

Sí Se Puede Con Diabetes Aplicación Móvil Program Proposal

by

Julia Heller

BS, University of Pittsburgh, 2019

Submitted to the Graduate Faculty of the
Graduate School of Public Health in partial fulfillment
of the requirements for the degree of
Master of Public Health

University of Pittsburgh

2022

UNIVERSITY OF PITTSBURGH
GRADUATE SCHOOL OF PUBLIC HEALTH

This essay is submitted

by

Julia Heller

on

April 11, 2022

and approved by

Essay Advisor: Martha Ann Terry PhD, Associate Professor, Department of Behavioral and
Community Health Sciences, Graduate School of Public Health, University of Pittsburgh

Essay Reader: Müge Kökten Finkel, PhD, Assistant Professor, Graduate School of Public and
International Affairs, University of Pittsburgh

Copyright © by Julia Heller

2022

Sí Se Puede Con Diabetes Aplicación Móvil Program Proposal

Julia Heller, MPH

University of Pittsburgh, 2022

Abstract

The prevalence of diabetes is increasing worldwide, indicating a serious public health crisis. Diabetes is the ninth leading cause of mortality in the world. The public health significance of diabetes is that type 2 diabetes is considered a pandemic. Mexico has one of the highest prevalence of type 2 diabetes in the world. Reducing individuals' blood glucose levels and improving diabetes management is critical for improving quality life. Diabetes self-management education and support (DSMES) is a patient-person centered management framework. It is associated with improved diabetes knowledge and self-education behaviors, decreased blood glucose levels, lower self-reported weight, improved quality of life, and reduced healthcare costs. The Sí Se Puede Con Diabetes Aplicación Móvil pilot program aims to create a clinic-based diabetes self-management education and support mobile application (app) for patients with type 2 diabetes at Clinica Especializada en Diabetes in Mexico City, Mexico. The intention of the project is to replicate culturally sensitive DSMES mobile apps that provides interactive and user friendly supplemental self-management content at all clinics in Mexico City.

Table of Contents

Preface.....	ix
1.0 Introduction.....	1
2.0 Background	3
2.1 Global Burden of Disease.....	3
2.2 Determinants of Diabetes.....	4
2.3 Type 2 Diabetes.....	7
2.3.1 Type 2 Diabetes in Mexico.....	8
2.4 Diabetes Self-Management Interventions	9
2.4.1 Self-Management.....	9
2.4.2 Mobile Applications	10
2.5 Diabetes Management Interventions in Mexico	12
2.5.1 Clinica Especializada en el Manejo Integral de la Diabetes Iztapalapa	13
2.6 Program Description	13
2.6.1 Logical Framework.....	14
2.6.2 Program Design.....	18
2.6.2.1 Logic Model.....	20
2.7 Program Implementation	23
2.7.1 Program’s Diabetes Quality of Life Survey.....	23
2.8 Assumptions, Timeline, Challenges and Sustainability	28
2.8.1 Project Budget	31
3.0 Evaluating Si Se Puede Con Diabetes Aplicación Móvil	33

3.1 Program Evaluation	33
3.2 Impact Evaluation	34
3.2.1 Impact Evaluation Question.....	34
3.2.2 Impact Evaluation Design	35
3.2.3 Impact Evaluation Method.....	36
3.2.4 Triangulation.....	36
3.2.5 Challenges	37
3.2.6 Generalizability	37
4.0 Conclusion	39
Bibliography	41

List of Tables

Table 1 Diabetes Medical Expenditures	4
Table 2 Program Budget	32

List of Figures

Figure 1. Logframe	16
Figure 2. Logic Model.....	22
Figure 3. Appraisal of Diabetes Scale	25
Figure 4. Short Form-12 Health Survey	27
Figure 5. Gantt Chart	30

Preface

I would like to acknowledge and give my warmest thanks to my advisor, Dr. Martha Terry, who helped make this work possible. Your guidance and advice carried me through all the stages of writing this project proposal. I would also like to thank Dr. Müge Finkel for letting my capstone project come to life in this essay and for your brilliant comments and suggestions.

I would also like to give special thanks to my mother, Judith, for her unwavering support and patience throughout my graduate education. Without you, none of this would have been possible. Your constant support and guiding light were what sustained me this far.

1.0 Introduction

The prevalence of diabetes mellitus is increasing worldwide, indicating a serious public health crisis. Diabetes mellitus, also referred to as diabetes, is the ninth leading cause of mortality in the world. More than one million deaths per year can be attributed to diabetes.¹ Diabetes develops when an individual's pancreas can no longer produce insulin or does not effectively use the insulin it produces.² Insulin is a hormone that regulates blood sugar.³ Diabetes can be divided into three subtypes: type 1 diabetes mellitus (T1D), type 2 mellitus (T2D), and gestational diabetes mellitus.

T2D is the most common type of diabetes, representing 85-90% of all cases of diabetes.⁴ The T2D pandemic increased from 171 million cases in 2000 to 462 million in 2018, and is expected to rise to 366 million in 2030.⁵ In addition, the global burden of T2D is increasing. The surge is largely concentrated in middle- and low-income countries.¹ Over the last 15 years, high-income countries have developed effective tools to maintain and control blood glucose, blood pressure, lipids, and screening for early complications.⁶ In addition to the increased risk of chronic health issues, the cost of health care for people living with diabetes is two to three times higher than among peers without diabetes.³

Diabetes requires individuals to make a multitude of self-management decisions and engage in self-care activities. Diabetes self-management education and support (DSMES) is one strategy for diabetes management. Culturally sensitive DSMES programs consist of personally relevant content and have been proven to be more effective in promoting behavior change. Such DSMES approach is essential for population-specific needs within a cultural group.⁶ Programs designed with DSMES approach establish the foundation to help people with diabetes navigate

decisions and activities that have been demonstrated to improve health outcomes.⁷ These include choosing nutritionally dense food, participating in physical activity, taking necessary medications, having emotional and behavioral support, monitoring HbA1c levels, and reducing risks. Culturally sensitive DSMES is associated with improved diabetes knowledge and self-education behaviors, decreased HbA1c levels, lower self-reported weight, improved quality of life, and reduced healthcare costs.⁸

The expansion and adoption of new methods for digital communication provide the opportunity to deliver health behavior change interventions on a handheld, technological platform. *Sí Se Puede Con Diabetes Aplicación Móvil* is a mobile app that contains culturally sensitive DSMES content for healthcare providers and patients with T2D at Clínica Especializada en el Manejo Integral de la Diabetes Iztapalapa. This app can serve as an extension for diabetes educators and healthcare providers. In order to create the digitally available content, a team of healthcare providers and patients will work collaboratively to create culturally sensitive healthcare provider and patient DSMES curriculums and training programs. Utilization of culturally sensitive DSMES resources and services will result in decreased HbA1c levels for patients with T2D and overall improved quality of life.

2.0 Background

2.1 Global Burden of Disease

Diabetes is a chronic disease that has spread widely in high-income, middle- and low-income countries. In 2013, diabetes affected 382 million people, globally. The estimated global prevalence rate in 2013 was 8.3% among individuals between 20 and 79 years and was globally highly concentrated in populous countries, such as India and China. At this time, the prevalence rate of diabetes in India and China was 9% and 10%, respectively. This corresponded to 65 and 100 million people, respectively. In 2013, approximately two-thirds of all individuals with diabetes lived in low- and middle-income countries. The increasing prevalence of diabetes in low- and middle-income countries can be attributed to rapid urbanization, nutrition transition, and increasingly sedentary lifestyles.⁸

In addition to adverse health consequences, diabetes also creates an economic burden on individuals and households and healthcare systems. According to the International Diabetes Federation, global healthcare spending on diabetes for individuals between 20 and 79 years old increased from \$232,000 million in 2007 to 727,000 million in 2015.⁹ Furthermore, this increasing trend continued as the total health expenditure on diabetes reached \$727,000 million for that respective age group in 2017.

Similarly, the global economic burden of diabetes is predicted to increase from \$1.3 trillion in 2015 to \$2.2 trillion by 2030. Overall, the total share of diabetes care will increase from 1.8% of global Gross Domestic Product (GDP) in 2015 to 2.2% of global GDP in 2030. The largest components of medical expenditures include, hospital inpatient care, prescription medications to

treat diabetes complications, anti-diabetic agents and supplies and physician office visits. See Table 1 for breakdown of diabetes medical expenditures on health systems.

Table 1 Diabetes Medical Expenditures

Medical Expenditure	Total Medical Cost
Hospital inpatient care	30%
Prescription medications	30%
Anti-diabetic supplies	15%
Physician office visits	13%

The most substantial burden for the individual is the out-of-pocket treatments. Out-of-pocket treatments include therapies, medications and healthcare provider visits for which patients are completely responsible for paying, dependent on insurance coverage. The burden is generally higher for people with lower household incomes as they often lack health insurance coverage. In low- and middle-income countries, non-medical costs for transportation and informal healthcare or food considerably add to the diabetes cost of burden.¹⁰

2.2 Determinants of Diabetes

Several social and environmental determinants of health can increase an individual's risk for developing diabetes and subsequent outcomes. These highly intertwined determinants can be represented in the social-ecological framework, also referred to as the socioecological framework. The socioecological framework depicts the complexity between individual, relationship, community, and societal factors.¹¹ The individual level identifies biological and personal factors that increase the likelihood of developing diabetes.¹² There are several social and economic

determinants at the individual level including genetic predisposition, income, and educational attainment.

