The U.S.—Mexico Border
Diabetes Prevention and Control Project
Phase I

Prevalence study of type 2 Diabetes and its risk factors Technical Report

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The overall coordination of this technical report was the responsibility of Maria Teresa Cerqueira, M.S., Ph.D., and Rosalba Ruiz-Holguin, M.D., M.P.H., Pan American Health Organization/World Health Organization (PAHO/WHO) U.S.–Mexico Border Office, with technical advice and support from the contributing authors.

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The style editing, layout, and graphic design were coordinated by Lorely Ambriz, M.S.I.S, PAHO/WHO U.S.–Mexico Border Office Knowledge Management and Communication Advisor. Please send comments or any requests for information to the following e-mail address: email@fep.paho.org or visit us online at www.fep.paho.org.

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Prevalence study of type 2

Diabetes

and its risk factors

Technical Report

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US-Mexico Border Office Pan American Health Organization
5400 Suncrest Drive Suite C-4
El Paso, Texas 79912
Phone 915.845.5950. Fax 915.845 4361
www.fep.paho.org

Foreword

The history of public health along the United States of America (U.S.)–Mexico border is inscribed in a series of events and mechanisms of binational collaboration, in which the U.S.–Mexico Border Diabetes Prevention and Control Project is a key component.

The U.S.–Mexico Border Diabetes Prevention and Control Project is a good example of binational efforts and collaboration from both countries to determine the prevalence of diabetes, identify the risk factors, and develop a program for preventing and controlling it in response to the needs of the border population.

The U.S.–Mexico Border Diabetes Prevention and Control Project originated because of the high mortality and morbidity rates from type 2 diabetes along the border. It is known that diabetes causes terrible damage not only to those who have the disease but also to their relatives, communities, and health services. Efforts to prevent and control this chronic noncommunicable disease need to be intensified to avoid an increase in the number of people who live with this illness. Therefore, it is fundamental to raise awareness and to train those affected, their relatives, the community, and health professionals interested in diabetes as well as decision makers about diabetes and its repercussions.

We are proud to present this report on the prevalence of diabetes and associated risk factors, including methodology, results, and recommendations to guide people working in public health, practitioners, researchers, teachers, and everyone interested in the health of people living on the U.S.–Mexico border, to develop and implement their actions in the fight against diabetes.

Mirta Roses Periago, M.D.

Director,

Pan American Health Organization/World Health Organization (PAHO/WHO)

Preface

Type 2 diabetes is considered the tip of the iceberg of chronic diseases in the world and on the United States of America (U.S.)–Mexico border. A few years ago, professionals from public health institutions in the United States and in Mexico identified progressive increases in the number of diabetes cases in the border area. This attracted their attention and spurred them to work collaboratively to assess the extent of the problem and generate recommendations for its control and prevention.

This is a report of the results of the Diabetes Prevalence Study, Phase I, of the U.S.–Mexico Border Diabetes Prevention and Control Project, a unique study that considered the border area of the United States and Mexico as an epidemiologic unit. The study included a representative sample of the border population from both sides with the same methodology. It provided valuable information on the prevalence of diabetes, characteristics of those affected, and the risk factors.

Results of this study confirm the urgent need to strengthen binational and across-border efforts to control chronic noncommunicable diseases and their risk factors such as physical inactivity, unhealthy diet, smoking, alcohol consumption, and overweight and obesity. This project demonstrated the need for binational and multisectoral team work and collaboration to achieve a specific goal. This kind of positive experience could be replicated, mobilizing the community to obtain the resources and the political will to face and solve public health problems and needs along the U.S.–Mexico border.

On behalf of the Pan American Health Organization/World Health Organization, we wish to acknowledge the collaboration of personnel of the more than 130 institutions including the U.S. Centers for Disease Control and Prevention, the Mexico Secretariat of Health, the Paso del Norte Health Foundation, the California Endowment, the 10 border states' diabetes programs, and the nongovernmental organizations that participated in the study and made this publication possible. We hope the information presented in this report is useful for developing and implementing programs and activities to control and prevent diabetes and other chronic diseases as well as for generating policies and environmental changes to promote the health of the people on the border.

This study would have never been accomplished without the invaluable contribution of many institutions and participants, all of whom we gratefully thank and acknowledge.

Maria Teresa Cerqueira, M.S., Ph.D.

Chief, U.S.–Mexico Border Office

Pan American Health Organization/World Health Organization (PAHO/WHO)

EXECUTIVE SUMMARY

Executive Summary

The information in this report is intended for public health professionals and everyone interested and/or involved in planning and implementing activities to promote the health and well-being of the population on the United States of America (U.S.)–Mexico border.

