15:e1002575.
37 Islam NS, Zanowiak JM, Wyatt LC, *et al*. Diabetes prevention in the new York City Sikh Asian Indian community: a pilot study. *Int J Environ Res Public Health* 2014;11:5462–86.
38 Kandula NR, Dave S, De Chavez PJ, *et al*. Translating a heart disease lifestyle intervention into the community: the South Asian heart lifestyle intervention (SAHELI) study; a randomized control trial. *BMC Public Health* 2015;15:1064.
39 Hamman RF, Wing RR, Edelstein SL, *et al*. Effect of weight loss with lifestyle intervention on risk of diabetes. *Diabetes Care* 2006;29:2102–7.
40 Perreault L, Pan Q, Mather KJ, *et al*. Effect of regression from prediabetes to normal glucose regulation on long-term reduction in diabetes risk: results from the diabetes prevention program outcomes study. *Lancet* 2012;379:2243–51.