The onset of both type 1 and type 2 diabetes is attributed to both an inherited risk and external factors. Researchers have identified 18 regions of the human genome that are linked to influencing the development of type 1 diabetes. This genome region contains several genes that code for immune response proteins, the insulin gene, and regulatory immune responses.¹³ T2D is largely considered a multifactorial disease. However, researchers identified two genes associated with increased risk of developing T2D: the calpain 10 and 4 alpha genes.¹⁴ Similarly, the insulin receptor gene at least five glucose transporter genes contribute T2D susceptibility.¹⁴ While genetic predisposition increases an individual's risk for developing diabetes, other factors are associated with triggering the onset of the chronic disease, such as household income and employment status.¹⁵

Gaskin et al. (2014) conclude that poor adults living in poor neighborhoods are twice as likely to have diabetes compared to nonpoor adults living in nonpoor neighborhoods.¹⁶ In addition, unemployment was associated with increased odds of prediabetes and T2D.¹⁷ Moreover, shift work is highly associated with an increased risk for developing diabetes compared to those who work normal daytime schedules. It was also demonstrated that individuals working long hours, more than 55 hours per week, had a higher incidence rate of diabetes.¹⁸ Most notably, in a population-based study on diabetes, researchers conclude that the highest prevalence of diabetes was among transportation workers and the lowest prevalence of diabetes was among physicians.¹⁹

The community level of the socioecological framework highlights the characteristics of settings or environments that are associated with developing diabetes.¹³ This includes the built neighborhood environment. Built neighborhood environment is defined as the physical parts of

where people work and live, which includes streets and open spaces.⁶ For example, neighborhood physical activity environments, particularly related to factors of walkability and greenspace, are consistently associated with lower risk of T2D. In addition, Bilal et al. (2018) concludes that more walkable neighborhoods were associated with lower incidence and prevalence of T2D.²⁰

The societal level of the socioecological framework highlights the characteristics of society that are associated with diabetes.¹³ Most notably, urbanization and economic growth contribute to the increased risk of developing diabetes. Urbanization has resulted in the increased access to high-fat, calorie-dense foods and beverages. In addition, it has promoted the consumption of larger portions, often times processed goods. In many cases, this results in higher blood glucose levels. As previously stated, chronic high blood glucose levels can lead to the development of T2D and may also lead to greater insulin resistance.²¹ Furthermore, urbanization has increased everyday efficiency at home and work through transportation and technological advances. However, urbanization also has contributed to less physical activity and movement and increased sedentary lifestyle behaviors.²²

In addition, access to comprehensive and affordable healthcare influences an individual developing T2D.⁶ Access to comprehensive, quality and affordable health care services is critical for diagnosing and treating diseases, such as diabetes. Furthermore, limited access to healthcare is associated with poor glycemic control and blood pressure control. This suggests that access to healthcare services is critical for controlling and reducing the risk of developing T2D.²³ Moreover, affordability of healthcare is equally as important as accessibility. The health care costs of individuals with diabetes is 2.3 times more than those without diabetes.²⁴ Furthermore, between 14 and 20 percent of adults with diabetes report delaying or reducing their medications due to the cost.²⁵

2.3 Type 2 Diabetes

T2D develops when an individual's pancreas does not effectively or properly use the insulin their body produces. T2D usually takes years to develop and is typically diagnosed in adults.⁵ Measuring glycated hemoglobin (HbA1c) levels is critical for making a T2D diagnosis. The HbA1c test measures the percentage of hemoglobin proteins in the blood that are coated with sugar. HbA1c levels over 6.5% are indicative of T2D.²⁶ In 2017, T2D affected approximately 462 million individuals, corresponding to 6.28% of the world's population. If untreated or poorly managed, T2D increases the risk of premature mortality as well as several serious long-term complications that can result in damage of blood vessels. Furthermore, this can lead to increased risk of heart attack, stroke, neuropathy, retinopathy, and kidney failure.²⁷

Several risk factors can increase an individual's likelihood for developing T2D. These include being prediabetic, overweight, obese, 45 years or older, or having a family history of diabetes.²⁸ Prediabetes develops when blood glucose levels are higher than normal, but are not high enough to be diagnosed with T2D. Individuals with HbA1c levels between 5.7 and 6.4% are diagnosed with prediabetes. Prediabetes also increases a person's risk of developing cardiovascular disease. The HbA1c levels for individuals with prediabetes are between 5.7% and 6.4%. Prediabetes does not always result in developing T2D. Early treatment can decrease blood sugar levels to normal range, or below 5.7%. This includes losing 7% of body weight and exercising moderately for 30 minutes a day, five days a week.²⁹

2.3.1 Type 2 Diabetes in Mexico

Mexico has one of the highest obesity and overweight rates (71.2%) in the world.³⁰ Consequently, in 2015, Mexico had the fifth highest prevalence of diabetes in the world (15.8%). The prevalence rate of diabetes in Mexico is much higher than most high-income countries, such as 10.8% in the United States and 7.4% in Canada. It is predicted that by 2025, approximately 11.7 million Mexican residents are expected to be diagnosed with diabetes.³¹

T2D in Mexico accounted for approximately 30% of the total mortality in adults between 1998 and 2002. More specifically, the prevalence of T2D amongst adults 20 years or older with low socioeconomic status living in Mexico City was 13.8%. Age-specific incidence peaks between the ages of 57 and 59 years.³² In addition, the Encuesta Nacional de Salud 2000 and the Encuesta Nacional de Salud y Nutrición 2006, 2012, and 2016 highlighted that diabetes in Mexico was more prevalent in urban regions than in rural areas.³³ Similarly, the highest increase in prevalence of T2D was observed in East and Southcentral regions.³⁴

The cost of care services for diabetes and subsequent consequences have also increased. In 2000, diabetes was the 11th most frequent cause for hospitalization in Mexico. In the same year, diabetes was the most common cause of hospital mortality in Mexico. In Mexico, the average percentage of spending on diabetes care in 2011 was approximately 15.7% of total spending on health. Furthermore, the cost of the diabetes in Mexico is predicted to increase by 8% by 2022.¹⁷ In 2013, the economic burden of diabetes in Mexico was approximately \$363,000 million pesos. This accounted for 2.25% of that year's GDP. More specifically, in 2013, the direct costs of T2D in Mexico was approximately \$179,495 million pesos.³⁵

2.4 Diabetes Self-Management Interventions

2.4.1 Self-Management

DSMES was introduced in the 1940s; however, first of quantitative evaluations on results were not conducted until the 1990s.⁷ For this reason, the largest gap in research is the lack of quantified population-based studies, specifically with regards to culturally adapted DSMES programs. This limits future generalization of culturally adapted DSMES intervention programs.

DSMES requires healthcare providers and diabetes education specialists to foster knowledge, skills, and abilities necessary to manage diabetes. In addition, it includes support that is necessary for sustaining coping skills and behaviors needed to continuously self-manage diabetes.³⁵ DSMES is not only critical for maintaining HbA1c levels but has also been proven to be cost-effective. DSMES also reduces the number of hospital admissions and readmissions. In addition, it is estimated that DSMES reduces the lifetime healthcare costs as it decreases the onset and/or advancement of diabetes complications.³⁶ Furthermore, DSMES has a positive effect on psychosocial, clinical and behavioral aspects of an individual's life. For example, DSMES has been demonstrated to improve quality of life and behaviors. This includes adopting a healthier eating pattern and increasing physical activity. DSMES is a patient-centered approach that fosters sustainable lifestyle changes and is associated with better health outcomes. As healthcare resources become scarcer, self-management will become more important.³⁷

A DSMES curriculum framework must include content based on current evidence, teaching strategies and methods, appropriate learning resources, and outcome evaluation. The content of the DSMES curriculum typically covers several topics: pathophysiology and treatment options, nutrition, activity, medication usage, monitoring health data, preventing acute

complications, preventing chronic complications, healthy coping, and problem solving. The successful implementation and execution of DSMES curriculum are largely determined by measuring HbA1c levels of patients living with diabetes. Furthermore, culturally sensitive DSMES programs consist of personally relevant content and have been proven to be effective in promoting behavior change.⁴

2.4.2 Mobile Applications

There were more than 318,000 mobile health applications available to consumers in 2017. Mobile apps designed for individuals with diabetes accounted for more. More than 16% of the total available disease-specific apps.³⁸ Diabetes mobile apps vary in functions. Some apps focus on one topic, such as increasing physical activity, while others are multifunctional. The apps offer tools for tracking blood glucose levels, carbohydrates, physical activity and weight. In addition, many apps concentrate on nutrition and offer recipes and nutrition recommendations for specific metabolic diseases. Furthermore, many apps allow users to share their data with clinicians or peers.³⁹

Mobile phone-based DSMES offers the opportunity to provide highly accessible behavioral and educational support to individuals anytime, anywhere. Mobile DSMES health apps can improve coverage and access to healthcare services for patients. In addition, mobile diabetes management apps are one of the most common technologies that World Health Organization (WHO) member states have adopted.⁴⁰ Similarly, the American Diabetes Association includes mobile health apps as a standard of medical care for diabetes.⁴¹ However, despite the international recognition for mobile health apps, they are currently underused in managing diabetes.

Previous evaluated studies demonstrate that use of mobile apps decreases HbA1c levels and body mass Index (BMI). The majority of research assesses the effectiveness of short message service (SMS) interventions on medication adherence. Furthermore, several studies concentrated on medication adherence rather than lifestyle modification adherence.⁴² However, little literature discusses the effect of mobile app-delivered interventions that aim to improve the quality of life of individuals with T2D.

