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Exploring Community Acceptability in Diabetes Prevention for South Asian Indians: A Qualitative Study

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Abstract

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Diabetes has been quietly raging the globe, affecting 415 million worldwide in 2015 – a number expected to rise to 642 million by 2040 (Unnikrishnan et al., 2017). With a snowballing prevalence rate, the threat of life-altering diabetic complications from undetected or untreated diabetes, and many unsolved healthcare access barriers for underserved and low-income populations, diabetes remains a key non-communicable disease of public health interest. Amid India's increasingly industrialized economy and transitions in nutritional status, South Asians develop diabetes at younger ages and have increased glucose tolerance as well as lower criteria for central obesity compared to Europeans (Hu 2011) (Chowdhury et al., 2003). There is currently a lack of research on culturally relevant diabetes prevention for South Asian Indians. In 2016, clinically overweight South Asians in Chennai, India with prediabetes enrolled in the Diabetes Community Lifestyle Improvement Program (D-CLIP) study. A follow-up qualitative study was conducted with former D-CLIP participants to gain participant feedback and to gauge participants' perceptions of D-CLIP. Findings from this study will pinpoint motivators, facilitators, and barriers to lifestyle change to help explore phenomena related to health behavior change and engagement with the D-CLIP intervention. This research will provide recommendations for fostering community acceptability, long-term dissemination, and sustainability for future lifestyle intervention programs for South Asian communities and future diabetes prevention efforts. Community-raised and -based recommendations for effective diabetes prevention is needed to fill the gap in diabetes burden for South Asian Indians.

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I. Introduction

Problem Statement

As the 9th leading cause of mortality worldwide and the 7th leading cause of loss of DALYs, diabetes had a hand in 1 million deaths in 2017 (Khan et al., 2020). On a global scale, diabetes boasts an incidence of 1.5 million cases per year (Crandall et al. 2008) with 451 million adults living with the condition (Lin et al. 2020) and 7% of adults in the U.S. affected by type 2 diabetes mellitus (T2DM) -- the most abundantly seen form of diabetes (Crandall et al. 2008). Those living with type 2 diabetes face a twofold- to fourfold-increased risk of developing other chronic diseases as well, such as cardiovascular disease or stroke (Crandall et al. 2008).

This population suffers vulnerabilities on multiple fronts--they have higher risk of contracting infectious disease such as tuberculosis, peripheral vascular disease, hospital-acquired postoperative infections, and severe gram-positive infections compared to people without diabetes (Harding et al., 2019). They face increased mortality from these infections and from major chronic disease involving the kidneys and liver (Lin et al. 2020). When glucose is not taken up into the cells, the excess sugar traveling along the bloodstream can cause damage to different areas of the body, such as the eyes and feet. Diabetes complications -- macrovascular and microvascular -- have led to a plethora of health issues, including blindness, renal failure, and amputation. These complications account for much of the burden linked to diabetes (Harding et al., 2019).

Beyond physical consequences, diabetes also has social ramifications. Diabetes diagnosis, management, and complications can result in significant mental toll for its victims.

Those with diabetes are at increased risk for acute and severe mental illness, such as major depressive disorder, anxiety, and dementia (Harding et al., 2019). Previous studies have also found diabetes to be associated with higher rates of depression when compared to the general population (Poulsen & Pachana 2012). People with diabetes have increased risk for mobility loss, reduced basic activities of daily living, and work disability (Harding et al., 2019). Some diabetes complications, such as 'diabetic foot', threaten to disfigure patients with diabetes, increasing the potential for lower quality of life. Finally, diabetes is responsible for substantial economic costs as well; in 2010, diabetes accounted for 12% of health expenditures globally (Hu 2011). The authors of the Bommer et al. study predict that the global economic burden of diabetes and its complications will come to over $2.1 trillion by 2030 (Bommer et al., 2018).

Significance of the Study

Two-thirds of the world's diabetes cases occur in low- or middle- income countries, and 60% of the world's diabetic population is found on the Asian continent (Hu 2011). Between 1990 to 2017, South Asia experienced some of the highest age-standardized mortality and disability-adjusted life-years (DALYs) associated with diabetes when compared with other regions (Lin et al., 2020). In urban areas of India, diabetes prevalence has doubled from 9% to 17% in the past 20 years (Prabhakaran, Jeemon, & Roy 2016). The rising diabetes prevalence in low- and middle-income countries in Asia is due to rapid economic development, urbanization, increasingly sedentary lifestyles, and transitions in nutritional status (Hu 2011). Although the average BMI of these populations is lower, abdominal, or central obesity is highly prevalent and Asian people develop diabetes at younger ages compared to Western populations (Hu 2011). Those living in rural or semi-urban areas in India have low awareness of diabetes prevention and

care and low diagnosis, likely due to their limited access to diabetes clinics offering comprehensive diabetes care, which can result in untreated diabetes and can invite the development of multiple diabetes complications (Viswanathan, V. 2017). The medical costs from treating these complications have been shown to place further economic burden on populations in areas like Chennai (Yesudian, Grepstad, and Visintin et al., 2014).

At the prediabetes stage, progression to type 2 diabetes may be preventable, prompting increased public health focus on screening individuals for prediabetes and using this time as an intervening point to educate and equip the individual to make health behavior changes necessary for delaying or preventing type 2 diabetes. Several lifestyle intervention trials have pursued this route. The 1996 Diabetes Prevention Program (DPP) examined the effectiveness of a lifestyle intervention as opposed to a metformin intervention, which was disseminated to a racially diverse sample population of people with impaired glucose tolerance across 27 clinical centers in the United State (The DPP Research Group, 2002). The lifestyle intervention used ethnically tailored materials and strategies to deliver its core curriculum and ultimately demonstrated a 58% decrease in type 2 diabetes reduction (The DPP Research Group, 2002). Other lifestyle intervention studies like the Da Qing and Finnish Diabetes Prevention studies also showed promising risk reduction rates (The DPP Research Group, 2002).

However,, research on culture-specific diabetes prevention for South Asians is lacking. Although economically advanced states like Tamil Nadu and Kerala host an abundance of diabetes centers and research institutes, these centers tend to focus on monitoring epidemiological trends of diabetes amongst the population (Atre 2019). And, as it stands, there is poorer diabetes awareness and control in the rural regions of India as compared to the urban regions (Prabhakaran, Jeemon, & Roy 2016). The D-CLIP study, a randomized controlled

diabetes prevention study aimed to help fill this gap by providing a low-cost, community-based lifestyle intervention for South Asian adults in rural Chennai, India (Weber et al. 2012).

To support future interventions in this direction, there is a need for studies that highlight strategies to increase community acceptability amongst the South Asian population. Lifestyle intervention programs (LIPs) will benefit from research that examines study participants' perspectives on LIP features, and home- and program-based factors that influence health behavior in a South Asian cultural context. This thesis will aim to contribute to this area of knowledge by analyzing the experiences of D-CLIP study participants both during and after the intervention.

Aims of the Study

This thesis will explore the experiences of D-CLIP participants in Chennai, India after the program. Stemming from the D-CLIP study's original goals, this thesis will ponder ways to increase community acceptability and determine ways of sustaining the program for long-term and broadened dissemination (Weber et al., 2012). On a small scale, this thesis hopes to generate D-CLIP participant feedback that helps the program discover improvements that can be made for education, recruitment, program logistics, accommodations, and partnerships. On a large scale, it hopes to demonstrate potential focal points and grassroot-inspired possibilities to increase community acceptability for current and future diabetes prevention programs, contributing to literature on effective diabetes prevention for South Asian Indians. This thesis will also explore the topic of cost-effective innovations that can mitigate common barriers to diabetes prevention and support/facilitate healthy behavior change in low-resource settings. Ideally, increased attention towards community acceptability and culturally tailored lifestyle intervention will allow

for feasible community restructuring that promotes feasible positive health behaviors and stunts the ongoing rise in diabetes incidence (Harding et al., 2019) (Khan et al., 2020).

Research Question

What were the experiences of D-CLIP program participants during and after the diabetes prevention intervention in Chennai, India? Specifically:

1. What factors influenced the D-CLIP study participants' decision to enroll in and continue engaging with the D-CLIP program?
2. What facilitators and barriers influenced the D-CLIP study participants' initial health behavior change?
3. What facilitators and barriers influenced the D-CLIP study participants to maintain health behavior change?

Frequently Used Words

"Awareness" = consciousness about topic (e.g., "food consciousness")

"D-CLIP" = Diabetes Community Lifestyle Improvement Program

"D&E" = D-CLIP recommended diet and exercise

"Health behavior change" = positive changes to dietary practices or food intake and physical activity levels

"Maintenance" = consistent performance at same level

"Walking behaviors" = walking routines, consistency, and intensity

II. Background

Diabetes and Prediabetes in India

In 2013, diabetes prevalence in India was 9.1% while diabetes prevalence worldwide was 8.3% (Yesudian, Grepstad, and Visintin et al., 2014). India has the second-largest population living with diabetes--65.1 million people in 2013 and 77.0 million by 2019 (IDF 2019). India was crowned "the diabetes capital of the world" in the Yesudian et al. literature review on the economic burden of diabetes in India as diabetes is a growing problem in India -- particularly in South India (Yesudian, Grepstad, and Visintin et al., 2014). Compared to Europeans, South Asians have a fourfold risk of developing type 2 diabetes, and the condition develops approximately 10 years earlier for South Asians than for their European counterparts (Chowdhury, Grace, and Kopelman, 2003). Patients in India have much lower thresholds for waist circumference (central obesity) and increased glucose intolerance compared to Europeans (Chowdhury, Grace, and Kopelman, 2003).

A 2011 cross-sectional study assessed the prevalence of diabetes risk factors amongst 529 urban residents from Chennai, Tamil Nadu, South India (Vigneswari, Manikandan, and Satyavani et al., 2015). The sample population was randomly selected from three slums and had a median monthly family income of 3000 INR; approximately one-fifth were illiterate and over a third were either unemployed, retired, or housewives (Vigneswari, Manikandan, and Satyavani et al., 2015). The group had an obesity prevalence of 57.3%, a central obesity prevalence of 75.7%, a self-reported diabetes prevalence of 20.8% and a self-reported hypertension prevalence of 24.2% (Vigneswari, Manikandan, and Satyavani et al., 2015). The median duration of time spent walking each day was 30 minutes and the mean duration of time spent sitting was 240 minutes

(Vigneswari, Manikandan, and Satyavani et al., 2015). This implies that key existing risk factors amongst the low-income urban population in Chennai include living a sedentary lifestyle, having central obesity, and having an unhealthy dietary pattern (Vigneswari, Manikandan, and Satyavani et al., 2015).

Diabetes presents economic costs for not only the individual, but also the nation. Across six studies included in a 2014 review of diabetes economic burden in India, drug costs were responsible for half the total direct costs and lost patient income made up 61% of the total indirect costs (Yesudian, Grepstad, and Visintin et al., 2014). Though the highest expenditure on diabetes care comes from the higher-income population, this disproportionality may be because low-income and rural populations members encounter issues with affordability and access to diabetes care (Yesudian, Grepstad, and Visintin et al., 2014). Low-income individuals in India are less likely to receive medical treatments, which are often beyond their capacity to pay (Prabhakaran, Jeemon, & Roy 2016). Furthermore, lower income individuals bear the highest diabetes burden as they generally spend a larger proportion of their income to pay for diabetes care (Yesudian, Grepstad, and Visintin et al., 2014). The lowest income group in urban India spends 34% of its annual family income for diabetes care (and 27% for the lowest income group in rural India) (Prabhakaran, Jeemon, & Roy 2016).

However, early intervention does provide individuals and their families an opportunity to avoid this catastrophic spending. A Chennai study that examined economic burden from diabetes complications from 2008 and 2009 found total costs for patients without complications to be much lower as opposed to total costs for patients with complications (Yesudian, Grepstad, and Visintin et al., 2014). Reduced hospitalization costs, including emergency room visits and diabetes complication treatment procedures, would significantly chip away at the current

economic burden on Indian households and society as well as increase the patient quality of life (Yesudian, Grepstad, and Visintin et al., 2014). Unfortunately, there are issues with underdiagnosis and underreporting of cardiovascular disease in India as several cases of diabetes go undetected (Prabhakaran, Jeemon, & Roy 2016). Of the individuals diagnosed with diabetes in the Viswanathan 2017 study, 47.3% were previously undiagnosed, which is a sign of poor diabetes management (Viswanathan 2017). Those who are uneducated, unemployed, or living in semi-urban or rural areas of India are more likely to be diagnosed later due to access and affordability issues, allowing diabetes to continue untreated (Yesudian, Grepstad, and Visintin et al., 2014). Undiagnosed people risk only being diagnosed once advanced diabetic microvascular complications are already present (Viswanathan, 2017). In the SEARCH for Diabetes in Youth study, 10% with type 2 diabetes presented with diabetic ketoacidosis at the time of at diagnosis (Harding et al., 2019). This is a problem as some diabetes complications are irreversible -- such as diabetic retinopathy or decreased kidney function (low glomerular filtration) -- and others may cause individuals to be temporarily disabled or must attend more hospital visits (e.g., in the case of diabetic foot) which may be more problematic for low-income individuals (Viswanathan, 2017) This circular chain of events makes timely diabetes intervention seem dismal for the low-income population.