More personalized forms of lifestyle modifications, such as curricula and consultations for living a healthy lifestyle are not widely available. Previous studies concluded that apps improved users' self-management awareness and compliance.⁴³ Furthermore, studies have indicated that mobile apps for diabetes management have statistically significant effects in improving individuals' self-efficacy, increasing disease knowledge, and enhancing physician-patient communication. In addition, mobile apps have statistically significant impacts on decreasing diabetes incidence through delivering information, education, self-management, therapeutic advice, and drug guidance.⁴⁴ Overall, there is strong evidence for the efficacy of mobile apps for lifestyle modification and improvement of quality of life for individuals with T2D.

Glucose Buddy is an example of a diabetes self-management mobile app. It is available to Android and Apple users. The app allows users to track blood glucose, HbA1c levels, meals, carbohydrates, medication and physical activity. In addition, the Glucose Buddy mobile app allows users to set medication and glucose measurement reminders. The mobile app also helps users calculate their HbA1c. A six-month randomized controlled trial evaluated the efficacy of Glucose Buddy. The intervention group required participants to use Glucose Buddy in addition to receiving regular diabetes care services. The control group consisted of participants who only received regular diabetes care services and did not use Glucose Buddy. The trial concluded that the

interaction effect between the intervention and control groups was clinically and statistically significant.⁴⁵

2.5 Diabetes Management Interventions in Mexico

National consensus in Mexico holds that T2D is one of the highest priority public health issues.⁴⁶ During the 2007-2012 federal administration, efforts in diabetes prevention, treatment, and control intensified. Throughout this administration, the Ministry of Health developed several public health services to prevent and control diabetes. Most notably, Mexico's Ministry of Health established "Mutual Health Groups" (GAM) in 2001. According to the Ministry of Health, in 2012 7,059 GAM groups existed with 172,595 beneficiaries. However, only 30% of GAM groups were certified under Ministry of Health standards. The need for evidence-based, culturally sensitive DSMES interventions is clearly demonstrated.⁴⁷ Despite improvements in access to care for people with T2D in Mexico, the majority of adults with T2D do not meet glycemic targets of less than 6.5%.⁴⁷

Although the Ministry of Health in Mexico made efforts to better manage and prevent diabetes, DSMES is still suboptimal. As previously stated, DSMES is a standard of care in many countries and provides education, skill development, and behavioral support for managing T2D. Poor self-management and glycemic control in Mexico are largely attributed to the limited understanding of the importance of self-management and low health literacy.⁴⁸ As noted, evidence-based, culturally sensitive DSMES interventions are needed.²¹

2.5.1 Clinica Especializada en el Manejo Integral de la Diabetes Iztapalapa

Clinica Especializada en Diabetes is located in the Iztapalapa District of Mexico City, Mexico. It was the second clinic to provide comprehensive care to patients with diabetes in Mexico City, offering a variety of services and resources including individual and group diabetes education sessions. The clinic serves approximately 300 patients in the Mexico City area. Patients must be referred to this specialty clinic by their primary care physician. The interdisciplinary team of healthcare providers consists of specialized physicians, nurse practitioners, clinical nutritionists, pharmacists, mental health specialists, and exercise physiologists.⁴⁹

2.6 Program Description

The purpose of this project is to improve DSMES in patients with T2D at Clinica Especializada en Diabetes through the creation of a mobile app. This includes training healthcare providers and patients with T2D in culturally sensitive DSMES. Culturally sensitive DSMES educated healthcare providers are better equipped to train their patients in DSMES. Patients trained in DSMES are more likely to have an improved quality of life and diabetes management.

Traditional diabetes management programs provide information to individuals with diabetes in a didactic manner. However, newer culturally sensitive DSMES services have evolved that promote patient empowerment models that effectively improve diabetes self-management.⁶ *Sí Se Puede Con Diabetes Aplicación Móvil* is a pilot program to be implemented at Clinica Especializada en Diabetes. This program will develop a comprehensive and dynamic culturally sensitive DSMES mobile app for patients with T2D by designing clinic-based DSMES curricula

and trainings for patients and healthcare providers to ensure consistent delivery of content, education, and techniques. The mobile app will be comprised of the culturally sensitive healthcare provider and patient DSMES curricula. This mobile app is critical for delivering patients and healthcare providers with guides, tips, resources, and services related to managing a lifestyle with diabetes. The long term goal of this project is to improve the quality of life of patients with T2D at Clinica Especializada en Diabetes.

2.6.1 Logical Framework

The Logical Framework (Logframe) was instrumental in creating the Sí Se Puede Con Diabetes Aplicación Móvil. The Logframe is a tool of project cycle management. It is used to develop the project design, improve program implementation monitoring and strengthen continuous project evaluation. The Logframe is a “cause and effect model” of project interventions to create impacts for the necessary beneficiaries.

This project utilizes the model from the World Bank’s Logframe. This framework uses a 16-box matrix to structure the project design. The first column describes the causal logic of the project’s objectives. This column establishes the important distinction between program goal, project impact, project outputs and activities. The second column identifies the indicators and targets at each level. Furthermore, the third column identifies the process, events, people and information necessary for implementation over time. The final column describes other conditions that determine the success of the project. The assumptions and degrees of risk vary at different levels.⁵⁰

There are several advantages for modeling the project design on the Logframe. The Logframe guides a systematic analysis of the interrelated conditions that create a well-designed

program. In addition, it highlights linkages between the project and external factors. Due to its highly interconnected relationship, the Logframe facilitates stronger communication among managers, stakeholders and beneficiaries involved in the project. Although this project design framework is entirely results-driven, decision-makers can miss the opportunity to improve existing processes.⁵¹

The Si Se Puede Con Diabetes Aplicación Móvil Logframe, depicted in Figure 1 summarizes the project cycle. The overall goal of the program is to improve “Quality of life of patients with T2D at Clinica Especializada en Diabetes.” As a result in improving the quality of lives of patients with T2D, diabetes self-management at the clinic will be utilized and more impactful, as referred to as the project outcome. In order to achieve the project’s outcome, three outputs need to be created: healthcare provider curriculum, patient curriculum and the mobile application.

Figure 1. Logframe

Project Structure	Indicators of Achievement	Means of Verifications	Assumptions
Goal: Quality of life of patients with T2D at Clinica Especializada en Diabetes is improved.	-60% of patients with T2D at Clinica Especializada en Diabetes self-report increased quality of life by 10%	-Diabetes Quality of Life survey	-Patients complete the survey and respond to follow-ups -Patients with T2D are able to continue to receive healthcare services at Clinica Especializada en Diabetes
Outcome: Diabetes self-management at Clinica Especializada en Diabetes is utilized.	-40% of patients with T2D at Clinica Especializada en Diabetes decrease their HbA1c levels by 20% by the end of the first two years of program implementation	-Patient health records from Clinica Especializada en Diabetes	- Clinica Especializada en Diabetes has patient health records
Outputs: 1. Culturally sensitive healthcare provider DSMES training programs at Clinica Especializada en Diabetes is created. 2. Culturally sensitive patient DSMES training program at Clinica Especializada en Diabetes is created. 3. Culturally sensitive DSMES mobile app for Clinica Especializada en Diabetes is created.	1.1. 20 healthcare providers at Clinica Especializada en Diabetes complete DSMES training within the first 19 months of program implementation 1.2. 100% of training team members contribute to creation of healthcare provider DSMES curriculum chapter 2.1. 100% of training team members contribute to creation of patient DSMES curriculum chapters 2.2. 20% of patients with type 2 diabetes decrease their HbA1c levels by 20% by the end of the first year 3.1. 15 app developers from Interexy will adapt the created curriculums for patients with type 2 diabetes and healthcare providers at Clinica Especializada en Diabetes within 3 years 3.2. 30% of patients with type 2 diabetes register through DSMES Clinica Especializada en Diabetes mobile app within the first year after the application is launched	1.1.1. Training team weekly meetings sign-in sheet 2.1.1. Training team weekly chapter meetings' notes 2.2.1. Patient health records from Clinica Especializada en Diabetes 3.1.1. Training team weekly chapter meetings' notes 3.2.1. App analytic reports	- Healthcare providers attend weekly trainings - Patients utilize DSMES curriculum - Clinica Especializada en Diabetes has patient health records
Activities: 1.1. Recruit healthcare providers at Clinica Especializada en Diabetes 1.2. Conduct discussion groups to understand gaps in education content within the first 6 months 1.3. Create healthcare provider DSMES curriculum 1.4. Utilize healthcare provider DSMES curriculum	1.1.1. 20 interdisciplinary healthcare providers are recruited to training team within the first two months 1.2.1. 100% of training team will participate in discussion groups with 40 patients within 1 month 1.2.2. 100% of training team and 10 patients with type 2 diabetes contribute to education content gap analysis 1.3.1. 100% of training team creates healthcare provider DSMES curriculum with 7 chapters within 8 months 1.3.2. 100% of training team conduct healthcare provider DSMES trainings within 8 months	1.1.1. Recruited training team members volunteer sign-in sheet 1.2.1. Content gap analysis report 1.3.1 DSMES curriculum chapters undergo weekly review 1.3.2. Weekly training sign-in forms 2.3.1. Patient agreement form	- Healthcare providers participate in program - Healthcare providers adopt the Association of Diabetes Care and Education Specialists' standards - Interexy firm agrees to participate in app development

<p>2.1. Create patient-centered DSMES curriculum</p> <p>2.2. Create clinical nutritionist raffle</p> <p>2.3. Recruit patients with type 2 diabetes at Clinica Especializada en Diabetes</p> <p>2.4. Educate patients with type 2 diabetes in DSMES</p> <p>3.1. Create Clinica Especializada en Diabetes culturally adapted DSMES web-based mobile app</p> <p>3.2. Train healthcare providers at Clinica Especializada en Diabetes how to use mobile app</p> <p>3.3. Train patients with type 2 diabetes at Clinica Especializada en Diabetes how to use mobile app</p>	<p>2.1.1. 100% of training team and 10 patients with type 2 diabetes create patient DSMES curriculum with 7 chapters within 8 months</p> <p>2.2.1. 1 clinical nutritionist will create a raffle in which program participants could receive free 6 months of counseling</p> <p>2.3.1. 75 patients with type 2 diabetes at Clinica Especializada en Diabetes will be recruited within the first 2 months of the patient program.</p> <p>2.4.1. 18 DSMES trained healthcare providers will train 75 patients with type 2 diabetes in DSMES within the first year of patient program</p> <p>3.1.1. 15 app developers from Interexy are hired to adapt the health provider and patient curriculums within the first 3 months</p> <p>3.1.2. 15 app developers and 10 healthcare providers participate in the mobile app adaptation of the healthcare provider curriculum within the first two years</p> <p>3.1.3. 8 DSMES trained healthcare providers and 5 patients participate in the mobile app adaptation of the patient curriculum within the first 3 years</p> <p>3.2.1. 15 app developers will train 18 DSMES trained healthcare providers in app usage within the first 2 years</p> <p>3.3.1. 18 DSMES trained healthcare providers will train 60 patients with type 2 diabetes in app usage within the first 3 years</p>	<p>2.4.1. Patient quality survey</p> <p>3.1.1. Contract Agreement</p> <p>3.1.2. Weekly app adaptation sign-in forms</p> <p>3.1.3. Weekly app adaptation sign-in forms</p> <p>3.2.1. Weekly app adaptation sign-in forms</p> <p>2.4.1. Patient quality survey</p>	
---	--	--	--

2.6.2 Program Design

The project *Sí Se Puede Con Diabetes Aplicación Móvil* will produce three outputs with several corresponding activities. The first output is training healthcare providers at *Clinica Especializada en Diabetes* in culturally sensitive DSMES. The second output is training patients with T2D at *Clinica Especializada en Diabetes* in culturally sensitive DSMES. The third output is creating a mobile culturally sensitive DSMES application accessible to patients and healthcare providers at *Clinica Especializada en Diabetes*. The project team will recruit 20 interdisciplinary healthcare providers at *Clinica Especializada en Diabetes* to be members of the program team within the first two months. These healthcare providers will oversee and produce the three outputs. The first output proposes modeling current healthcare provider diabetes self-management trainings on the Association of Diabetes Care and Education Specialists' (ADCES) standards. The team of healthcare providers will conduct weekly discussion groups with patients with T2D who currently receive care at *Clinica Especializada en Diabetes* within three months. The goal of these discussion groups is to understand existing diabetes self-management education resources and tools and assess patients' wants and needs through direct participant feedback.

A diabetes self-management education content gap analysis will provide the framework for improving both the clinic's healthcare provider and patient culturally sensitive DSMES curricula. The healthcare curriculum must address the six domains of competencies for diabetes care and educational specialists: clinical management resources, health equity, cultural competency, health literacy, disaster preparedness, and tips for education conversations. Healthcare providers on the team will work in groups of three for nine months to

develop the healthcare provider curriculum. After the chapters are finalized, the healthcare providers will train 10 additional healthcare providers at Clinica Especializada en Diabetes using the culturally sensitive healthcare provider DSMES curriculum and supplemental trainings per ADCES recommendations for eight months.

The second output involves creating a culturally sensitive patient DSMES training program at Clinica Especializada en Diabetes. The team of healthcare providers will conduct weekly discussion groups with patients with T2D who currently receive care at Clinica Especializada en Diabetes within three months. The patient DSMES curriculum will include key self-management topics to ensure successful and effective diabetes self-management. Topics will include healthy eating, being active, monitoring HbA1c levels, taking medications, problem solving, healthy coping, and reducing risks as per the ADCES' recommendations.⁵¹ The patient curriculum will explain changes in blood glucose numbers. For example, one module will discuss how eating a meal high in carbohydrates can cause blood glucose levels to spike. Several articles will explore how to manage and avoid those rapid increases. In addition, the patient curriculum will include culturally appropriate references that incorporate photos of local community members, culturally relevant and available food preferences and references, and emphasize engagement of participants' collectivistic family dynamics as a means of self-management.

The third output involves adapting the culturally sensitive healthcare provider and patient DSMES curricula to the *Sí Se Puede Con Diabetes Aplicación Móvil*. This application will be available to patients and healthcare providers at Clinica Especializada en Diabetes. The team of clinic healthcare providers will work in tandem with five developers from Interexy, an app development firm. The app developers will adapt materials from the first two outputs to create a user-friendly diabetes self-management mobile app. App developers will work alongside the team

of healthcare providers and patients to ensure that the mobile application is feasible and efficient. The mobile app interface will allow users to register as healthcare providers or patients and caregivers with their Patient ID. The duality of the interface will allow for personalized content pertaining to both patients/caregivers and healthcare providers. The mobile app will be available through the Google Play Store for Android users and Apple Store for iOS users. The *Sí Se Puede Con Diabetes Aplicación Móvil* application will be available only on mobile phones.

Adaptation of the healthcare provider and patient curricula will occur over the course of one year. The process will include registering and creating the mobile app in the Google Play Store and the App Store. The mobile app will include the aforementioned topics as well as a cookbook that includes all information pertaining to nutrition and recipes. Nutrition content will discuss how users can make diabetes-friendly options in restaurants, make healthy food choices while traveling, and provide information about how alcohol and carbohydrates affect blood sugar levels. Recipes will highlight healthier and more nutritiously dense versions of traditional meals such as carnitas huevos rancheros, mole poblano chilaquiles and chicken tamales. Healthier substitutions will incorporate lower carbohydrate and lower sodium options. Following this adaptation, the app developers will train healthcare providers and patients with T2D for two years on how to use the app.

2.6.2.1 Logic Model

Logic models, similar to logframes, are effective tools to assist in a project cycle. The logic model highlights the relationship among resources, activities and the sequence of intended outcomes. Logic models differ from logframes in that they are a visual representation of the project cycle road map.⁵² Furthermore, logic models illustrate the desired program outcomes in the short,

middle- and long-term, as depicted in Figure 2. The measurable outcomes of this project span from the first two months of program implementation to three years following implementation.

Figure 2. Logic Model

Inputs	Outputs		Outcomes		
	Activities	Participants	Short	Medium	Long
<p>Health care providers at Clinica Especializada en Diabetes</p> <p>ADCES curriculum</p> <p>Impact evaluation team</p>	<p>Recruit interdisciplinary health care providers and patients with T2D to participate as training team members</p> <p>The training team participate in focus groups to contribute to the educational content gap analysis</p> <p>The training team creates the culturally sensitive health care provider DSMES curriculum</p> <p>Health care providers conduct DSMES trainings</p> <p>The training team creates the culturally sensitive patient DSMES curriculum</p> <p>The clinical nutritionist will create a raffle for 6 months of free counseling</p> <p>Recruit patients with T2D to participate in program</p> <p>DSMES trained health care providers train patients with T2D in DSMES</p> <p>Hire app developers</p> <p>Adapt culturally sensitive health care provider and patient DSMES curriculums to mobile application format</p> <p>Educate health care providers in app use</p> <p>Health care providers train patients in app use</p>	<p>Patients with type 2 diabetes at Clinica Especializada en Diabetes</p> <p>Health care providers at Clinica Especializada en Diabetes</p> <p>Clinical nutritionist</p>	<p>20 interdisciplinary health care providers are recruited to training team within the first two months</p> <p>100% of training team will participate in focus groups with 40 patients within 1 month</p> <p>100% of training team and 40 patients with type 2 diabetes contribute to education content gap analysis within the first six months</p> <p>100% of training team creates health care provider DSMES curriculum with 7 chapters within 8 months</p> <p>100% of training team conduct healthcare provider DSMES trainings within 8 months</p> <p>15 app developers from Interexy are hired to adapt the health provider and patient curriculums within the first 3 months</p>	<p>100% of training team and 10 patients with type 2 diabetes create patient DSMES curriculum with 7 chapters within the first year</p> <p>1 clinical nutritionist will create a raffle in which program participants could receive free 6 months of counseling within the first year</p> <p>75 patients with type 2 diabetes at Clinica Especializada en Diabetes will be recruited within the first year</p> <p>18 DSMES trained health care providers will train 75 patients with type 2 diabetes in DSMES within the first year</p>	<p>10 health care providers participate in the mobile app adaptation of the health care provider curriculum within the first two years</p> <p>8 DSMES trained health care providers and 5 patients participate in the mobile app adaptation of the patient curriculum within the first 3 years</p> <p>15 app developers will train 18 DSMES trained health care providers in app usage within the first 2 years</p> <p>18 DSMES trained health care providers will train 60 patients with type 2 diabetes in app usage within 3 years</p>

2.7 Program Implementation

Patients with T2D will be recruited with flyers to participate in the program in the clinic's waiting room and in monthly health visits. Prior to participating in the program, patients with T2D will be required to complete the Diabetes Quality of Life survey. In addition, DSMES trained healthcare providers will conduct rapid HbA1c tests to assess the HbA1c levels of patients with T2D. In order to participate in the program, patients with T2D must have a HbA1c level of 6.5% or higher. Participants will be asked to self-report all medications they are currently taking at every visit to control for the use of medications that lowers blood glucose.