One opportunity to reach individuals before they develop complications or diabetes itself is to target individuals at risk of developing type 2 diabetes, such as those with prediabetes. Prediabetes is indicated by blood glucose levels or glycated hemoglobin (HbA1C) that record higher than normal yet are not necessarily high enough to indicate diabetes (CDC 2021). The Chennai Urban Rural Epidemiology Study (CURES), study based in Chennai, India, collected data on progression to diabetes and prediabetes from a cohort of 1,376 individuals from Chennai

over a median of 9 years of follow-up (Anjana, Rani, and Deepa, 2015). The study reported a prediabetes incidence rate of 29.5 per 1,000 person-years and stated Asian Indians demonstrate one of the highest incidence rates of diabetes as well as a high conversion rate from normal glucose tolerance to dysglycemia (Anjana, Rani, and Deepa, 2015) (Prabhakaran, Jeemon, & Roy 2016). The prevalence of prediabetes in India is concerning as well. The 2008-2015 ICMR-INDIAB study was a community-based study with 57,117 adults aged 20 and older, representing 14 of India's 28 states (Anjana et al. 2017). Diabetes and prediabetes were diagnosed via the use of glucose tolerance tests and the study collected data on diabetes prevalence across the 14 included states in relation to socioeconomic status (SES) of individuals and GDP of each state (Anjana et al. 2017). The overall prevalence of prediabetes was 10.3% and a higher prevalence had impaired fasting glucose as opposed to impaired glucose tolerance (Anjana et al. 2017).

Studies Examining Diabetes Awareness in South India

A 2014 study assessing the general population's knowledge and awareness of diabetes was conducted amongst 16,607 adults selected from urban and rural areas in the following Indian regions: Chandigarh, Tamil Nadu, Jharkhand and Maharashtra (Deepa, Bhansali, and Anjana et al., 2014). Less than half had previously heard of diabetes, and among those without diabetes, 56.3% knew diabetes could be prevented and 51.5% knew diabetes could affect other organs (Deepa, Bhansali, and Anjana et al., 2014). Among those living with diabetes, 63.4% were aware diabetes was preventable (Deepa, Bhansali, and Anjana et al., 2014). When comparing composite diabetes knowledge scores by regions, Tami Nadu, which is in South India, had the lowest knowledge score amongst those with diabetes (Deepa, Bhansali, and Anjana et al., 2014). Illustrating the need for increased attention to rural Indians, Viswanathan's article, "The need for

improved diabetes care in India," reported that awareness and diagnosis particularly remain low in rural areas as these residents did not have as much access to the diabetes centers or clinics that provide comprehensive diabetes care, which are usually located in urban settings (Viswanathan, 2017). As such, people with diabetes in rural areas miss opportunities to be screened early for the microvascular and macrovascular complications (Viswanathan, 2017).

A 2005 population-based study assessed awareness, knowledge, and traditional beliefs of diabetes amongst study subjects in the urban south Indian population of Chennai, India via questionnaire (Mohan et al. 2005). Seventy-five percent reported they were aware of diabetes, while only 22% of the study subjects reported being aware that diabetes could be prevented. Diabetes knowledge was also poor among self-reported diabetic subjects -- only 41% reported awareness and while knowledge was generally higher amongst those with a higher level of education attained (postgraduates and professionals), only 42.6% of those with the highest level of education reported awareness (Mohan et al. 2005). Nineteen percent knew diabetes could cause health complications, but they lacked knowledge about the specific organs affected by diabetes, with the most common reported complications being foot problems and kidney disease. The study also asserts that, while 50% listed family history or sweets/high calorie consumption as a main cause of diabetes, there was low knowledge regarding the role that physical inactivity and obesity play in the development of diabetes (Mohan et al. 2005).

These three studies make the case that the Chennai population could benefit from more far-reaching diabetes education programs, and that better medical education programs on diabetes are needed for local doctors as well. Mohan et al. suggested that lack of time, lack of trained educators, and inadequate ways of providing information are barriers to diabetes prevention and must be addressed (2005). Mohan et al. also suggests that the community is slow

to access results of clinical trials and suggests there is an awareness gap (Mohan et al. 2005). In countries with rapidly developing economies, being overweight can be considered a sign of health, wealth, and power -- such is the case in India (Mohan et al. 2005). Among many South Asian communities, there is poor knowledge about the risks of increasing fatness, necessitating increased culturally appropriate education and intervention (Chowdhury, Grace, and Kopelman, 2003). This drives food habits and exercise behavior; thus, it is necessary to improve community-wide knowledge about healthy eating, the appropriate amount of physical exercise, the risk factors of diabetes, and steps to promote physical activity (Chowdhury, Grace, and Kopelman, 2003). There need to be extra efforts to transmit important PH diabetes- and health-related messages through popular media and more diabetes education needs to be offered to those living in rural areas, which are farther from central resources like the Mohan Diabetes Specialties Center.

Previous Lifestyle Intervention Program (LIP) Studies

Well-established risk factors for type 2 diabetes include behavioral factors such as diet, physical inactivity, smoking, alcohol use and medical history including low-grade systemic inflammation, gestational diabetes, obesity, and genetic susceptibility through family history (Hu 2011). Type 2 diabetes is preventable through modifications to diet and lifestyle and multiple studies regard this method of prevention a priority for global prevention of type 2 diabetes (Hu 2011) (Carlos, de Irala, & Hanley et al., 2014). Several well-known randomized controlled lifestyle intervention studies like the DPP or Da Qing studies have supported the role of lifestyle change in the prevention, or at least delay, of type 2 diabetes (Crandall et al., 2008). Studies, also including the Finnish Diabetes Prevention Study and Indian Diabetes Prevention Program

(IDPP), demonstrated reductions in T2DM in high-risk groups with varying risk reduction rates ranging from 28% to 67% (Crandall et al., 2008). Weight loss had a profound effect on incident reduction as well, in addition to medications such as metformin, which safely helped prevent or delay T2DM (Crandall et al., 2008). Another literature review examined the outcomes of 16 community-based lifestyle diabetes prevention interventions, with at least eight involving populations with disproportionate diabetes burden, such as African Americans, American Indians, and Mexican Americans) (Satterfield, Volansky, and Caspersen et al., 2003). Overall, adults in the intervention groups saw improvements in knowledge or adoption of regular physical activity, which are positive steps in diabetes prevention work (Satterfield, Volansky, and Caspersen et al., 2003).

U.S. Diabetes Prevention Program (DPP)

In the 1996 DPP study, study participants received only metformin treatment, only the lifestyle intervention, or were placed in the control group. The study was unique in that 45% of the study's sample population belonged to ethnic minority groups disproportionately affected by type 2 diabetes (e.g., African Americans, American Indians) (CDC 2020). The lifestyle intervention included 16 sessions with lifestyle change education, ethnically tailored materials and strategies, self-management strategies for performing consistent physical activity, physical activity sessions, strategies for non-adherent participants, individual case management and follow-up, and flexible program training/feedback support that allowed for 'restarts' and motivation campaigns to encourage health behavior change maintenance (CDC 2020). Metformin treatment resulted in a 31% incidence rate reduction, while lifestyle intervention resulted in a 58% incidence rate reduction, which offered up both methods as effective methods of decreasing diabetes incidences amongst the study population.

In the lifestyle intervention component of the DPP program, participants learned how to eat healthy, how to incorporate more physical activity into one's daily schedule, how to manage stress, how to stay motivated, and how to overcome challenges to continue progressing forward with health behavior change goals (CDC 2020). The program recruited trained coaches and helped participants receive support from others with similar goals and challenges to make those changes (CDC 2020). Due to its success, the curriculum and program structure from this intervention has been utilized as a template for many other lifestyle intervention programs targeting those with prediabetes.

Challenges Facing Lifestyle Intervention Studies

Recent research in diabetes prevention has been interested in the translatability of these studies. Lifestyle intervention may reduce diabetes incidence in the context of a resource-powered study, but the findings and recommendations need to function in a real-world setting and be sustainable. Haw and colleagues listed notable limitations for lifestyle intervention programs (LIPs). Firstly, the authors spoke of publication bias; diabetes RR reduction might run larger than normal due to underrepresentation of studies where there were small or null effects.

One concern is that standardized intervention strategies may fall short due to individual differences amongst different subgroups with different needs. A 2015 Australian study on people with prediabetes explored "patterns of risk factors and behavioral vulnerability" amongst adults diagnosed with prediabetes (Hardie, Critchley & Moore). Latent class analysis amongst those with prediabetes was performed to determine "classes or groups with distinct patterns of risk", followed by subsample analysis, one-way ANOVA and post-hoc comparisons to identify behavioral profiles for three 'risk clusters'. (Hardie, Critchley & Moore. One risk cluster for prediabetes included people of younger age with family history of diabetes. high levels of stress

and anxiety, low motivation and self-efficacy, and less social support (Hardie, Critchley & Moore). Authors proposed this group would most benefit from early lifestyle change intervention "that included mood and motivation management and social support." (Hardie, Critchley & Moore, 2015). Meanwhile, another risk cluster included people of older age who already engaged in healthy behaviors and had social support, but had larger waist circumferences and low physical activity, and so could benefit from more from a physical activity-focused intervention (Hardie, Critchley & Moore). The third risk cluster of people with diabetes tended to live an active lifestyle but practice poor eating habits and have high stress levels, therefore their tailored intervention would emphasize stress management and healthy eating skills as opposed to increased physical activity (Hardie, Critchley & Moore). People who were categorized within these three risk clusters for prediabetes showed wide-varying patterns of modifiable risk factors, implying people of different prediabetes risk clusters may differ in which interventions they receive the most benefit from (Hardie, Critchley & Moore). This study contributes to diabetes prevention literature by suggesting LIPs consider subgroup demographics and the presence of facilitators and barriers to produce tailored, targeted interventions. There is a need to understand what makes existing lifestyle intervention programs feasible for different subgroup populations.

Another concern with lifestyle intervention is that because it is so dependent on individual behavior, it requires the individual to maintain their initial behavior changes throughout the rest of their life. Thus, several studies have examined post-intervention maintenance and explored what factors facilitate or inhibit maintenance. Prior research reminds us that self-efficacy may facilitate success in achieving certain health goals. For example, in the 2018 Cioffi et al. study, some short-term and long-term secondary outcomes were significantly associated with exercise self-efficacy (Cioffi et al., 2018). The BMJ 2018 study evaluated the

effects of D-CLIP on self-efficacy and examined the associations between self-efficacy and diabetes-related outcomes (Cioffi et al., 2018). Cioffi et al. claim that improvements in self-efficacy in the D-CLIP study were not sustained during follow-up (Cioffi et al., 2018). Although dietary and exercise self-efficacy increased after intervention completion, this was not sustained long-term.

Davis and colleagues also examined the sustainability of dietary change post-intervention as well (Davis et al., 2013). Their study presented evidence that lifestyle intervention programs can lead to total energy intake reduction up to 9 years later (Davis et al., 2013). The study also found that higher leisure physical activity predicted lower fat intake, but not energy take, and that initial success in achieving reductions in fat and energy intake was associated with long-term success at maintaining those changes (Davis et al., 2013). The study found that an initially lower energy intake (at baseline) predicted a lower fat intake, but not energy intake, at Year 9 (Davis et al., 2013). Haw et al. 2017 reviewed clinical trials looking at the long-term effects of both lifestyle modification and insulin-sensitizing medication diabetes prevention interventions. The average follow-up observation period for the reviewed clinical trials was 17 weeks. Haw et al. 2017 found that although these interventions were associated with reduced diabetes risk, the effects were only sustained (post-intervention) for lifestyle modification intervention. Haw et al. also found that, with exception to the Da Qing study, physical activity interventions alone did not significantly reduce risk for diabetes (2017). Ultimately, Haw et al. asserted that lifestyle modification strategies are better in the long-term, but there needs to be more evidence-driven strategies to maintain their effects.

The Present Study

The Diabetes Community Lifestyle Improvement Program (D-CLIP)

D-CLIP was a diabetes prevention study conducted in Chennai, India with 578 clinically overweight South Asian adults diagnosed with prediabetes at the time of the study (Weber et al., 2016). The study's definition of prediabetes included people with impaired glucose tolerance (IGT), people with impaired fasting glucose (IFG), and people with both (IFG+IGT) to be included in the study (Weber et al., 2016).