Patients will receive the patient DSMES curriculum, DSMES training and an informational pamphlet on the mobile app from a DSMES trained healthcare provider. Patients with T2D will return to Clinica Especializada en Diabetes every three months for their routine HbA1c level test. During visits, DSMES trained healthcare providers will train patients on the culturally sensitive DSMES curriculum and provide additional information on the mobile app. In addition, trained DSMES healthcare providers will distribute the Diabetes Quality of Life survey and collect patients' responses. Data collection will continue every three months following the start of the program. In order to reduce loss to follow-up, for every appointment for which patients keep they will be entered into a raffle to win six months of free counseling with the clinical nutritionist.

2.7.1 Program's Diabetes Quality of Life Survey

The program's Diabetes Quality of Survey will consist of the Appraisal of Diabetes Scale and the Short Form-12. The Appraisal of Diabetes Scale is a short and relatively straightforward

survey that frequently used in clinical practice. The Appraisal of Diabetes Scale is used to evaluate an individual's thoughts and coping mechanisms with diabetes, as depicted in Figure 3. The survey consists of seven items and uses a 5-point adjectival scale. Scores that sum to zero represents those least affected by diabetes. Conversely, scores that sum to 35 represent those affected the most by diabetes.⁵³ Furthermore, the survey is strongly associated with measures of psychological adjustment and stress. In addition, it is moderately associated with health beliefs about the perceived severity of diabetes and its complications.⁵⁴

Figure 3. Appraisal of Diabetes Scale

Appraisal of Diabetes Scale				
1. How upsetting is having diabetes for you?				
1	2	3	4	5
None at all	Slight Amount	Moderate Amount	Large Amount	Total Amount
2. How much control over your diabetes do you have?				
1	2	3	4	5
None at all	Slight Amount	Moderate Amount	Large Amount	Total Amount
3. How much uncertainty do you currently experience in your life as a result of being diabetic?				
1	2	3	4	5
None at all	Slight Amount	Moderate Amount	Large Amount	Total Amount
4. How likely is your diabetes to worsen over the next several years?				
1	2	3	4	5
None at all	Slight Amount	Moderate Amount	Large Amount	Total Amount
5. Do you believe that achieving good diabetic control is due to your efforts as compared to factors which are beyond your control?				
1	2	3	4	5
None at all	Slight Amount	Moderate Amount	Large Amount	Total Amount
6. How effective are you in coping with your diabetes?				
1	2	3	4	5
None at all	Slight Amount	Moderate Amount	Large Amount	Total Amount
7. To what degree does your diabetes get in the way of your developing life goals?				
1	2	3	4	5
None at all	Slight Amount	Moderate Amount	Large Amount	Total Amount

The Short Form-12 is one of two validated generic quality of life instruments that assess a variety of general health status measures. The other instrument is the Short Form-36. The Short Form-12 is closely correlated with the Short Form-36, but is significantly shorter, as depicted in Figure 4. As a result, the Short Form-12 is preferred in clinical routines.⁵⁵ The Short Form-12 survey addresses six health domains that measure quality of life: physical function, symptoms, global judgement, psychological well-being and role activities. The Short Form-12 evaluates

overall health and comorbidities of an individual. The Short Form-12 and Appraisal Diabetes Scale are typically used together to assess diabetes-related quality of life. These instruments are critical for a complete assessment and are the most feasible for a clinic setting.⁵⁰

Figure 4. Short Form-12 Health Survey

Short Form-12 Health Survey						
1. In general, would you say your health is:						
Excellent	Very good	Good	Fair	Poor		
The following questions are about activities you might do during a typical day. Does <u>your health now limit</u> you in these activities? If so, how much?						
	YES, limited a lot	YES, limited a little	NO, not limited at all			
2. Moderate activities such as moving a table, pushing a vacuum cleaner, bowling, or playing golf.						
3. Climbing several flights of stairs.						
During the <u>past 4 weeks</u> , have you had any of the following problems with your work or other regular daily activities <u>as a result of your physical health</u> ?						
		YES	NO			
4. Accomplished less than you would like.						
5. Were limited in the kind of work or other activities.						
During the <u>past 4 weeks</u> , have you had any of the following problems with your work or other regular daily activities <u>as a result of any emotional problems</u> (such as feeling depressed or anxious?)						
		YES	NO			
6. Accomplished less than you would like.						
7. Did work or activities less carefully than usual.						
8. During the <u>past 4 weeks</u> , how much <u>did pain interfere</u> with your normal work (including work outside the home and housework)?						
Not at all	A little bit	Moderately	Quite a bit	Extremely		
These questions are about how you have been feeling during the <u>past 4 weeks</u> . For each question, please give the one answer that comes closest to the way you have been feeling. How much during the <u>past 4 weeks</u> ...						
	All of the time	Most of the time	A good bit of the time	Some of the time	A little of the time	None of the time
9. Have you felt calm & peaceful?						
10. Did you have a lot of energy?						
11. Have you felt down-hearted and blue?						
12. During the past 4 weeks, how much of the time has your physical health or emotional problems interfered with your social activities (like visiting friends, relatives, etc.)?						
All of the time	Most of the time	A good bit of the time	Some of the time	A little of the time	None of the time	

2.8 Assumptions, Timeline, Challenges and Sustainability

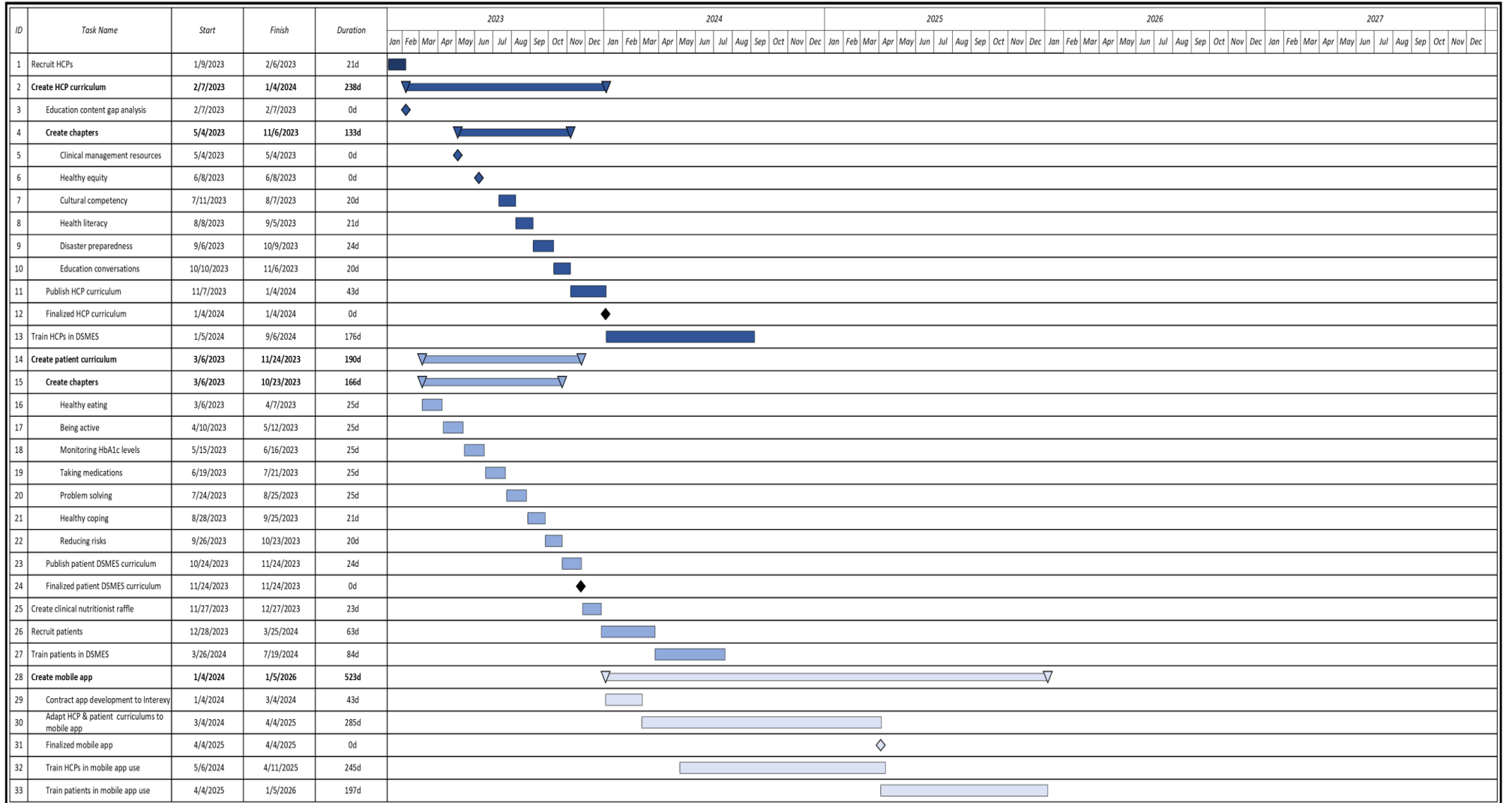
This project assumes that patients will complete the Diabetes Quality of Life survey prior to starting the program and at monthly follow-up appointments. Patients must be able to continue to receive healthcare services at Clinica Especializada en Diabetes. Patients must maintain insurance coverage through the clinic or must be able to afford healthcare services at Clinica Especializada en Diabetes. This project assumes that the clinic will continue to provide patient health records and information, particularly HbA1c levels. In addition, this project assumes that patients with T2D will download the mobile app.

This project is designed as a pilot program that can be replicated in diabetes specialty clinics. If this program is successful, it can be adopted in cities and countries with a high prevalence of T2D. This project incorporates feedback and flexibility in order to create a replicable model in non-specialty and specialty clinics.

This project is budgeted for two years. The first month will require recruiting healthcare providers. After healthcare providers have been recruited, the team will create the healthcare provider curriculum for 11 months. Healthcare providers will then be trained using the curriculum for nine months. The team will develop the patient curriculum for nine months. After the patient curriculum is created, the clinical nutritionist will create the raffle. This is to be completed within one month. Patients will then be recruited for four months. Following recruitment, patients will be trained in DSMES for five months. After both curricula are finalized, developers will spend 23 months creating the mobile app. During these 23 months, healthcare providers and patients will receive training on how to use the application's features. If the project demonstrates that HbA1c levels have decreased, the DSMES Training Team can take on new members for training. See Figure 2 for detailed timeline of deliverables and outputs.

One of the main limitations is engaging with participants to promote and advocate for health behavior change. In most studies, individuals have to be self-motivated to change their lifestyle behaviors. It is critical that this program works with local resources, such as community centers, schools, libraries, food services, local food and supply vendors, transportation services and outreach programs. These resources will be highlighted in the culturally sensitive DSMES patient curriculum . Another limitation is losing participants to follow-up. If patients choose to not return to Clinica Especializada en Diabetes for HbA1c levels the study must note this loss. If a large portion of participants are lost to follow-up the statistical inference of the effectiveness of the culturally adapted intervention program will be weak. Patients may not be able to return to the clinic every three months due to numerous external factors, including employment status, health insurance status, accessibility to the clinic, and COVID-19 regulations. Due to the unpredictable nature of the COVID-19 pandemic, there is concern regarding reaching participants if in-person activities are not recommended. In the future, it will be critical to adopt the intervention program model to a virtual environment, including telehealth.

Figure 5. Gantt Chart



2.8.1 Project Budget

This project will cost approximately \$539,000 USD or \$11,000,000 Mexican Dollars. The current Mexican Dollar exchange is 1 Mex\$ = 0.05 USD. The majority of the budget is dedicated to the third output, the mobile app. The mobile app adaptation accounts for approximately 30 percent of the total budget. Refer to Table 2 for detailed breakdown of billable resources and services.

Table 2 Program Budget

Project Outputs	Activities	Inputs	Cost	Budget
Output 1: Train healthcare providers in DSMES	1.1. Recruit healthcare providers	1.1.1. Costs associated with staff time	Covered by Clinica Especializada en Diabetes	N/A
	1.2. Discussion groups	1.2.1. Space to hold meetings	Provided by Clinica Especializada en Diabetes	N/A
	1.3. Create healthcare provider DSMES curriculum	1.3.1. Access to ADCES curriculum	\$165/year X 20 access codes	\$16,500
		1.3.2. Graphic designer	\$400/week X 12 weeks	\$4,800
	1.3.3. Published curriculum	\$750 X 50 copies	\$37,500	
	1.4. Train healthcare providers in DSMES	1.4.1. Weekly training sessions	Covered by Clinica Especializada en Diabetes	N/A
Output 2: Train patients in DSMES	2.1. Create patient DSMES curriculum	2.1.1. ADCES curriculum 2.1.2. Published curriculum	See 1.3.1. \$1,000 X 125 copies	N/A \$125,000
	2.2. Create clinical nutritionist raffle	2.2.1. Costs associated with staff time 2.2.2. Patient training sessions	Covered by Clinica Especializada en Diabetes	N/A
	2.3. Train patients in DSMES	2.3.1. Costs associated with staff time	Covered by Clinica Especializada en Diabetes	N/A
	2.4. Impact Evaluation	2.4.1. Costs associated with staff time	\$40,000 X 2	\$80,000
2.4.2. ADCES curriculum		See 1.3.1	N/A	
2.4.3. Published patient curriculum		\$1,000 X 125 copies	\$125,000	
2.4.4. Cost associated with clinical nutritionist		Covered by Clinica Especializada en Diabetes	N/A	
Output 3: Create mobile app	3.1. Hire app developers	3.1.1. Costs associated with app developers	(\$100/hours X 300 hours) X 5 app developers	\$150,000
		3.1.2. Cost associated with Apple App Developer Program	\$99/year X5 years	\$495
		3.1.3. Cost associated with Google Play Developer Console	\$25	\$25
	3.2. Train healthcare providers in application use	3.2.1. Weekly training sessions	Covered by Clinica Especializada en Diabetes	N/A
	3.3. Train patients in application use	3.3.1. Costs associated with staff time	Covered by Clinica Especializada en Diabetes	N/A
			Total	\$538,800

3.0 Evaluating Si Se Puede Con Diabetes Aplicación Móvil

3.1 Program Evaluation

As previously discussed, healthcare providers will measure patients' HbA1c levels and collect patients' responses to the Diabetes Quality of Life survey at every follow-up appointment. Healthcare providers will be able to track and observe trends in HbA1c to best understand the effectiveness of the curricula and app. Confidentiality is critical for complying with health data and information restrictions. The collected data will be stripped of identifying factors before conducting an analysis. If patients do not return for the monthly follow-up appointments, they will be unenrolled from the study. For means of consistency, health providers will measure HbA1c levels. The team plans to compare include age, gender, potential comorbidities, and weight. This will include cross tabulating these variables to find relationships and establish patterns.

The responses from the Diabetes Quality of Life survey will allow the team to gain insight on participants' self-reported perspectives on how these two different self-management programs impact their daily lives. As previously stated, confidentiality is critical for complying with health data and information restrictions. Responses from the survey will be sorted based on the similarity in responses. Responses will be represented in multi-level of similar perceptions and perspectives.

Since the mobile app will be available in the Google Play Store and the App Store, the team will have access to several data analytic metrics. The data are automatically matriculated once individuals download the application. The Google Play Store and the App Store can pull metrics on the number of application installs and uninstalls on devices and how long users are engaged with content. In addition, these analytics can be further filtered to regional installs. This

will allow team members to analyze patterns in region-specific downloads. This will be helpful to understand how many patients and healthcare providers download and engage with content. These data are accessible to anyone on the team once the mobile app is registered through the two respective application stores. The success of and engagement with the app will be measured by the number of installs, time spent on the application, number of uninstalls and reduced HbA1c levels. This evaluation will aid in promoting and implementing policies for cultural DSMES resources and services within the Ministry of Health.

3.2 Impact Evaluation

3.2.1 Impact Evaluation Question

The impact evaluation will answer the question, “How much of the culturally sensitive DSMES mobile app is responsible for reduced HbA1c levels of patients with T2D at Clinica Especializada en Diabetes in Mexico City, Mexico?” Answering this question is critical for understanding the impact of the mobile app training portion of the program. If this component is found to significantly decrease HbA1c levels, future funding, resources, and technologies will promote self-management through mobile, hand-held, and user-friendly applications. The hypothesis for this impact evaluation is that increased access to culturally sensitive DSMES trainings will lead patients with T2D to utilize culturally sensitive mobile resources and services.

3.2.2 Impact Evaluation Design

This impact evaluation will be carried out in the first two years following implementation of the program. Within the first month of the impact evaluation, the evaluation team will recruit 100 adult patients with T2D in Clinica Especializada en Diabetes' waiting room and in monthly health visits.

After one month of recruitment, DSMES trained healthcare providers will conduct rapid HbA1c tests to record patients' baseline HbA1c levels. In order to participate in the program, patients with T2D must have a HbA1c level of 6.5% or higher. In addition, participants will be asked to self-report all medications they are currently taking at every visit to control for the use of medications that lowers blood glucose.

After baseline HbA1c levels are recorded, each participant will be assigned a random number via a random number generator. The evaluation team will then randomly split the recruited individuals into two groups. The first 50 randomly drawn numbers will be participants in the comparison group. The second 50 randomly drawn numbers will be participants in the treatment group.

Participants in the treatment group will receive the patient DSMES curriculum and DSMES training from a DSMES trained healthcare provider. Participants in the treatment group will return to Clinica Especializada en Diabetes every three months for their routine HbA1c level test. During visits, DSMES trained healthcare providers will train patients on the DSMES curriculum and locally available resources. Conversely, participants in the comparison group will receive only the patient DSMES curriculum and no additional DSMES training from DSMES trained healthcare providers. Data collection will occur every three months following the start of the intervention for one year. In order to reduce loss to follow-up, every time a patient returns to the clinic for an

appointment they will be entered into a raffle to win six months of free counseling with the clinical nutritionist.

3.2.3 Impact Evaluation Method

Random assignment of patients with T2D will allow the evaluation team to determine if there are systematic differences in HbA1c levels between the treatment and comparison group of patients with T2D at Clinica Especializada en Diabetes. The evaluation team will have access to data to statistically analyze the effectiveness of the culturally sensitive DSMES curriculums. In addition, this allows for a strong comparison group as participants will be recruited from the same clinic, possess similar characteristics, and have access to similar resources and services.

This impact evaluation has several strengths due to random assignment. This design is critical for ensuring internal validity. This includes controlling for possible confounds of participants in this pilot program. Furthermore, this study design reduces selection bias. In addition, this study design ensures external validity as it best represents the eligible population of patients with T2D receiving care at Clinica Especializada en Diabetes in the Iztapalapa District. One weakness is that the sample size is not significantly large. Another issue is ethical concerns with regards to only one group receiving additional trainings from DSMES trained healthcare providers.