D-CLIP was a low-cost, community-based, translational study inspired by the format of the DPP study (Islek, Weber, and Mohan et al., 2020) (Weber et al. 2012). Per recommendations from the American Diabetes Association (ADA), D-CLIP offered the intervention group a lifestyle prevention intervention and administered metformin in a stepwise fashion as needed (Weber et al., 2016). This randomized, controlled study aimed to assess the effectiveness of a lifestyle intervention that applied conservative usage of metformin South Asian people with prediabetes (Islek, Weber, and Mohan et al., 2020). The study's control group received 'standard of care' treatment for prediabetes -- a day of scheduled individual visits with healthcare professionals (i.e., a physician, fitness trainer, and a dietician) plus one provided class on diabetes prevention (Weber et al., 2016). D-CLIP provided screenings for diabetes and recruited those diagnosed with diabetes soon afterwards, optimizing on the time when people may be most motivated and willing to initiate positive lifestyle changes (Abel et al., 2018). The classes were team-taught and utilized professionals as well as trained community educators (Weber et al. 2012). The study was interested in outcomes such as diabetes incidence, cost-effectiveness,

weight loss, and sustainability, which was measured via anthropometric and questionnaire data (Weber et al. 2016).

Three years post-intervention, 25.7% of the participants in the intervention group went on to develop diabetes as opposed to the 34.9% in the control group that did so, producing an overall relative risk reduction (RRR) of 32% (Weber et al. 2016). The RRR varied based on the method of prediabetes diagnosis—the IGT and IFG+IGT-diagnosed groups had an RRR of 31% and higher, while the IFG-diagnosed group had an RRR of 12%. The program was least effective in reducing diabetes incidence amongst the IFG group and the study concluded that lifestyle interventions with low-fat dietary recommendations and metformin use may not appropriately target the pathophysiological mechanism of the IFG phenotype (poor insulin secretion and gluconeogenesis) (Weber et al., 2016). Ultimately, the study concluded D-CLIP could serve as a translatable framework for chronic disease prevention in other low- and middle-income country settings outside of Chennai, India (Weber et al., 2016). Additionally, a subsequent economic evaluation study with the 578 D-CLIP participants found the study's stepwise approach to be cost-effective, even with added prediabetes screening costs (Islek, Weber, and Mohan et al., 2020). However, there is a need to understand participant views of the program to adequately determine community acceptability and inform sustainability and dissemination.

Gaps to Be Addressed

Lifestyle intervention has been shown to help individuals with prediabetes significantly reduce their risk of progressing their condition to type 2 diabetes. However, the constant goal is to improve the effectiveness and translatability of these studies and to target those experiencing the highest diabetes and economic burden. This study focused on exploring the perspectives of

South Asian Indians living in Chennai, who participated in D-CLIP, a culturally tailored lifestyle intervention program that emphasized diet and exercise education and incorporated stepwise usage of metformin as needed. Ideally, this qualitative analysis hopes to provide strategies for LIPs to build community acceptability and feasibility to help support long-term sustainability of diabetes awareness and positive health behavior change amongst this subgroup population.

III. Methods

Population and Sample

This study was conducted with former D-CLIP study participants. D-CLIP participants were adults aged 20-65 years old with impaired fasting glucose (IFG), impaired glucose tolerance (IGT), or both (IFG+IGT) and were recruited in Chennai, India. Participants were considered clinically overweight or obese based on World Health Organization Asian-specific cut-off points for BMI and waist circumference.

Research Design

This was a qualitative study that collected and analyzed primary source data from focus group discussions.

Procedures

This data was collected via qualitative data collection, from which eight transcripts were produced. These transcripts recorded data from eight focus group discussions conducted with D-

CLIP graduates. Four focus groups consisted of all women while the other four groups consisted of all men. The groups consisted of participants from different "batches" of the program, meaning they attended the program at different times and sometimes reported different experiences. Potential focus group participants were invited to participate in the discussions based on the recommendations of the D-CLIP health educators who recommended individuals who completed the program and were information-rich. Participants were not selected based on "intervention success" in terms of weight loss, degree of behavior change, or participation in program components (class attendance, diet, and physical activity tracking, etc.)

Instruments

A focus group discussion interview guide was used for data collection and MAX-QDA 2020 software, provided by Emory University, was utilized for data manipulation.

Data Analysis

Coding

Memos were created throughout the transcripts during the first read-through. These memos were used to identify themes, note recurring or interesting ideas, and help develop codes. A codebook of inductive, deductive, and in vivo codes was created based on emerging themes in the data, relevant themes in diabetes prevention-related literature, and terms coined by the participants, such as 'Meds', respectively.

Coding was conducted using MAX-QDA 2020 software, provided by Emory University. Data was coded liberally, by selecting paragraphs and larger text surrounding the applicable data to provide necessary context for retrieved data segments. Double-coding was also applied; some chunks of data were labeled with multiple codes, which allowed for the reader to gain increasing familiarity with the data as well as observe and identify potential implications of relationships between codes -- relational analysis. For example, by reading overlapping data, the presence or lack of 'Family Support' and 'Education about D&E (Diet and Exercise)' seemed to be an influencer for participants' 'Home Adherence'. This was evidenced by data segments where two or the codes applied, such as when one participant said she doesn't go walking because her husband won't accompany her on walks and when others spoke about using D-CLIP-taught strategies to avoid eating unhealthy foods at a wedding. As another example, a data segment where the participant spoke about the pedometer serving as motivation for walking helped demonstrate a relationship where the 'D-CLIP-Provided Materials' supports 'Home Adherence' to D-CLIP recommended D&E.

The process was iterative, as the codebook was revised several times throughout the coding process. For example, after completing the initial codebook and first round of coding, the code 'Home Adherence' was created because there was not a code that specifically brought attention to the successes and challenges with implementing health behaviors learned from D-CLIP in the home or other settings. Some codes were found to be less useful than others, such as 'Barriers to Participation', which were better encompassed by codes such as 'Culture' or the code 'Home Adherence'. Some codes were found to have better uses — the code 'Meds' was an in vivo code meant to review the moments when participants spoke about the use of metformin while participating in D-CLIP; however, this was barely mentioned amongst the focus groups,

and this code instead provided data for the participants' pre-existing health beliefs prior to joining D-CLIP.

Preparing for Analysis

Pre-analysis, the following variables were applied in MAX-QDA 2020: 'Gender', 'Employment', 'Income', 'Marital Status', 'Education Level', 'Religion' because all focus groups indicated the gender of all groups' participants, and some of the participant groups listed out these demographics for its participants. Those that did not explicitly list out these demographics were further reviewed for moments when participants identified these variables individually; these data segments were then labeled with the code 'Participant Profiles' to attempt to identify these variables for subgroup analysis.

For each code, notes were taken on the retrieved segments of data and were stratified by focus group to facilitate subgroup analysis and structured comparisons. Throughout this process, efforts were made to account for disproportionate application of codes, a coding bias which could affect data representation and subgroup analysis. This was done by incorporating a method of doubling back for a second round of coding after initial coding is complete: For each code, documents containing the code were activated and those documents which did not contain that specific code were noted. Those documents were placed under review to determine whether there was any missed data that could be applied back to those codes. For example, there were no retrieved segments for 'Family Support' from the third men focus group and only one from the second women focus group. Upon doubling back and rereading, as well as utilizing the 'Search Toolbar' to search for keywords related to the code, useful data was found about women participants' key motivators for their participation in the program.

Analysis

Focus Group	Main Points	Unique Points
Men		
Men 2..		

Figure 1aa: Chart Analysis by Code

For each of the codes selected for analysis, main points and unique points arising from each focus group were listed in chart format, as seen in Figure 1aa. By doing this, larger themes were identified, subgroup analysis was performed by gender, and minority/dissenting ideas were able to be incorporated into the findings. Knowledge gained from the literature review about diabetes risk factors and prevention methods were used while reviewing and making conclusions about data. For example, Ballon, Neuenschwander & Schlesinger's 2019 Journal of Nutrition publication listed "breakfast skipping" as a risk behavior for developing type 2 diabetes; thus, when study participants spoke about no longer skipping meals, this was read as a diabetes prevention-related lifestyle change. From these methods, thick descriptions for each of those codes was created.

Cognitive mapping was used to create a concept map, shown in Figure 2 (in 'Discussion' section), to illustrate the relationships between concepts and how they contribute to the larger process and goals of D-CLIP. Word Cloud, a visual tool available in MAX-QDA, was applied to the following groups: all participants, all women participants, all men participants, and each individual focus group. The purpose of this tool was to display the most frequently-used words to

learn which topics were most important to participants, and to determine whether these topics vary by focus group or gender (displayed in Table 1 and Table 2 under 'Results').

Ethical Considerations

The Emory University Institutional Review Board (IRB B00016503) and the Madras Diabetes Research Foundations Ethics Committee approved the D-CLIP study procedures and materials. IRB approval was waived for this project given that it is an evaluation that is not meant to generalize findings to a broader population.

Limitations

It was difficult to perform subgroup analysis because the demographic classification of participants amongst different focus groups was not consistent. For some focus groups, religion, employment status, income level, marital status, and age were collected for all members, while for other focus groups, this was not done. For example, the age of the participants was not mentioned in 3 of the 8 focus groups. This hindered subgroup analysis for potentially useful demographic variables such as employment, age, and marital status. As aforementioned, there was an attempt to mitigate this obstacle by labeling participant-provided demographic data as the code, 'Participant Profile' to classify members in focus groups that did not collect this demographic information. Even with this strategy, no other variables were properly represented across all focus groups or gender groups, so 'Gender' was ultimately the primary variable that could be utilized for subgroup analysis.

The language barrier presented another challenge for coding and analysis. Some words, phrases, or terminology were unfamiliar. This was mitigated by re-reading and gaining

familiarity with the data, by conducting further research, and by verifying terms with Dr. Mary Beth Weber, who is intimately familiar with the study and its participants. For example, after making significant headway in memo-ing, it became apparent that respondents sometimes referred to having diabetes as “having the sugar,” and described consuming a food item by stating that they “took in” the food. In another instance, a participant stated that his wife referred to him as “Butha,” and Dr. Weber clarified that his wife was alluding to the commonly referenced figure, Buddha, and making a comment about the participant’s body appearance. Finally, when speaking about lowering consumption of oily foods, participants often mentioned a food item called ‘dosai’; upon personal research, it was determined that dosai is comparable to a crepe or thin pancake, which is significant because crepes are sweet foods.

IV. Results

Factors Influencing Decision to Enroll in and Engage with D-CLIP

Participant Acquisition

Eight focus groups were conducted with D-CLIP graduates. Four groups comprised only male participants while the last four comprised only female participants. The mean number of participants in each focus group was 6.5, with women showing a lower turnout. Participants were asked to disclose demographic information such as sex and occupation. Based on this information, many of the men in the focus groups held white collar job positions and few identified themselves as unemployed. Some female respondents worked as teachers, but the majority identified themselves as housewives. Additionally, most focus group participants were married, and many mentioned their wives or husbands in these discussions (Table 1 and Table 2).

Participants first spoke about ways they were recruited for the D-CLIP study (D-CLIP). More than half of the group members were screened at an MDRF camp close to frequented places, such as their home, apartment complex, local park, or workplace. Some men were referred to D-CLIP by their insurance agents and several men reported that MDRF coordinated with their company workplaces to provide this screening camp. Over half of the group members have, or have had, a family member with diabetes, and some participants were recruited while accompanying a family member with diabetes to the hospital or clinic. Half were referred by a family member and a few attended D-CLIP with a family member. Women frequently noted that their husband either told them to join or supported them joining D-CLIP. Overall, female

participants largely heeded referrals and support from family members when deciding whether to enroll in the program. A few participants thought a strategically timed telecast, or some other form of media publicization, would be an effective way of spreading awareness about D-CLIP as well.

Table 1: Comparison of Word Frequency by Sex

Focus Groups	All	Men	Women
Main Word	Food	Food	Class
Top 5 Words	Food, Exercise, Class, Eat, Walking, Able	Food, Exercise, Eat, Time, Class	Class, Food, Walking, Exercises, Eat, Feel
Unique Word(s)	Control, Family	Body, Wife	Shoes, Reduced, Oil

Table 2: Comparison of Word Frequency by Sex and Focus Group

Sex	Men			
Focus Group	1	2	3	4
Main Word	Food	Food	Exercise	Eat
Top 5 Words	Food, Exercise, Group, Difficult,	Food, Borderline,	Exercise, Good, Walking, Health,	Eat, Class, Time, No,

	Check	Exercise, Weight, Diabetes	Class, Motivation	Good
Unique Word(s)	Women, Continuity	Department, Madras	Office, Understand	Fruit, Minimum
Sex	Women			
Focus Group	1	2	3	4
Main Word	Walking	Class	Eat	Class
Top 5 Words	Walking, Home, Exercises, Food, Husband	Class, Food, Children, Attend, Eat, Diet	Eat, Exercise, Able, Class, Walking, Feel	Class, Exercise, Sugar, Walking, Weight, Eat
Unique Word(s)	Oil, Shoes	Centre, Booklet	Rice, Body	Idli, Disease

Motivators for Enrollment

Respondents joined D-CLIP for personal, social, and economic reasons. Motivators for D-CLIP participation included desires to: learn how to change one's lifestyle, prevent or postpone diabetes, lose weight, improve health, and live without medicine. Those who wanted to lose weight said they wanted to move around more easily, wanted to maintain body norms, or

wanted to gain partner approval. Some were wary of rising healthcare costs and did not want to burden others if they were to acquire diabetes.