3.2.4 Triangulation

The evaluation team will triangulate results using qualitative support for the quantitative findings. The team will collect data from the Diabetes Quality of Life Survey from patients with

T2D at Clinica Especializada en Diabetes. In addition, patients with T2D may seek out additional care at local hospitals in the case of an emergency or outside clinic hours. The evaluators will design a survey to determine if patients with T2D are utilizing alternative and additional DSMES care. In addition, the evaluation team will collect data regarding obesity levels, heart disease levels, kidney failure levels, and levels of retinopathy of patients with T2D at Clinica Especializada en Diabetes. Since patients are already patients at the clinic, this information will already be accessible to healthcare providers via patients' health records.

3.2.5 Challenges

The impact evaluation will account for approximately for 30 percent of the total project budget, about \$250,000. In order to address the concern that the evaluation will cost one third of the entire project budget, it is critical to emphasize the importance of understanding the effectiveness of this project and its potential generalizability for other communities.

Another challenge might arise with regards to the extensive coordination required between DSMES trained healthcare providers in the project and impact evaluation. If this becomes a critical challenge, the project may need to increase the number of DSMES trained healthcare providers to ensure the delivery of comprehensive care.

3.2.6 Generalizability

The intention of the project is to replicate culturally sensitive DSMES mobile apps that provide interactive and user friendly supplemental self-management content at all clinics in Mexico City. Results from this project will be beneficial for communities with high prevalence of

T2D. DSMES services and resources are dependent on healthcare delivery system's protocols. There is no universal understanding of culturally appropriate DSMES training program for healthcare providers or patients. If culturally sensitive DSMES mobile apps for healthcare providers and patients result in improved quality of life and reduced HbA1c levels of patients with T2D, it is possible and encouraged for healthcare providers and systems to adopt similar curricula. In addition, it is essential to understand which component of this program is responsible for reducing patients' HbA1c levels. This can be critical for governments and organizations aiming to reduce overall healthcare costs.

4.0 Conclusion

Diabetes is one of the highest global leading causes of mortality. It is a costly chronic health condition that can lead to damage of the circulatory, nervous, and immune systems. T2D is the most common type of diabetes, and develops as a result of chronic high blood glucose levels. There is no cure for T2D. Individuals diagnosed with T2D are encouraged to eat healthy, be physically active, and lose extra weight in order to reduce long-term harmful consequences. These lifestyle modifications can also reduce the risk of developing T2D. There are several forms of management for T2D. Regardless if an individual is prescribed medication for treatment, they must practice self-management. Inadequate self-management and glycemic control is highly related to the limited knowledge and understanding of self-management and poor health literacy.

DSMES is a cost-effective tool and resource to promote healthy behaviors and outcomes for people with diabetes. Furthermore, new technologies can play an important role in improving the quality of life of individuals affected by T2D. The *Sí Se Puede Con Diabetes* Aplicación Móvil pilot program at Clinica Especializada en Diabetes aims to engage with healthcare providers and patients with T2D to increase the quality and accessibility to culturally sensitive DSMES materials and services. DSMES is a patient-centered and holistic approach to managing diabetes. It is critical for addressing all aspects of an individual's life, including, lifestyle, medication, blood glucose monitoring, nutrition, and behavioral and emotional support. The culturally sensitive component is critical for ensuring healthcare providers and patients receive information and have access to locally and culturally appropriate resources. If this program demonstrates success in improving the quality of life of patients with T2D, then it would be critical to adopt similar programs in clinics and diabetes education facilities in the region. Overall, if these types of programs demonstrate

regional success, it would be imperative that the Mexican Ministry of Health nationally recognize the importance of these technological interventions and implement a national-level program.

As with every project, this proposal has its limitations. A major limitation is that this program has not actually been done. Another limitation is losing patients to follow-up. If patients do not return to the clinic following their initial HbA1c reading, Diabetes Quality of Life Survey, and mobile app discussion, the team has to unenroll the patient. This would reduce the sample size of the program. Another limitation is bias that may be introduced in patients' self-reported Diabetes Quality of Life Survey. Participants may report improved quality of life to demonstrate they are practicing healthy behaviors.

Diabetes is often referred to as a lifestyle disease. Many individuals feel that once they are diagnosed with this disease, their life will never return to what it was. A life with a T2D diagnosis is often thought to be followed with a life of constant medication, doctor appointments, and decreased quality of life. However, this diagnosis does not have to drastically change the lives of patients and caregivers. Patients with T2D deserve a quality of life superior to what they have now. *Sí Se Puede Con Diabetes Aplicación Móvil* can help ensure that individuals affected by T2D can live their "normal life" and manage their lifestyle with T2D.

Bibliography

- ¹ Khan MA, Hashim MJ, King J, Govender RD, Mustafa H, Al Kaabi J. Epidemiology of Type 2 Diabetes – Global Burden of Disease and Forecasted Trends. *Journal of Epidemiology and Global Health*. 2020;10(1). doi:10.2991/jegh.k.191028.001
- ² What is Diabetes. International Diabetes Federation. Published March 26, 2020. Accessed January 12, 2022. <https://idf.org/aboutdiabetes/what-is-diabetes.html>
- ³ World Health Organization. Diabetes. World Health Organization. Published November 10, 2021. Accessed October 1, 2021. <https://www.who.int/news-room/fact-sheets/detail/diabetes>
- ⁴ Diabetes - PAHO/WHO | Pan American Health Organization. Pan American Health Organization. Accessed October 1, 2021. <https://www.paho.org/en/topics/diabetes>
- ⁵ Diet, Nutrition and the Prevention of Chronic Diseases. World Health Organization. Published 2003. Accessed October 1, 2021. <https://pubmed.ncbi.nlm.nih.gov/12768890/>
- ⁶ Osborn, C.Y. and Fisher, J.D. (2008) Diabetes Education: Integrating Theory, Cultural Considerations, and Individually Tailored Content. *Clinical Diabetes*, 26, 148-150. <http://dx.doi.org/10.2337/diaclin.26.4.148>
- ⁷ Standard 6 – Curriculum. Centers for Disease Control and Prevention. Published December 20, 2019. Accessed October 1, 2021. <https://www.cdc.gov/diabetes/dsmes-toolkit/standards/standard6.html>
- ⁸ IDF Diabetes Atlas, 6th edn. International Diabetes Federation 2013. Accessed March 8, 2022. <https://www.diabetesatlas.org>.
- ⁹ International Diabetes Federation. The global picture. In: International Diabetes Federation, editor. *International Diabetes Federation. Diabetes Atlas*. 7th ed. Brussels, Belgium: International Diabetes Federation; 2015: 47-66
- ¹⁰ Seuring T, Archangelidi O, Suhrcke M. The Economic Costs of Type 2 Diabetes: A Global Systematic Review. *Pharmacoeconomics*. 2015;33(8):811-831. doi:10.1007/s40273-015-0268-9
- ¹¹ The Social-Ecological Model: A Framework for Prevention. Centers for Disease Control and Prevention. Published 2021. Accessed March 12, 2022. <https://www.cdc.gov/violenceprevention/about/social-ecologicalmodel.html>

- ¹² Hill JO, Galloway JM, Goley A, et al. Scientific statement: Socioecological determinants of prediabetes and type 2 diabetes. *Diabetes Care*. 2013;36(8):2430-2439. doi:10.2337/dc13-1161.
- ¹³ Dean L, McEntyre J. Genetic Factors in Type 1 Diabetes. National Institutes of Health. Published July 7, 2004. Accessed December 9, 2021. <https://www.ncbi.nlm.nih.gov/books/NBK1662/>
- ¹⁴ Luo W, Zhang L, Sheng L, Zhang Z, Yang Z. Increased levels of YKL-40 in patients with diabetes mellitus: a systematic review and meta-analysis. *Diabetol Metab Syndr*. 2021;13(1):6. Published 2021 Jan 15. doi:10.1186/s13098-021-00624-9
- ¹⁵ Hill-Briggs F, Adler NE, Berkowitz SA, et al. Social Determinants of Health and Diabetes: A Scientific Review [published online ahead of print, 2020 Nov 2]. *Diabetes Care*. 2020;44(1):258-279. doi:10.2337/dci20-0053
- ¹⁶ Gaskin DJ, Thorpe RJ Jr, McGinty EE, et al. Disparities in diabetes: the nexus of race, poverty, and place. *Am J Public Health*. 2014;104(11):2147-2155. doi:10.2105/AJPH.2013.301420
- ¹⁷ Varanka-Ruuska T, Rautio N, Lehtiniemi H, et al. The association of unemployment with glucose metabolism: a systematic review and meta-analysis. *Int J Public Health*. 2018;63(4):435-446. doi:10.1007/s00038-017-1040-z
- ¹⁸ Kivimäki M, Virtanen M, Kawachi I, et al. Long working hours, socioeconomic status, and the risk of incident type 2 diabetes: a meta-analysis of published and unpublished data from 222 120 individuals. *Lancet Diabetes Endocrinol*. 2015;3(1):27-34. doi:10.1016/S2213-8587(14)70178-0
- ¹⁹ Gallup-Sharecare. The Face of Diabetes in the United States, State of American Well-being, 2017. <https://wellbeingindex.sharecare.com/wp-content/uploads/2017/12/The-Face-of-Diabetes-in-the-United-States-2017.pdf>.
- ²⁰ Bilal U, Auchincloss AH, Diez-Roux AV. Neighborhood Environments and Diabetes Risk and Control. *Curr Diab Rep*. 2018;18(9):62. Published 2018 Jul 11. doi:10.1007/s11892-018-1032-2
- ²¹ Drewnowski A, Eichelsdoerfer P. Can Low-Income Americans Afford a Healthy Diet?. *Nutr Today*. 2010;44(6):246-249. doi:10.1097/NT.0b013e3181c29f79
- ²² Krämer U, Herder C, Sugiri D, et al. Traffic-related air pollution and incident type 2 diabetes: results from the SALIA cohort study. *Environ Health Perspect*. 2010;118(9):1273-1279. doi:10.1289/ehp.0901689
- ²³ Zhang X, Bullard KM, Gregg EW, et al. Access to health care and control of ABCs of diabetes. *Diabetes Care*. 2012;35(7):1566-1571. doi:10.2337/dc12-0081