Motivators for participation, as well as perceived motivators for participation, differed by sex. Men mentioned being motivated by a desire to improve or maintain their health, while women mentioned this as a motivating factor less frequently. Women from two groups, and some of the male participants, indicated that women tended to prioritize home responsibilities -- like managing household day problems and tending to children -- over addressing their own health. However, one participant served as an exception to this, explaining that she was prompted to join D-CLIP to take care of her health. A few female participants suggested the program might be more appealing to women if they were told participating women felt lighter on their feet and were able to do more housework with increased ease after attending D-CLIP. One woman stated, *"...now we are feeling lighter and active. We used to feel less confident to do work because we had a doubt whether we could finish ... But now we have the confidence to do the work which we did not handle earlier. So, by inspiring people [women] about this we should develop self-interest in them and motivate them to join the programme.*" This sentiment was reverberated across all women's focus groups. Women wanted to maintain flexibility in their bodies and spoke positively about feeling "*soft and light*," more energetic, and more capable of completing housework after following D-CLIP diet and exercise recommendations (D&E).

Barriers to Enrollment

Participants spoke of many common barriers they faced while enrolled in D-CLIP, with some being specific to gender. Some women stated it was challenging for them to attend the program due to time constraints from home commitments, such as cooking and household work, tending to children, and entertaining guests. Many needed to plan and prepare food before

attending and a few had time conflicts with D-CLIP due to school. Men also perceived household duties as a barrier for women's participation and furthermore claimed women were not accustomed to attending programs alone and had difficulty with the logistics, such as traveling and coordinating transportation to and from the D-CLIP center. When asked about difficulties attending D-CLIP, men sometimes mentioned longer distance travel, while one claimed the D-CLIP center was located in a prime place. Some men travelled for work, which forced them to miss a few classes.

Respondents asserted that people in the community do not join due to lack of understanding and awareness of both the program and the condition of diabetes. Participants felt the benefits of D-CLIP were not inherently obvious to them before they attended the classes and regarded this a significant obstacle to recruitment efforts. One stated, "*They [D-CLIP] have to create value for this program*," explaining how the program should make its usefulness and benefits better well-known, similar to the function of a brand name, while another said the Mohan Diabetes Specialties Center itself was well-known. Another participant voiced that she previously thought the information provided by D-CLIP did not apply to her because she did not have diabetes. Some suggested people also lack understanding of diabetes screening procedures. One participant remembered a woman who visited an MDRF screening camp and remarked: *"if they [the camp] are giving one packet of glucose to drink, then definitely my sugar levels will be high.*"

Pre-D-CLIP Perceptions and Awareness about Health

Several groups claimed lifestyle, knowledge, and perceptions about diabetes, diet and exercise varied by region. They insisted on lifestyle differences between village culture and city culture. According to the participants, rural residents were more likely to walk and burn calories

while urban residents were more likely to sit and watch TV. On the other hand, some claimed those who lived in urban areas had more knowledge about diabetes while those who had a village background had less awareness about healthy body composition and the condition of diabetes. A participant said, *"In our village, you are healthy only if you are fat."* Participants felt many people in their community carried this perception. In at least half of the groups, participants said members of their community responded negatively to their weight loss during D-CLIP. People told them they 'lost their bodies' and looked unhealthy. Some even assumed the D-CLIP graduates were sick and attempted to refer them to doctors. At the same time, participants said it is good to be thin for events (such as a wedding) and described weight loss as one of their motivators for joining D-CLIP. One participant said his wife even appreciated him more after he lost weight. Overall, perceptions about ideal and healthy body weight varied throughout the focus groups.

Some participants said there is little to no awareness about health and diet even in the cities and brought up common misconceptions amongst the general population. They claimed some community members -- including a D-CLIP dropout case -- believe taking medicine, with no diet modification, is sufficient intervention to prevent health consequences from diabetes. One participant stated, *"They [people] say if you take a tablet it is enough."* Several participants had familiarity with the condition of diabetes prior to D-CLIP -- most often when they had a family member or acquaintance with diabetes who suffered consequential health complications (such as eyesight or kidney problems). These D-CLIP graduates previously knew of diabetes as a form of disease but had limited knowledge of diabetes prevention and outcomes. Before they attended D-CLIP, participants did not know the importance of avoiding low sugar levels, did not know how

to properly prevent diabetes beyond reducing sugar intake, and did not know the nutrient values of commonly consumed food items, like rice.

Respondents spoke of a few previous sources of information about diabetes and health. One participant used to read about the benefits of exercises like yoga from a local newspaper. Most respondents received health information from their doctors. Some maintained that doctors' medical guidance placed emphasis on taking tablets, or 'meds', while others said their doctors advised them on consumption of foods like fruit and rice but did so at a surface level void of explanation. Several spoke to their doctors about participating in D-CLIP and many were encouraged to attend D-CLIP (or were even recruited this way). However, one participant reported feeling discouraged about her positive experience with D-CLIP after a discussion with her doctor. The participant explained that when she spoke about the benefits and lessons learned at the program, the doctor laughed and said the participants did not learn anything new or special.

Facilitators and Barriers to Making Initial Health Behavior Changes

Perceptions about D-CLIP After Attending Intervention

Participants shared feedback about their experiences with D-CLIP staff, program content, and program materials. During D-CLIP, participants developed community-ship with fellow members and staff and wished to maintain this enthusiasm by having more interaction with D-CLIP staff and D-CLIP graduates post-intervention. They repeatedly asked for a forum where they could interact, share resources, and extend support to each other post-D-CLIP.

Program Staff

Participants demonstrated particularly positive attitudes towards the program staff. They spoke about how the staff applied personal touch and liveliness to their classes and made accommodations based on participants' needs, such as selecting class date/time based on participants' schedules. Participants claimed the staff were flexible towards the participants' individual circumstances. As one example, a staff member stayed after class and briefed a participant who had a work conflict. In another instance, study staff taught simpler exercises to a participant with knee issues. When the study staff switched sessions snacks from samosas to sandwiches one week after receiving participant feedback, the participants felt staff were receptive and responsive to their concerns. They described study staff as patient and willing to go further into detail to ensure participants could clearly understand the lessons. A few participants commented that the staff were young and were initially skeptical about their own ability to handle the course and complete the exercises up to the instructors' expectations. But these same participants afterwards explained the staff encouraged them to push themselves during exercise -- *"They spoke to us, made us feel strong while doing it [the exercises]."*

Program Structure & Logistics

D-CLIP offered 16 core sessions with 4-8 follow-up 'maintenance' classes. The classes ran an hour long, with the first half hour devoted to class and the second half hour devoted to exercise instruction. Classes were conducted in the auditorium of the Mohan Diabetes Specialties Center. Participants were satisfied with the class, the venue, and the length of the program. Some had issues with the timings due to work shifts, classes, or other time commitments, but noted that staff asked about their convenient times when scheduling the classes, which gave them the sense that the program was truly for their benefit. Participants said the long distance to the D-CLIP

facility was a significant drawback, as previously addressed in the 'Barriers to Participation' section.

The participants liked that they were encouraged, yet not forced, to attend the classes. Many said they attended the classes by their own volition and desire. One commented *"[the classes] were free, yet still started on time*." Some felt the program should run longer; participants would have liked to attend more sessions. Several wanted more D-CLIP to offer more 'refresher' classes post-intervention -- on a semiannual basis, for example. One participant pointed out that research changes over time and thought refresher courses would help keep former participants up to date on the most recent health recommendations and best practices for diabetes prevention.

Participants also offered opinions and suggestions for the program's recruitment methods. When asked about charging a fee, most felt community members would not join, and suggested the fee be honorarium, minimal, and/or only be imposed after 2-3 free classes. Many also stated that keeping the program completely free could hinder recruitment as well, saying people would assume a free program has low value. On the subject of socioeconomic level differences, some participants said the program needs to use different recruitment and retention approaches for people of different socioeconomic groups. For example, they felt that outreach for the lower-income population should impart resources to address common barriers (such as distance and travel), while outreach for the higher-income population may necessitate adaptations to the program format. They felt this subgroup would be more amenable to a luxury-adjacent experience like a 7-10-day intensive program at a hotel as opposed to a 16-week-long commitment, for example.

The D-CLIP participants gave opinions about the organization of peer groups as well. Participants were more encouraged to exercise when with a group than when by themselves, and several felt more motivated when the peer group was larger. Some respondents felt the groups, or 'batches' should be stratified by age so the group members could better relate to each other, be able to compare themselves against each other, and match each other's pace as they progressed in the program. For example, one felt it was harder for a 60-year-old participant to compete with a 30-year-old participant while completing exercises. However, most participants thought the groups should be mixed, claiming they could motivate each other -- for instance, a younger person might see an older person doing the exercises and feel more encouraged to push themselves harder during the session. Others wanted people with diabetes to be mixed into the groups so participants could hear their experiences with managing diabetes. Some felt D-CLIP should allow anyone in the community to join regardless of blood sugar level as they felt the class content was pertinent to everyone. They maintained that this information should be shared with people before they need to be diagnosed as "borderline", so they can implement these practices earlier in their lives.

Figure 1a: (Word Art) Word Frequency Across All Participants

Education

Participants found the D-CLIP course content detailed and useful. Participants felt they gained in-depth knowledge and understanding about diet and exercise, which helped them *"buil[d] on their awareness,"* on topics including daily walking and nutrient value. Overall, participants desired to have and maintain control over their lifestyles -- the word 'Control' was a frequently used word amongst all focus groups (Table 1). Participants appreciated when content about diet, exercise, and diabetes prevention was taught in empowering and relevant ways.

Participants were taught warm-up, abdominal, circuit, muscle strengthening, and cooling exercises, and male participants enjoyed the morning yoga and muscle strengthening exercises in particular. Participants emphasized that they were not only taught these exercises but were also told about the functionality of the exercises; they enjoyed learning about what exercise does to the body. A few participants briefly mentioned that they learned stress relief exercises but did not go into much detail about this. Many appreciated the liveliness and positivity that the program staff brought to the exercises. They said the D-CLIP was able to spark their interest in exercising and one claimed, "*We are happy and jolly when we do the exercises.*"

Many participants verbalized that the D-CLIP educated them on how to determine nutritive values of various foods, which enabled them to make changes in their diet choices. Several said they gained 'food consciousness,' and felt this new awareness helped them make informed decisions about which foods to eat and which ingredients to use. They liked that the D-CLIP suggested changes that entailed smaller modifications and incremental changes in their diets with the goal of moderation; they often mentioned how they were taught to 'reduce', a word that came up often within the focus groups (Figure 1a). The diet chart and measurement

cup, items provided by D-CLIP, served participants as useful aids for practicing healthy eating and moderation.

Participants then shared how they applied learned content at home. Most learned the importance of incorporating more fruits and vegetables into their daily diet, and some moved away from non-vegetarian items like chicken and mutton. Amongst the groups, participants mostly felt confident about the knowledge they gained about diet, but there was confusion concerning whether or not fruits should be eaten regularly, and which fruits should be avoided. For example, some felt like mangoes and bananas should be avoided, while others did not. At times, participants asked the moderators clarifying questions about this. There was also some disagreement and lack of consensus about whether it is okay to still eat certain food items, like sweets, from time to time.

Women in particular learned about healthy ways of preparing food and often mentioned food items that can be unhealthy in excess, such as idli, oil, and rice (Table 2). They also learned about healthy alternatives for commonly consumed food items. For example, several identified chapatis as an appropriate alternative to deep fried food like dosai. When it came to describing diet, the female participants more often identified food items by their ingredients, while men generally referred to the food item as a whole. For example, all focus groups learned about high cholesterol, but the women reported that they now use less oil while cooking, while the men spoke less about oil as an ingredient.

Many spoke about being taught the importance of being mentally -- and sometimes physically -- equipped when encountering temptations to deviate from D-CLIP diet and exercise recommendations. The participants listed several strategies taught to them in class and gave examples of ways they employed these strategies in daily social situations. For example, in the

face of tempting unhealthy foods, they spoke of learned strategies like taking 1 spoonful of the unhealthy food and leaving the rest, eating sweets slowly and in small bites at parties, and eating fiber-rich foods instead of sweets in times of stress. At home, participants said they found it helpful to hide sweets and make healthy foods more visible on tables at home, avoid taking sweets home, and picture a D-CLIP staff member's scolding face when tempted to stray from their new diet. They were also given a few strategies for help with exercises. Participants were taught a 'Shape of 8' barefoot walking strategy, told to aim for 10,000 steps, and were advised to slow walk instead of completely stopping or sitting down during exercises. Lastly, participants said the program emphasized the need to strategize and plan one's day. The participants learned it was important to adhere to a schedule to stay on track with their lifestyle changes. They also learned about the relationship between their time management and their diet and exercise behaviors. One gave an example, saying that waking up late in the morning may result in one eating meals late or skipping out on exercise due to other time commitments. Another commented, "*It's the time factor.*"

Facilitators and Barriers to Maintaining Healthy Behavior Changes

Lifestyle Challenges

At home, participants experienced challenges performing exercises learned at D-CLIP. Once the 16 weekly sessions of D-CLIP were over, almost all groups had a difficult time remembering the sequence of the exercises. Some forgot the warm-ups and others performed the exercises out of order. Participants were particularly concerned with completing the exercises in order and felt this was necessary for conducting the exercises properly and safely. As mentioned in detail in the next section, 'Program Materials', participants desired additional materials -- like

a CD, manual, booklet, or online videos -- to help them execute these exercises in the proper sequence. Participants also wanted to be able to self-monitor themselves after D-CLIP. Some had easy access to height and weight and cholesterol machines while others did not.

When discussing walking adherence, participants often named 'the rainy season' as a deterrent for regular walking. One participant claimed there was a lot of water stagnation in the walkways. The female participants' barriers to regular walking were unique in that the women's ability to go walking was often dependent on the schedules or willingness of other family members. Female participants had to plan around family members' school and work schedules, and several said they were unable to go walking when their husbands worked late or when they had to drop their children to school. Some female participants were less comfortable going walking alone. A few said their husbands would not accompany them and others cited fears of being approached by strange men or street dogs while walking alone. One said there was recent violence at a nearby park, so her husband did not want her to go walking there.

Some female participants felt even the environment at home was not conducive for them to complete their exercises. Throughout the day, they had to complete housework, cook for the family, and tend to the children. They also spoke of frequent disturbances, such as guests, visiting neighbors, or household problems. Some mitigated this challenge when they walked early in the morning before they would need to cook for others. Some of these women said it would be better if they could come to the D-CLIP center to do their exercises --*"At least here we come to the class we can spare some time for ourselves."*

Quite a few participants experienced challenges adhering to dietary recommendations in certain social contexts but explained how they mitigated the temptations. One participant said they normally make Payasam and Kesari (sweet dishes) during traditions like Pournami &

Kammavasai, or for festivals. Several participants felt tempted to eat oily foods and sweets, but many said they were able to show discipline when they utilized strategies provided in class (discussed previously in the 'Education' section), such as eating before attending the function, eating slowly, or folding sweets in a napkin to avoid offending others. They cited the D-CLIP-provided booklet as a helpful resource for finding these tactics.

The word 'family' came up very frequently amongst all focus groups (Table 1 and Figure 1a). Participants often reflected that the presence or lack of family support impacted their level of adherence. While discussing D-CLIP participation, a participant said "*...it depends on, as we discussed, the family situation, support, background and cooperation…*" Participants found it easier to adhere to D-CLIP D&E recommendations when family members or peers were supportive of these lifestyle changes. Several preferred to exercise with others and felt encouraged when their spouses, friends, or children joined them for walks or completed exercises with them. They also felt encouraged when their children reminded them about their diet or exercise and/or implemented health behavior changes themselves.

On the other hand, some participants said their family members showed significant resistance against the dietary recommendations. Several women claimed their families complained about taste when they made foods with less oil, such as chapati or wheat upuma. One commented, "*Earlier I used to add lots of oil because everyone should find it tasty and appreciate me.*" They felt it was hard to explain the importance of healthier foods to spouses and children. Some participants attempted to appease their family by designating Sunday as the day family members could choose the foods, such as non-vegetarian items or dosai, and some female participants decided to cook separate foods for the rest of the family. Along these lines, men reported difficulty persuading their wives, who are in charge of cooking for the household, to

implement the dietary changes. Many participants felt that women in particular needed to be more involved or attend program lessons so they can understand the importance of the health changes. They said this was crucial because women are the ones who can properly implement the dietary changes in the home. One participant commented: "*Healthy family is in the hands of the woman of the house…*"

Program Materials

All found the diet chart/booklet to be useful in making decisions about what food items to eat or use for cooking. Participants said they used the diet chart as a reference for determining calorie and cholesterol content for frequently used food items, like ghee, chutney, and sambar. They liked that the diet chart made diet recommendations based on different height, weight, and occupation (such as housewife), and claimed that this tool helped them develop the habit of checking nutrient value of foods they eat.

Participants felt that some of the tools were helpful aids for self-monitoring their diet and physical activity. Many of the focus groups spoke extensively about the pedometer and stated that this tool helped them get an accurate picture of the amount of exercise they had done. One participant stated that she had previously thought she was exercising a sufficient amount due to household work but understood this was not the case only after wearing the pedometer. Some said they received motivation to walk more when they wore the tool and saw their steps on display. The participants felt that the measurement cups and spoons played an important role in raising their consciousness as well, speaking often about how they used these measurement cups to measure out rice, a commonly used food item. They felt that the measurement cups helped them take control over their food habits. One participant remarked: "*Take the measurement cups*

and eat food as per the measuring cups there is a control on our food habits like as we have control on our finances when we run our family."

Amongst the groups, there were mixed feelings towards the utility and functionality of the shoes. Some felt the D-CLIP-provided shoes made walking faster, easier, safer, and smoother once they became accustomed to the feel of the shoes as opposed to their usual sandals. Some participants stated that the shoes were a hassle because the shoes were a bit more difficult to take off once going inside and some women participants stated that they did not use the shoes because they only went walking in their home grounds or terrace.

Many desired more visual aids for learning and properly executing the exercises taught at D-CLIP. Quite a few groups desired some version of a print-out (such as a document, booklet, or manual) to help them see the correct sequence and performance of the exercises. Some desired a CD for the same purpose. Some groups received or were able to buy the 1-hour CD with exercises, but felt the CD was insufficient for properly carrying out the exercises. A few of the male participants wished to have these exercises displayed in online video format and stated that a D-CLIP-related website would be useful for this. They thought a website would also enable study staff and participants to share helpful adherence strategies and diabetes prevention-related materials as well as maintain community post-intervention. Many voiced the desire for additional training post-program.

Additional Findings

During the discussion, moderators told participants they would like to continue the program so they can offer the program to others in Chennai as well. Participants suggested using D-CLIP graduates to advocate or recruit for the program -- coined as "*mouth campaigning*" by

one. They felt it would be helpful for former participants to speak about their takeaways from participating in D-CLIP, such as decreased blood sugar levels, weight loss or no longer identifying as a borderline case. Some suggested that former D-CLIP participants could help with translating and distributing pamphlets on healthy food habits and exercise throughout Chennai.

Many said they had already begun imparting knowledge about the importance of diet and exercise, diabetes prevention, and "*how to keep control on food habits*" upon others. Some spoke about advocating for more awareness in the workplace. One claimed he was able to institute and enforce healthier snacks in the office with his subordinates at work. Another said he promoted the program to his company and indicated that his coworkers were more receptive to the D-CLIP team when they visited the office. Women who work as teachers reported success with this as well. They shared information from the diet chart with other teachers, and said those teachers shared the information with other teachers as well. A few said they shared D-CLIP materials, like the diet chart, as a form of advocacy. One let their friend wear the pedometer while walking so the friend could understand that regular walking alone was insufficient. Another said their spouse created Xerox photocopies of the written exercises and distributed them to others. A participant also spoke about allowing their son to use the CD to learn the D-CLIP exercises.

Men spoke about urging their family units to adopt healthier lifestyles. Some did this by bringing their wives or children to a few classes, some got their family members involved in the exercises, and some spoke to their children about potential health consequences of poor diet. Several indicated that, when children saw them consuming healthier foods, like fruit, they tended to follow practice. Women said that, since they cook for the family, they are able to instill a lot of these diet changes, like reducing fat. One stated, "*Whatever I cook my children eat.*"

Interestingly, when a participant was talking about telling her children about healthier foods and ways of cooking, she says that telling this information to her children helps her as well. She commented, "*Whether they listen or not … for me it is like internalizing myself with the lessons taught in the class. It gets memorized…*"

Participants also went over some of the ways they were able to get others to be receptive towards making health changes. Many said they were able to get a dialogue going with others when someone would inquire how they have gotten to look so 'lean'. A few mentioned that they had success with suggesting specific exercises that help relieve body pain. One spoke about sharing knee exercises he had learned from D-CLIP with family members and said the family members found that this relieved the joint pain, so they proceeded to practice these exercises regularly. Another said he shared information about warm-up exercises with people he plays games with and said those stretches help relieve body pain. Several found it easier to teach exercises to other people when the exercise involved simple, "*small, small things, … not like lifting a mountain.*"

Some reported less success with advocating to others. One participant stated, "*It is a very nice programme, but [I] don't know how to convey and convince others.*" When asked about running classes, some indicated that they would be quite willing to do so and offered ideas about incentivizing former members to serve in this capacity by offering monthly post-intervention classes. Several others expressed doubt or discomfort with this role. Some felt they could informally provide information about nutrition values and exercises to others, but felt the study staff were better equipped, had more credibility, and had better infrastructure, and thus were better suited to handle a large-scale setup.

Summary

‘Lack of time’ and ‘presence or lack of family support’ were prevailing factors that pervaded several aspects of the study participants’ D-CLIP experiences. Presence or lack of family support played a role in the participants’ ability to maintain health behavior change at home. Oftentimes the home environment and local public infrastructure failed to provide a conducive atmosphere for maintained health behavior change post-intervention, especially for women. The diet chart, measuring cup, and pedometer were the most well-liked and regarded the most useful supports for health behavior change post-intervention. After completing the intervention, participants felt they received helpful, relevant education on (and reasonable action steps for) diabetes prevention.

V. Discussion

Overview of Results

Most study participants were referred to the study by family members or through prediabetes screening camps, and ultimately joined due to desires for health, fitness, social approval, or body maintenance. Deterrents to enrollment included long distance travel, lack of time due to daily responsibilities, and lack of understanding about diabetes and health, which related to larger community misperceptions and gaps in knowledge regarding proper diabetes prevention and management. Facilitators to making initial health behavior changes included lively, flexible, and amicable study staff, culturally relevant food and meal preparation education, and class-taught discipline strategies to help mitigate temptation to deviate from health behavior changes. Barriers included scheduling conflicts between work and attending the program, lack of time, and issues with time management. Back at home, facilitators that helped participants maintain health behavior changes included family support, discipline strategies, self-monitoring tools like the pedometer, and reference tools like the measuring cups and diet chart. Barriers included the rainy season, forgetting the exercise sequence, lack of safety outdoors for women, lack of family support, spousal resistance to the changes, lack of time, and an unconducive home environment. Additional findings from the study were that participants advocated to others and shared learned knowledge with friends and family members, and were most successful when they shared simple, useful exercises or when family members emulated their own healthier eating practices.