- ²⁴ American Diabetes Association. Economic Costs of Diabetes in the U.S. in 2017. *Diabetes Care*. 2018;41(5):917-928. doi:10.2337/dci18-0007
- ²⁵ Kang H, Lobo JM, Kim S, Sohn MW. Cost-related medication non-adherence among U.S. adults with diabetes. *Diabetes Res Clin Pract*. 2018;143:24-33. doi:10.1016/j.diabres.2018.06.016
- ²⁶ Understanding A1C. American Diabetes Association. Accessed October 1, 2021. <https://www.diabetes.org/a1c>
- ²⁷ Diabetes - long-term Effects. Better Health Channel. Accessed October 1, 2021. <https://www.betterhealth.vic.gov.au/health/conditionsandtreatments/diabetes-long-term-effects>
- ²⁸ Risk Factors for Type 2 Diabetes. National Institute of Diabetes and Digestive and Kidney Diseases. Published March 6, 2019. Accessed October 1, 2021. <https://www.niddk.nih.gov/health-information/diabetes/overview/risk-factors-type-2-diabetes>
- ²⁹ Diagnosis. American Diabetes Association. Accessed March 8, 2022. <https://www.diabetes.org/diabetes/a1c/diagnosis>
- ³⁰ OECD (2017), *Health at a Glance 2017: OECD Indicators*, OECD Publishing, Paris, https://doi.org/10.1787/health_glance-2017-en.
- ³¹ American Diabetes Association. 7. Diabetes Technology: Standards of Medical Care in Diabetes-2019. *Diabetes Care*. 2019;42(Suppl 1):S71-S80. doi:10.2337/dc19-S007
- ³² Seiglie JA, Franco RR, Wirtz VJ, et al. Regional and state-level patterns of type 2 diabetes prevalence in Mexico over the last three decades. *Diabetes Res Clin Pract*. 2021;177:108927. doi:10.1016/j.diabres.2021.108927
- ³³ Barquera S, Tovar-Guzmán V, Campos-Nonato I, González-Villalpando C, Rivera-Dommarco J. Geography of diabetes mellitus mortality in Mexico: an epidemiologic transition analysis. *Arch Med Res*. 2003;34(5):407-414. doi:10.1016/S0188-4409(03)00075-4
- ³⁴ Powers MA, Bardsley J, Cypress M, et al. Diabetes Self-management Education and Support in Type 2 Diabetes: A Joint Position Statement of the American Diabetes Association, the American Association of Diabetes Educators, and the Academy of Nutrition and Dietetics. *Clin Diabetes*. 2016;34(2):70-80. doi:10.2337/diaclin.34.2.70
- ³⁵ Salinas, M. A. (2021). Cost of diabetes treatment in Mexico. *Mexican Journal of Medical Research ICSA*, 9(17), 16-21. <https://doi.org/10.29057/mjmr.v9i17.5593>
- ³⁶ Diabetes Control and Complications Trial Research Group, Nathan DM, Genuth S, et al. The effect of intensive treatment of diabetes on the development and progression of long-term complications in insulin-dependent diabetes mellitus. *N Engl J Med*. 1993;329(14):977-986. doi:10.1056/NEJM199309303291401

- ³⁷ DSMES Settings. Centers for Disease Control and Prevention. Accessed October 1, 2021. <https://www.cdc.gov/diabetes/dsmes-toolkit/staffing-delivery/dsmes-settings.html>
- ³⁸ The Growing Value of Digital Health. IQVIA. Published November 7, 2017. Accessed January 10, 2022. <https://www.iqvia.com/insights/the-iqvia-institute/reports/the-growing-value-of-digital-health>
- ³⁹ Ristau, RA, Yang, J, White, JR. Evaluation and evolution of diabetes mobile applications: key factors for health care professionals seeking to guide patients. *Diabetes Spectrum*. 2013;26(4):211-215. <https://doi.org/10.2337/diaspect.26.4.211>.
- ⁴⁰ Digital Health. World Health Organization. Accessed January 26, 2022. <https://www.who.int/health-topics/digital-health>
- ⁴¹ American Diabetes Association. 7. Diabetes Technology: Standards of Medical Care in Diabetes-2019. *Diabetes Care*. 2019;42(Suppl 1):S71-S80. doi:10.2337/dc19-S007
- ⁴² Farmer AJ, McSharry J, Rowbotham S, McGowan L, Ricci-Cabello I, French DP. Effects of interventions promoting monitoring of medication use and brief messaging on medication adherence for people with Type 2 diabetes: a systematic review of randomized trials. *Diabet Med*. 2016;33(5):565-579. doi:10.1111/dme.12987
- ⁴³ Waite M, Martin C, Franklin R, Duce D, Harrison R. Human Factors and Data Logging Processes With the Use of Advanced Technology for Adults With Type 1 Diabetes: Systematic Integrative Review. *JMIR Hum Factors*. 2018;5(1):e11. Published 2018 Mar 15. doi:10.2196/humanfactors.9049
- ⁴⁴ Hou C, Carter B, Hewitt J, Francisa T, Mayor S. Do Mobile Phone Applications Improve Glycemic Control (HbA1c) in the Self-management of Diabetes? A Systematic Review, Meta-analysis, and GRADE of 14 Randomized Trials. *Diabetes Care*. 2016;39(11):2089-2095. doi:10.2337/dc16-0346
- ⁴⁵ Bonoto BC, de Araújo VE, Godói IP, et al. Efficacy of Mobile Apps to Support the Care of Patients With Diabetes Mellitus: A Systematic Review and Meta-Analysis of Randomized Controlled Trials. *JMIR Mhealth Uhealth*. 2017;5(3):e4. Published 2017 Mar 1. doi:10.2196/mhealth.6309
- ⁴⁶ González-Villalpando C, Dávila-Cervantes CA, Zamora-Macorra M, Trejo-Valdivia B, González-Villalpando ME. Incidence of type 2 diabetes in Mexico: results of the Mexico City Diabetes Study after 18 years of follow-up. *Salud Publica Mex*. 2014;56(1):11-17. doi:10.21149/spm.v56i1.7318
- ⁴⁷ Barquera, S., Campos-Nonato, I., Aguilar-Salinas, C. et al. Diabetes in Mexico: cost and management of diabetes and its complications and challenges for health policy. *Global Health* 9, 3 (2013). <https://doi.org/10.1186/1744-8603-9-3>
- ⁴⁸ Whittemore R, Vilar-Compte M, De La Cerda S, et al. ¡Sí, Yo Puedo Vivir Sano con Diabetes! A Self-Management Randomized Controlled Pilot Trial for Low-Income Adults with

Type 2 Diabetes in Mexico City. *Curr Dev Nutr.* 2020;4(5):nzaa074. Published 2020 Apr 14.

- ⁴⁹ Se inauguró Centro Especializado en el Manejo de la Diabetes en Iztapalapa. Federación Mexicana de Diabetes. Published 2016. Accessed October 1, 2021. <https://fmdiabetes.org/se-inauguro-centro-especializado-manejo-la-diabetes-iztapalapa/>
- ⁵⁰ The World Bank. (2000). *The Logframe Handbook: A Logical Framework Approach to Project Cycle Management*. The World Bank. Retrieved March 11, 2022, from <https://documents.worldbank.org/en/publication/documents-reports/documentdetail/783001468134383368/the-logframe-handbook-a-logical-framework-approach-to-project-cycle-management>
- ⁵¹ ADCES7 Self-Care Behaviors - The Framework for Optimal Self-Management. Association of Diabetes Care & Education Specialists. Accessed October 15, 2021. <https://www.diabeteseducator.org/practice/practice-tools/app-resources/the-aade7-self-care-behaviors-the-framework-for-optimal-self-management>
- ⁵² Logic Model Tip Sheet. Department of Health & Human Services Accessed March 12, 2022. https://www.acf.hhs.gov/sites/default/files/documents/prep-logic-model-ts_0.pdf
- ⁵³ Nair R, Kachan P. Outcome tools for diabetes-specific quality of life: Study performed in a private family practice clinic. *Can Fam Physician.* 2017;63(6):e310-e315
- ⁵⁴ Carey MP, Jorgensen RS, Weinstock RS, et al. Reliability and validity of the appraisal of diabetes scale. *J Behav Med.* 1991;14(1):43-51. doi:10.1007/BF00844767
- ⁵⁵ Ware, J. E., Kosinski, M., Keller, S. D., QualityMetric Incorporated., & New England Medical Center Hospital. (2002). *SF-12: How to score the SF-12 physical and mental health summary scales*. Lincoln, R.I: QualityMetric Inc