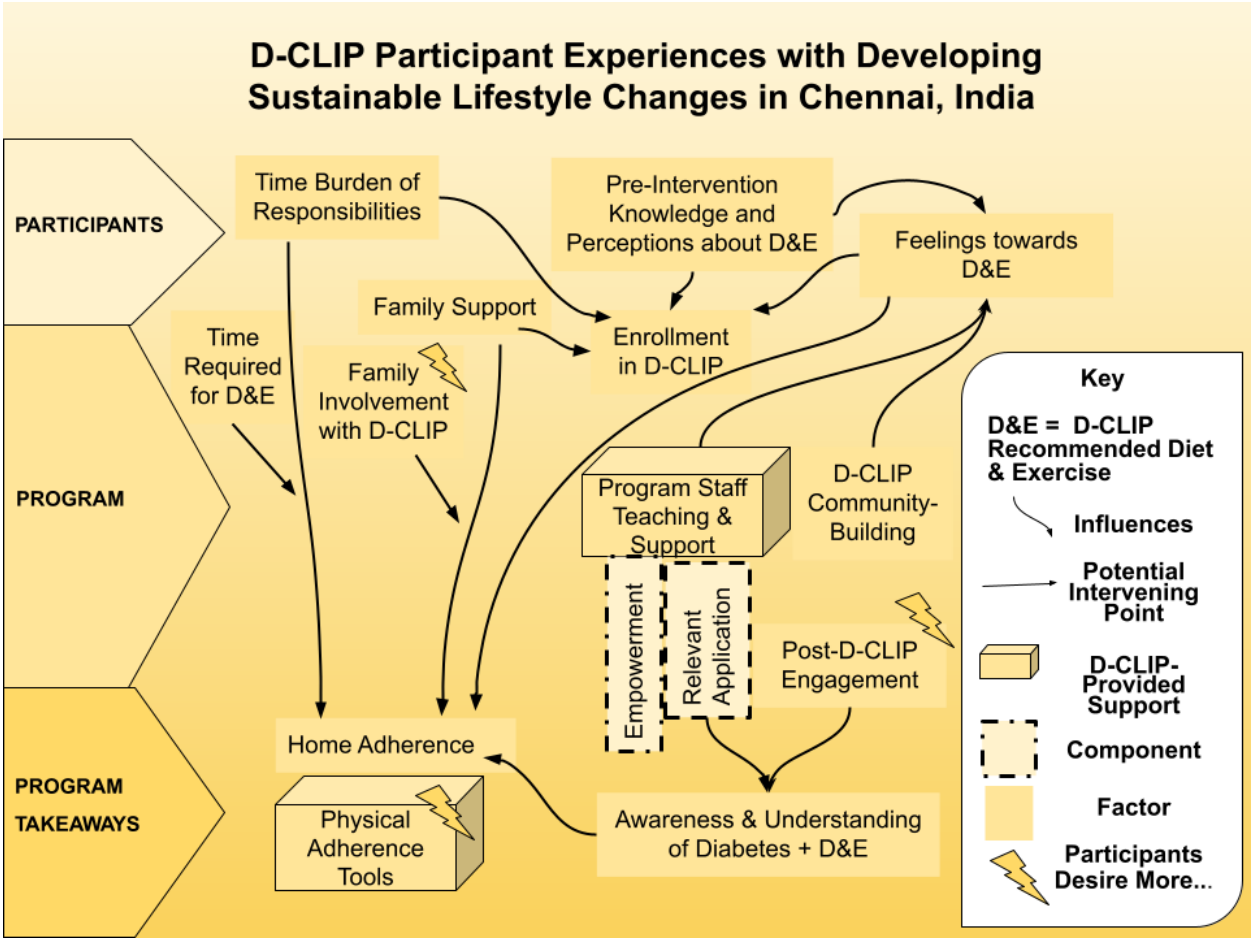

Figure 2: Concept Map

Discussion of Key Results

Population Misconceptions about Diabetes

Participants unequivocally felt the general population in Chennai lacks knowledge and understanding about prediabetes, healthy food and exercise behaviors, and the importance of diabetes prevention. Based on this finding, the study's population of interest does not understand the value and relevance of D-CLIP, a diabetes prevention program that recruits those with prediabetes. This was already made apparent from previous assessments of South Asian

population diabetes awareness, (Deepa, Bhansali, and Anjana et al., 2014), (Viswanathan, V. 2017), and (Mohan et al. 2005). But what was interesting was that this lack of knowledge ultimately threatened the success of the program's outreach and retention efforts. Multiple participants stated that the general populations' lack of understanding of these topics posed a huge barrier for both program recruitment and retention. One participant said they initially thought they were not qualified for the program because they did not have diabetes, which implies that the purpose of the program may not be well-understood by the population.

In another case, an attendee of a MDRF screening camp doubted the accuracy of the glucose tolerance test, saying "*if they [the camp] are giving one packet of glucose to drink, then definitely my sugar levels will be high.*" It is not enough to simply make prediabetes screening tests available; people must also receive education about the functionality of these tests to feel the results are significant to them. And lastly, there was a widely reported misconception that taking medicine alone will prevent diabetes or diabetes-related disease. One participant recalled an ex-D-CLIP participant who believed this, and thus did not accept D-CLIP's teachings about diet change; he later dropped out from the program. If other community members strongly believe medicine alone is sufficient to tackle diabetes mellitus, then they may perceive the D-CLIP intervention as unnecessary and unhelpful and be less apt to join and/or complete the program. This relationship between pre-intervention knowledge and perceptions about D&E, feelings towards D-CLIP, and participant enrollment in D-CLIP is represented in Figure 2. This also relates to the availability and accessibility of timely health education sources to population members. A D-CLIP participant expressed interest in getting up-to-date information about diabetes prevention to the extent that he asked for more refresher classes to be offered for D-

CLIP graduates and another wished for an online forum for ex-participants to interact with study staff and share resources.

Benefits of Culture-Specific Recommendations for Behavior Change

D-CLIP was a translational study, which intended to be adaptive to the cultural context of the study population. This involved incorporation of cultural elements into the program's teaching, expectations, and recommendations. Participants spoke about how D-CLIP provided diet charts containing commonly consumed food items, like rice and dosai, and listed out strategies for realistic situations when adherence may seem challenging (i.e., a wedding). The program used community educators to teach the content and gave adherence tips relevant to the participants' daily lifestyles (i.e., performing healthy behavior and avoiding unhealthy behavior amidst potential deterrents to adherence, such as housework or arriving home late from work). This not only helped participants conceptualize healthy behavior change in terms of their own lives, but also helped them more easily incorporate lifestyle changes into their daily practices. Culturally tailored interventions have shown promising results in other contexts as well. A 2016 study conducted a 12-week group-based culturally tailored lifestyle intervention program with 70 at-risk adult Asian Indians adults belonging to the Gujarati subgroup, located in Houston, Texas, with a sufficiently high diabetes risk score, or A1C value over 6.4% (Patel, Misra, and Raj et al. 2017). Intervention sessions were led by a Gujarati American who orally translated and personalized diabetes education material with Gujarati colloquialisms, customs, and traditions, and served as a facilitator for the sessions (Patel, Misra, and Raj et al. 2017). The intervention included cultural messaging and visuals, cooking demonstrations, and a grocery store tour amongst other features, which resulted in significantly lower A1C levels and waist circumferences compared to the control group (Patel, Misra, and Raj et al. 2017).

Acknowledgement and community-informed incorporation of culture into LIPs has been important for other ethnic identities as well. The 2014 Vincent, McEwen and Hepworth study reported significant intervention effects on weight, diet self-efficacy, and waist circumference amongst overweight Mexican American adults who received the culturally tailored diabetes prevention as opposed to those who did not. The Abel et al. study found that food served a central role in social engagement and hospitality in Maori culture, which can be used to inform health behavior recommendations for individuals of Maori culture, just as the cultural significance of food was considered when making those recommendations for the South Asian participants of the D-CLIP study (Abel et al., 2018). And finally, Hispanic participants of the 2010 McCloskey and Flenniken study in southern New Mexico also faced large meals at family gatherings and reported important cultural elements to consider when making health behavior recommendations, such as the centrality of family, the "machismo" gender role attributed to Hispanic men, and commonly used foods such as tortillas, beans, and rice (McCloskey and Flenniken, 2010). They most liked that intervention guidelines called for them to modify the Hispanic diet rather than eliminating their favorite, traditional foods (McCloskey and Flenniken, 2010).

Failure to account for study population culture can hinder diabetes prevention efforts. A qualitative study on perceptions and attitudes towards diabetes prevention amongst the Bangladeshi community reported that diabetes prevention interventions designed for white populations were not translatable to the community because they were not culturally adapted, and therefore less meaningful to many Bangladeshis (Grace, Begum, and Subhani et al., 2008). Clinicians demonstrated limited cultural understanding and perceived Bangladeshis to be "poorly informed and fatalistic," while not understanding that some Islamic cultural norms actually

culturally align with diabetes prevention efforts (e.g., modesty) and that poor knowledge about diabetes was actually not the main barrier for this population (Grace, Begum, and Subhani et al., 2008).

Discipline Strategies

Another way D-CLIP incorporated the study participants' culture into the intervention was by offering 'discipline strategies,' which were D-CLIP's suggested ways of behaving when faced with challenging scenarios and home and in the community. The D-CLIP graduates often spoke about the adherence strategies they learned from both study staff and each other, such as eating foods with fiber in times of stress or consuming only one spoonful of the unhealthy food at a wedding and then stopping. These strategies were meant to help participants problem-solve around barriers such as attending frequent parties laden with sweets or arriving home from work late at night. Throughout the group discussions, the participants excitedly shared ways they were able to apply them. Based on this study's findings, these strategies played a crucial part in helping participants continue practicing the new learned health behaviors post-intervention. These strategies were helpful because they were very applicable to the study population's daily challenges with maintaining behavior changes. A 2018 qualitative study from a New Zealand-based lifestyle intervention argued the most effective dietary recommendations for participants will be those that were created with consideration to the participants' life circumstances (Abel et al. 2018). A 2016 Canada study that examined physical activity behavior of 232 adults with prediabetes stated that providing participants with adherence strategies helped study participants develop problem solving around barriers, which Taylor and colleagues referred to as "coping efficacy." (Taylor et al. 2016) Discipline strategies that are adaptive to the needs and challenges of the study population can operate as tools, of no consequential cost to the program, that provide

study participants with useful takeaway advice for continuing the desired health behaviors at home.

Peer Learning

As mentioned previously, D-CLIP used community educators to enroll the participants and to teach the program sessions. Participants developed very positive relationships with study staff and often mentioned cultural colloquialisms study staff repeated in class to help them understand the material. Participants said D-CLIP staff and other participants influenced their perceptions of the exercise. So, it is worth noting that some participants doubted their ability to perform exercises due to the age difference between older-aged participants and younger-aged exercise instructors; some felt they could not meet the younger instructors' expectations for the exercises. Participants in another LIP may have felt the same way -- the 2015 Jiang et al. study reviewed 'site characteristics' associated with participant retention in a DPP curriculum-based intervention with a study population of 2,500 American Indian and Alaska Native persons with an average age of 46.8 years old (Jiang et al., 2015). The study suffered 50% loss to follow-up and observed that sites with younger staff (under 40 years of age) had a lower likelihood of successful retention (Jiang et al., 2015). Older female participants with higher education and income had lower attrition rates when compared to other subgroups within the sample population (Jiang et al. 2015). When creating peer groups or hiring exercise instructors, it may be beneficial to participants' self-confidence if the program constructed the groups so that participants see their age group represented. For example, a 40-year-old participant may be less apt to feel their age limits their capability to perform and complete the taught exercises if at least one of the exercise instructors is middle-aged as well.

Relationship between Behavior Change and Feelings of Self-Efficacy, Empowerment, and Personal Responsibility

The D-CLIP graduates felt the program provided the education they needed to make informed health decisions. They said study staff taught diabetes and health content effectively and provided useful supplementary aids to increase awareness and 'food consciousness,' which suggests the general curriculum of the program was well-received by the participants. Food consciousness education is a proven way to empower individuals in LIPs, as seen in the Abel et al. 2018 New Zealand study (Abel et al., 2018). Participants in this study found it empowering when they learned to read food labels (Abel et al., 2018). A qualitative study examined perspectives of diabetes and health amongst 15 Mexican-origin males at risk for diabetes and found that poor understanding of nutrition was one of the most notable barriers to engaging in health behaviors (Miranda, Garcia, and Sanchez et al., 2020). It is worth noting that D-CLIP study participants constantly conceptualized lifestyle behaviors in terms of 'control' and frequently expressed the desire to wield control over their lives. Perhaps learning and speaking about lifestyle change as something participants could 'control' is a way D-CLIP can help participants resonate with, and find meaning within, the program content.

D-CLIP graduates loved the diet chart because they could look up calorie content and nutritive values of the foods they bought, and then make informed health decisions. Similar lifestyle intervention programs that target underserved populations sometimes find that the study population has low health literacy, and so tend to avoid speaking about diet change and effects from a science perspective for the sake of comprehension. However, shying away from the science aspect of 'food consciousness' may do participants a disservice. This may be an opportunity to empower study participants to feel equipped to make lifestyle changes and

furthermore feel a sense of ownership over those changes. To do so, it would be to better equip study participants with enough nutritional knowledge to where they can confidently make independent health choices post-intervention, which might help support behavior change maintenance. The drawback is that this approach may discourage or intimidate people with low health literacy and no background in nutrition, so further research should determine the best ways to communicate biochemical nutritional content knowledge to study participants of different literacy and science exposure levels.

Another promising finding was that some participants demonstrated feelings of personal responsibility for their health. While some joked that they pictured a D-CLIP instructor's scolding face when faced with temptation, several participants said they felt bodily discomfort or guilt when they skipped walking or ate unhealthy food items. One said they felt like they were cheating themselves. This means they attributed a negative body response to their own actions and assigned themselves culpability. This may be another way study participants can become empowered -- by learning they have the capability to control how their body feels. One of the most frequent words used amongst all participants was "Able", which might suggest that feeling "able" is a recurring sentiment or goal for the D-CLIP participants (Table 1). Participants in the New Zealand-based LIP liked that the study gave them "individualized, clear achievable goals" and participants in the 2010 McCloskey and Fenniken study with Hispanic participants in New Mexico liked capacity building as well (Abel et al., 2018) (McCloskey and Fenniken, 2010). The McCloskey and Fenniken study participants reported feelings of self-efficacy and empowerment once they gained skills in a supportive environment and were taught ways to enact behavior change amidst cultural barriers (McCloskey and Fenniken, 2010). They gained self-efficacy by setting feasible goals related to diabetes (McCloskey and Fenniken, 2010). Once LIP participants

feel equipped to make health behavior changes for themselves, they may then feel more encouraged to practice good health behaviors.

Physical Adherence Tools

Physical adherence tools that helped participants self-manage their own health behaviors were popular. The pedometer was well-liked for this reason, as participants were able to measure their physical activity throughout the day and compare it to D-CLIP goals (e.g., 10,000 steps a day). Participants frequently utilized the diet chart as this tool allowed them to determine the nutrition value in their food items and make decisions about their meals with this information in mind. Another adherence tool the study participants valued was the exercise sequence taught to them during the exercise sessions of the program. Across most focus groups, participants lamented that they forgot the sequence of exercises. They felt that proper execution of the exercise sequence was important. This makes sense, as proper execution of a learned sequence likely supports healthy habit-forming. Routine-building can serve as a promising strategy for building towards positive health behavior change. For example, a 2003 year-long study on the effects of dieting consistency followed 1429 participants and found those who maintained a consistent weekly diet were more likely to maintain their weight (Gorin, Phelan, and Hill, 2004).

Some also worried they might hurt themselves after forgetting the warm-up exercises in the sequence. If a participant acquired even a small injury from doing the exercises out of order--overstretching the arm, for example--this could deter them from continuing that positive health behavior. To mitigate this issue, many participants requested more visual aids (such as videos or illustrated printouts) to help remember the sequence and execution of the exercises they were taught. Perhaps if the participants were better able to visualize the positioning, execution, and

sequence of the exercises, they would feel more comfortable performing the exercises at home without the guidance of study staff.

The Role of Study Staff in Confidence Building

D-CLIP study staff were crucial drivers in helping participants develop feelings of self-efficacy, personal responsibility, and empowerment as they promoted positive feelings about behavior change. They did this by running the class sessions with flexibility, liveliness, and geniality, which generated enthusiasm amongst the study participants. Staff taught them in group settings but often provided individual counsel or motivated them to push participants past their comfort points. The D-CLIP graduates felt study staff listened and were willing to adapt and explain in further detail to ensure participants comprehended the class content. They liked and often remarked upon instances when staff demonstrated that their input mattered (e.g., scheduling the class times/dates or changing the snacks offered during sessions). Many credited the study staff with instilling confidence in the participants. Overall, participants liked when program staff explicitly centered their opinions and experiences and liked being pushed into being decision makers of their health plans. Qualitative studies following other LIPs found participants' relationships with and perceptions of study staff to be just as important for empowerment and capacity building (Abel et al., 2018) (McCloskey and Flenniken, 2010).

Family Support

Many participants expressed that family support was crucial and said family resistance made consistent adherence more challenging. Both sexes said it was more difficult to implement lifestyle changes if their spouse was not on board and/or did not understand the importance of the changes. In this way, family support was an influential factor in participants' home adherence, as

reflected in Figure 2. The program may want to consider ways to increase family involvement with the D-CLIP to support adherence post-intervention. Many participants reported that their partners were not on board with some of the new changes to diet and exercise until they gained understanding by speaking with study staff or attending D-CLIP classes. Currently, there is a class session where participants were invited to bring their spouses, but participants emphasized their family needed to understand the importance of making these changes on a deeper level to approve of these lifestyle changes, which likely cannot be accomplished with just one or two classes. There could be pushback if spouses believe the information does not apply to them or that attending the sessions are a waste of time. For this reason, spouse participation should not be a requirement, but rather a strong suggestion. Spouses that agree to participate could be given a "sponsor" title, or some other specific role.

Family support was a crucial facilitator for behavior change in several LIPs for people at risk for diabetes. In the Abel et al. 2018 study, participants of Maori, Pacific, and European ethnicities with prediabetes in urban areas of New Zealand felt it was extremely valuable to receive encouragement from family who understood the importance of the dietary changes (Abel et al., 2018). They felt lack of family support "significantly undermine[d] [their] confidence and determination to improve their diet" and felt deterred when household members performed unhealthy diet behaviors in their presence or when they had to cook unhealthy meals for household members (Abel et al., 2018). A 2010 qualitative study conducted interviews with 50 Hispanic participants of a southwestern New Mexico-based diabetes intervention program called, "LA VIDA." (McCloskey and Flenniken 2010) The intervention included diabetes education, grocery store tours, and support groups, participants reported family and friend support as "crucial" for making the desired health behavior changes (McCloskey and Flenniken 2010).

Gender roles also factor in. Although men were said to be the head of most households and function as ‘decision-makers’, women were crowned ‘key implementers’ because they alone dealt with food ingredients and made decisions about food while cooking for the household. Moving forward, D-CLIP men need to be approached and taught the importance of the program so the family can be supported in making dietary changes, while more women need to be enrolled and taught the importance of D&E so they can approve and enact the actual dietary changes.

Helpful When Intervention Cognizant of Time Burden

Some D-CLIP graduates reported meeting with study staff to look over their schedules and reorganize so they can practice proper diet and exercise behaviors. Additionally, D-CLIP provided transportation waivers for some participants to reduce the time and burden on travel to the D-CLIP facility. These resources were important as lack of time often encouraged unhealthy behavior practices; some focus group participants remarked that ‘lack of time’ prevented them from performing healthy behaviors daily. For example, several described how waking up late or arriving home late from work caused them to practice unhealthy dietary habits, like skipping a meal or eating a late breakfast--meal skipping has been associated with poor glycemic and cardiometabolic control, which can increase the risk of developing type 2 diabetes (Ballon et al., 2019). Participants in the 2019 Woods-Giscombe et al. study also found it difficult to carve out time in their days to perform desired health behaviors, deterring their practice of intervention taught mindfulness behaviors, and participants in the 2018 New Zealand study desired more guidance on incorporating the healthy lifestyle changes into their days (Abel et al., 2018) (Woods-Giscombe et al., 2019). Ultimately, any intervention resources or initiatives that can address the barrier of time burden would be helpful.

Recognizing that employed individuals spend a large amount of time at their workplaces, D-CLIP recruited participants and provided prediabetes screenings at their workplaces, and even visited some workplaces to promote healthy lifestyle education. The workplace is a convenient setting for finding individuals at-risk for diabetes and supplying them with a cost-effective LIP (Battista et al., 2017). The Prabhakaran, Jeemon, and Goenka et al. study examined the impact of a worksite intervention program on cardiovascular disease risk factors amongst 10 industrial worksites in India over a mean follow-up duration of 3.7 years for the intervention group (Prabhakaran, Jeemon, and Goenka et al., 2009). Prabhakaran and colleagues found those in the intervention group demonstrated more significant reductions in cardiovascular risk factor such as weight, plasma glucose, and total cholesterol and concluded worksite settings as an effective approach to reducing cardiovascular risk factors (Prabhakaran, Jeemon, and Goenka et al., 2009).

However, three of the worksites discontinued the intervention due to lack of support from management and lack of economic stability (Prabhakaran, Jeemon, and Goenka et al., 2009). Structural and economic barriers will need to be considered in the planning process. The intervention will also need to toe the line between being comprehensive and being feasible enough for the workplace settings. A 2007 evaluation of an employer-sponsored program promoting competition-based pedometer-use found this isolated approach to be a comparatively ineffective means of increasing long-term physical activity amongst its employees, which was echoed by the Freak-Poli, Cumpston, and Albarqouni et al. meta-analysis of 14 randomized controlled workplace pedometer-based interventions (Behrens, Domina and Fletcher, 2007) (Freak-Poli, Cumpston, and Albarqouni et al., 2020).

Strengths and Weaknesses of Analysis

Strengths

This analysis provided more context about relevant study outcomes such as the desire to make lifestyle changes, success or failure adhering to recommended diet and exercise behaviors post-intervention, reasons for enrollment in the study, resistance towards enrolling in the study, contributing factors to the good relationship reported with study staff, and positive feelings felt towards the program overall. This analysis also highlighted potential future intervention points based on participant-reported barriers to adherence. Because of the formatted table method used to organize and categorize data, the 'Results' chapter was able to highlight minority opinions (e.g., feelings towards younger exercise instructors and mixed-age peer groups) and experiences (e.g., skipping meals or being discouraged by the doctor) in addition to majority experiences, allowing for more nuanced and detailed discussion about generating confidence amongst participants and partnering with influential voices in the community, like doctors.

Weaknesses

This analysis does not account for factors relating to religious differences, political climate, drug or alcohol use, stress levels, mental illness, or other pre-existing chronic health conditions. There was also limited discussion about what D-CLIP components beyond group walks and group discussions allowed for community building amongst participants. Although the study touched on the ways group dynamics helped increase motivation amongst the participants,

less focus was placed on the ways that participants interacted and engaged with each other throughout the program.

Another limitation is that this is not an implementation or quantitative study therefore findings of this project cannot be generalized to the study population. For the focus group discussions, study staff were unable to recruit participants who dropped out of D-CLIP or were lost to follow-up, despite attempts. Therefore, these findings cannot provide much explanation for phenomena such as retention failure. Furthermore, there was an underrepresentation of blue-collar male workers and employed women in the focus group discussions. This means the findings from this study may not be reflective of the experiences of those subgroups in Chennai. Finally, data was analyzed by just one person, so personal interpretation or bias of the data may have factored into the analysis and portrayal of the study's findings.

Public Health Implications

Battle Population Misconceptions about Diabetes Through Community Initiatives

To mitigate this barrier to LIP recruitment and retention, targeted study populations should receive more education on the health implications of diabetes management practices and significance of lifestyle intervention. This education may need to first come from credible authority figures who have already gained trust within the community. A proven-effective way of generating trust, enthusiasm, and willingness to participate amongst the target population is via partnerships with local entities. Medical providers to the Chennai area should be approached and involved in the intervention. As evidenced by some participants, doctors play a role in bringing about awareness on diet and exercise. Some were even referred to D-CLIP by their

doctors. Local companies present another useful opportunity for partnership. As described by the participants, MDRF collaborated with workplaces for screening and recruitment. A few participants shared the thought that companies could boost recruitment efforts by encouraging or incentivizing qualified employees to enroll in D-CLIP.

Pre-intervention, study staff should plan to gauge and then address this barrier, making sure the purpose and value of the intervention is well-understood. To do this, the study should partner with local entities and trusted community leaders. Not only to build trust, but also to teach health education using familiarity and relevancy. If coming from a fellow community member, population members may be more receptive to health information that disturbs their previous notions about diabetes prevention. Additionally, community health educators can provide health education in a way that reduces gaps in cultural dissonance. The general population needs to have timely, consistent access to emerging public health research. This is important for population health awareness and may minimize the burden on study staff to provide pre-intervention education as well as decrease ex-participants' dependency on the lifestyle program post-intervention. Building off this, LIPs should work with local companies and organizations to provide more community-based diabetes prevention education. Many D-CLIP focus group participants struggled with the long distance between the D-CLIP facility, stationed at the Mohan Diabetes Specialties Center, and their homes. Community partners with local infrastructure could help host those sessions, mitigating this barrier for participants in the area. Study participants from the Woods-Giscombe et al. study also wished for sessions to be conducted "at more central locations in the community, like a local church." (2019)

Support Health Behavior Change by Promoting Positivity, Self-Efficacy, and Ownership over Behavior Change

Based on focus group feedback, enthusiasm towards diabetes prevention, health promotion, and lifestyle change needs to be harnessed and sustained before, during, and after the program. Participants were motivated to perform and adhere to D-CLIP-recommended health behaviors when they had positive feelings towards the D-CLIP staff, the concept of making lifestyle changes, and their capability in making lifestyle changes (as indicated in Figure 2). Therefore, D-CLIP will want to have a pulse on its target population in future iterations of the program to amplify recruitment, engagement, and adherence to the intervention.

Help Participants Develop Self-Confidence and Ownership over Health Behavior Change

One of the participants' glowing reviews of the program was that learning the D-CLIP course content and using the D-CLIP-provided measurement cups made them feel 'in control'. Low self-efficacy can present a barrier for substantive lifestyle change therefore it would be best to impress upon participants the perception of themselves 'taking control' of their health. Words are impactful; the way health education is presented may influence how participants relate to the class material. Study staff should teach and create learning materials with language that evokes confidence amongst participants. For example, the program could modify program materials to employ language implying that participants have ownership over their lives and bodies. D-CLIP could offer simple, culturally appropriate affirmations. The program could also seek and incorporate activities/group exercises that foster belief in self-capability as well. Future LIPs should consider ways they can build participants' confidence and help them feel increasingly more capable to make meaningful health changes in their lives.

One key response from the focus groups was that study staff motivated and empowered them to keep working towards their health behavior change goals. This seemed to be a crucial part of their experience with D-CLIP, so future D-CLIP staff should have the ability to make the participants feel increasingly more capable to follow (and then lead) their own ways in improving their health. One such way is to entrust participants with science-level 'food consciousness' -- to introduce participants to more biochemical concepts that link food and exercise with impact on the body. Pre-intervention, participants heard that diet control and exercise were important for one's lifestyle but did know understand the "why" and "how." They felt D-CLIP provided more comprehensive education on topics like nutrient value of food, potential health consequences of diabetes, potential health benefits from diet control and exercise, and strategies for control and adherence. But what is particularly interesting is that the participants showed a real interest in knowing the nutritive value of the foods they consume. They felt empowered and in control when they knew the calorie content or used D-CLIP-provided measurement cups. Many lifestyle programs may feel it best to teach broader ideas about nutrition and health to populations with low health literacy; however, this group seemed particularly fascinated with the calories and impact of food on their bodies. Overall, future LIPs should look for opportunities to give participants a sense of ownership over their bodies, experiences, and lives to equip them for post-intervention adherence.

Offer Sustainable Self-Monitoring

One reason D-CLIP participants appreciated the D-CLIP-provided pedometers was because this gave them a way to accurately assess how much physical activity they had performed throughout the day. This helped them understand that their daily activities (e.g., walking to work, doing housework) did not fulfill physical activity recommendations, which

prompted them to intentionally incorporate more physical activity into their day. Self-monitoring and self-regulation help support goal attainment and behavior change, as demonstrated by a 2016 meta-analysis of 138 randomized controlled intervention studies that promoted progress monitoring (Harkin et al., 2016). Self-monitoring is advantageous firstly because it brings attention to healthy and unhealthy strategies, secondly because it has been shown to reduce the unhealthy behaviors such as excessive drinking (Helzer, Badger, Rose, Mongeon, & Searles, 2002) and promote healthy ones, such as physical activity leading to weight loss (Greaves et al., 2011), and thirdly because it is a self-initiated strategy (Duckworth and Gross, 2020).

This is especially important post-intervention as participants will not have the same access to monitoring tools sustained by the program and may lack those tools in their home environment and community. Thus, further research should explore ways participants can measure their progress in low-resource settings, and then lifestyle intervention programs (LIPs) such as D-CLIP should translate these findings to measurable goals and recommendations for study participants. For example, if participants were able to access a local gym or recreational outdoor space at their local community centers, with markings repurposed for fitness goals, this would allow people a way of measuring their physical activity (by laps, or distance jogged for example). Participants will also want to monitor their blood glucose levels but may not have access to these instruments. LIPs could come up with other ways of detecting unusually high or low blood sugar (hyperglycemia and hypoglycemia, respectively) by educating participants on the symptoms and giving them healthy strategies to mitigate these conditions.

Provide Culturally Relevant Intervention Strategies

Participants found it extremely helpful when D-CLIP provided them with culturally relevant discipline strategies to help support sustained behavior change. Future LIPs should follow suit and incorporate culturally tailored discipline strategies into their lesson plans for teaching non-communicable disease (NCD) prevention education. Lifestyle interventions should address a range of social situations relevant to their study population, understand what aspects of these situations are most challenging to healthy behavior adherence, and then recommend useful strategies (or 'tips') for navigating those challenges.

D-CLIP should also actively create space for feedback from the community to add to/modify existing recommendations, lessons, and discipline strategies to reflect the practices of the Chennai residents. One such way is by encouraging its graduates to teach newly enrolled participants, increasing the pool of available peer educators to the program. Moderators of the focus group discussions gauged the D-CLIP graduates' willingness to do this, and feedback was varied. One prevalent concern was that they would feel less equipped to offer diabetes prevention education on a large scale, which should be considered a legitimate concern. A 2020 implementation study examined the feasibility, acceptability, and sustainability of utilizing peer educators to lead the worksite implementation of D-CLIP in ten worksites in India (Rhodes, Hennink, and Jose et al., 2020). The study found that, although this practice was feasible, peer educators needed adequate training, confidence, management support, and motivation to properly carry out this role (Rhodes, Hennink, and Jose et al., 2020). Thus, D-CLIP should consider some of these reported needs when deciding the extent to which peer educators should be utilized in future iterations of the program.

Family Support is Helpful to Behavior Change

The extent to which the study can intervene in the home environment is limited. However, D-CLIP graduates found the presence or lack of family support to be a significant factor in adherence to health behavior change post-intervention. One intervening point for LIPs could be family engagement with the program. Multiple study participants felt their spouses and children were not fully onboard with making the health behavior changes until they fully understood the necessity and significance of making those changes. This learning can be made available to family members during the lifestyle intervention classes; therefore, LIPs should restructure the classes so that family members are enrolled in the program as well. The 2008 New Zealand study also found that family and household members had a strong influence on behavior change amongst their study participants and argued family should be engaged in the education sessions and support offered to those newly diagnosed with diabetes (Abel et al. 2018). Besides increasing support for those individuals attempting to adopt more positive health behaviors, this method would also increase the intervention's scope of impact, allowing diabetes prevention education to be passed down as generational knowledge (Abel et al. 2018).

This study's findings about the need for increased spousal support may be particularly useful for populations in which the household roles are gender-specific. In the D-CLIP study population, women made decisions about foods to purchase and cook for the family, making them significant voices in household acceptability. For families with this distribution of household responsibilities, women especially should be recruited or more involved in the program. Predicting some pushback, further research should be conducted on best methods to do so and to examine reasons why spouses might choose to or choose not to get involved in their partner's health decisions.

Future Directions

Innovate D&E Recommendations to Reduce Time Burden

'Lack of time' is an opposing force to public health efforts. Many felt their other responsibilities at home, at class, or at work were impediments to regular implementation of D&E. D-CLIP participants listed 'lack of time' as one of the biggest deterrents to adherence. Many participants spoke of their struggles incorporating these learned health behaviors into their busy schedules One way forward would be to offer more exercises that can be completed (or contribute towards the completion) of other time and livelihood commitments, which would reduce the amount of time required to complete D&E. This is a potential intervening point for the program, as indicated in Figure 2. If the learned health behaviors were to help participants progress in their other responsibilities, perhaps there would be improvements in adherence. For example, a company could allow its employees to attend activities that enable positive health decisions and record this time as billable paid hours. Employees would then be compensated for attending a company-based exercise session during the workday or for partaking in mid-morning and mid-afternoon healthy snack breaks. This would look different for people who serve in other roles, such as housework. This subgroup could be supplied with ankle weights that they could use while performing lower-resistance tasks like sweeping the floor. Further research could investigate more opportunities to build convenience into health behavior recommendations.

Address Barriers Unique to Women

From the focus group discussions, it became clear that threats to women's safety diminished the number of opportunities women had to go walking (since some were unable to go walking at darker points of the day) and cheated them of pleasant, diverse walking experiences (when they were harassed by threatening men or dogs). One woman was unable to utilize one of her most available, local walking spaces due to a safety threat. She said her husband did not allow her to go walking at the park due to recent violence. Other women stated they would only be able to go walking when their husbands were willing and available, which also impeded both walking ability and consistency. These threats hampered their walking behaviors and discouraged them from participating in D-CLIP. To facilitate walking adherence, there should be solutions that help protect against environmental factors threatening women's safety.

A few of the women suggested there be an exercise center where women can come and do their exercises. While it may not be sustainable for LIPs to provide space at the teaching center for women to do exercises outside of classes on a long-term basis, this may be a short-term offering that provides long-term benefits. This may be a way to help encourage women to form walking groups with others local to their area. Many female participants felt uncomfortable going walking unaccompanied, so placing them in walking groups may help mitigate this issue. If too cost-intensive to provide use of the facility space outside of intervention class hours, LIPs may at least want to be more intentional about facilitating the formation of these walking groups to help provide women with the safety they need to go walking without post-intervention support.

Additionally, for study populations where women are responsible for a significant amount of home responsibilities, LIPs should create recruitment strategies for women based on

barriers that would classically prevent women from joining D-CLIP. Most D-CLIP focus groups echoed the sentiment that women were very busy with home responsibilities. Even if a woman has completed her responsibilities for the day, that woman may have to give up her limited free time to attend the program. Future LIPs that target similar study populations need to present compelling arguments why women should sacrifice their time to participate in a lifestyle intervention program. Findings from this study indicated that women from the study population may be more likely participate in this program if they believe the program functions as an asset to her and/or her family. For example, since this study found that home management was a priority for women, future D-CLIP recruiters should emphasize that making healthy lifestyle changes can help women feel lighter on their feet, more energetic, and more motivated to complete various housework tasks faster and with greater ease. One targeted strategy to help recruit more women would be to also explain program benefits to the husbands of women with prediabetes, so they might understand and approve the purpose of the program. This may help more women in the community to have the support and encouragement they need to enroll in the program.

Account for Within-Group Differences

Beyond learning about and tailoring an intervention to align with the study population's most prevalent cultural values and customs, it is important to be mindful of individual values and customs as well. Lifestyle intervention programs should look for ways to reasonably diversify its intervention methods to account for individual differences amongst its participants. One such way would be to provide more diverse methods of learning class material. Some focus group participants felt they were well-equipped with the oral instruction, pamphlets, peer group discussions, and CD's they were given in class and as program materials. However, some D-

CLIP graduates thought visual aids would help them to better conceptualize and properly execute the exercises at home. They requested D-CLIP videos or printouts that could illustrate the performance and sequence of exercises they were taught in class. In the 2018 New Zealand post-lifestyle intervention qualitative study for people with prediabetes, some of the ex-participants also felt access to '"study-specific videos"' would enhance exercise (Abel et al., 2018). Diabetes education classes should present the material in diverse ways to teach about exercises and general diabetes prevention content in ways that are most effective for participants, which would facilitate participants' comprehension. For example, those who understand visual representation of concepts might benefit from seeing staff demonstrate the amount of sugar in a commonly consumed fruit juice by weighing the amount of sugar on a weighing scale.

D-CLIP graduates also reported variable walking behaviors. They joined the program for different reasons and often had different schedules and different goals, so standardized walking recommendations may not be effective for all participants. It may be beneficial to create exercise recommendations that best help participants fulfill their personal goals and incorporate exercise according to their personal availability. The Kassavou et al. study explored how walkers' perceptions of their walking environment influenced their walking behaviors, and ultimately suggested walkers create a walking plan specific to their goals (Kassavou et al., 2013). For example, those who joined for weight loss and other improvements to physical health may most benefit from exercises that can be easily measured (e.g., walking laps around a racetrack), and then improved upon. Those who struggle with performing regular exercise due to work could benefit from walkable paths accessible by foot from their workplaces. To help support health behavior change, future LIPs may want to offer more diversified strategies to suit the different needs of subgroups within their sample population.

Modify Public Infrastructure to Accommodate Moderate Walking

One helpful structural public health intervention would be for governing bodies and applicable organizations (companies, NGOs) to make public infrastructure optimal for casual physical activity practices like walking. Positive feelings (enthusiasm) towards diet and exercise encouraged D-CLIP participant participation and adherence to the health behavior changes. Carlos and colleagues call for public health policies that promote accessibility and desirability for physical activity in public spaces (Carlos, de Irala, & Hanley et al., 2014). Aesthetically pleasing seasonal locations like parks, for example, offer a more positive, socialized experience of walking as opposed to environments with unchanging stimuli (Kassavou et al., 2013). Local governments should review land use and increase the amount of green space in the community.

Several participants also voiced environmental and safety concerns against walking in public spaces outside their homes and were sometimes relegated to walking only in limited inside spaces, such as the terraces of their homes. This alludes to a larger problem--lack of safe walking spaces. Additionally, water stagnation in the roads during the rainy season characteristic to Chennai poses a barrier to exercise adherence. Quite a few participants mentioned they were not able to go walking when it was rainy, potentially alluding to an inadequate storm sewage system or lack of safe, demarcated walking spaces in their local area. These are system-level issues that may present barriers for sustaining physical activity post-intervention and would need to be addressed on a larger scale—through government intervention with public infrastructure, for example. Overall, there should be greater effort to improve public infrastructure so that a greater number of safe, accessible, and varied walking spaces are made available to the general population. LIPs could perhaps coordinate with the local government and companies to advocate for improvements to public infrastructure. Additionally, further research should seek to

understand different spatial characteristics that facilitate comfortable, pleasant, interesting, and safe physical activity for different subgroup populations (Kassavou et al., 2013).

Conclusion

The D-CLIP intervention study disseminated culturally tailored, DPP-based lifestyle change education, materials, and counseling to South Asian Indian people with prediabetes in Chennai, India. Based on participant feedback, program participation and health behavior change were facilitated by confidence-inspiring study staff, culturally relevant and feasible lifestyle change recommendations, family support, and self-monitoring tools. Family resistance, fear of safety, time conflicts, and community misperceptions about diabetes and health were important deterrents for the participants. These findings pinpointed useful strategies for increasing community acceptability and program sustainability. Future lifestyle intervention programs should increase the family's engagement in the intervention, partner with local organizations and companies to disseminate diabetes health education and localize the intervention, offer participants self-sustainable means of monitoring and continuing their health progress, and provide culturally relevant, empowering instructors and instructional content. Future research could examine ways to incorporate more convenience, accessibility, safety, and fulfillment into health behavior recommendations and public infrastructure.

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