This report summarizes the results of the first prevalence study of diabetes in the adult population on both sides of the U.S.–Mexico border. It provides evidence about the burden of the disease and its risk factors for public health interventions focused on preventing and controlling diabetes on the border. The study analyzed and compared specific binational characteristics, considering the border as one epidemiologic unit.

The border extends 1 952 miles from the Gulf of Mexico to the Pacific Ocean and extends 62.5 miles north and south of the international boundary in each direction as of the 1983 La Paz Agreement. The population of the border is in an epidemiologic transition stage in which morbidity and mortality resulting from infectious and chronic diseases coexist.

In the early 1990s, the high mortality rates due to type 2 diabetes among the Hispanic border population prompted researchers from the border and from the Division of Diabetes Translation of the U.S. Centers for Disease Control and Prevention to undertake a study to assess the extent of the problem in order to develop effective strategies to control it. With this purpose in mind, in 1998 the U.S.–Mexico Border Diabetes Prevention and Control Project collaborative workgroup was established, and a consensus was reached that identified the partners who would implement the project: the Pan American Health Organization/World Health Organization (PAHO/WHO); the United States–Mexico Border Health Association; the diabetes prevention and control programs of the health departments in the U.S. states of Arizona, California, New Mexico, and Texas; the diabetes programs of the Mexican states of Baja California, Sonora, Chihuahua, Coahuila, Nuevo Leon, and Tamaulipas; the Mexico Secretariat of Health; the El Paso Diabetes Association; the Paso del Norte Health Foundation; the California Endowment/Project Concern International; and the state border health offices.

The results of this study show that more than 1.11 million inhabitants of the binational border region suffered from diabetes; of them, 22.0% were unaware of their status. Among the 18- to 44-year-old group, the border region doubled the national prevalence in each country (14.9%). Of adults with diabetes, 40.0% of those in Mexico border states and 11.6% of those in U.S. border states were unaware of their status. Overweight and obesity rates, as expected, were very high, with prevalence values among diabetic border residents of 27.7% and 54.5%, respectively. The high prevalence of diabetes and risk factors show that it is imperative to actively intervene to reduce the burden of the disease in the border population. If the risks for an even greater epidemic of this disease are to be brought under control, primary prevention measures must be applied from infancy, with a focus on actions that promote and sustain lifestyle changes at all stages.

This report has 11 sections and eight appendices. The first four sections provide a brief geopolitical and socioeconomic description of the border, study rationale, population sample, and methodology. In order to enable the reader to better understand the complexities of implementing such an extensive binational study, a description of the obstacles related to cross-border initiatives and strategies for dealing with them are included as well as a brief review of similar studies and projects implemented in the same time period as the border study. Results, recommendations, and lessons learned from this study are summarized in sections 5 to 8. The last three sections list the institutions involved in the project and the reference literature used in generating this report.

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1 Introduction

Noncommunicable diseases have become a global epidemic (1) and are currently threatening human life expectancy and quality of life as a result of increased death and disability (2). Among the noncommunicable diseases, diabetes mellitus occupies an important place.

Diabetes is a very common chronic disease that is rapidly increasing in prevalence; it is estimated that by 2025, 333 million (6.3%) individuals worldwide will be suffering from this disease; 284 million of them will be in developing countries (3, 4). The rapid increase in the number of cases could be attributed to a longer life expectancy, resulting in an aging population, changes in lifestyle such as unhealthy diet and physical inactivity with a consequent increase in obesity, and the actions and interactions of multiple genetic and environmental factors.

Diabetes is a costly disease to manage, presenting an overwhelming economic burden for the individual, the health care system, and society as a whole (2). Since the onset of the disease is currently being observed at younger ages, when men and women are at their productive prime, the burden of disease complications and premature death is much worse.

Type 2 diabetes mellitus (T2DM), characterized by disorders of insulin action and/or insulin secretion, accounts for 90.0% to 95.0% of all diagnosed cases of diabetes (5). Different risk factors have been associated with T2DM; the most common are ethnic background; body mass index (BMI) > 25.0, particularly central obesity (6); waist-to-hip ratio; waist circumference; birth weight; "westernization" (4, 7–9); low birth weight (10–12); older age, although the onset of the disease is now increasingly present at younger stages of life; and poor dietary practices (13).

T2DM is diagnosed when fasting plasma glucose (FPG) levels are persistently ≥ 7 mmol/L or when 2-h glucose levels following a 75-g oral glucose load are persistently ≥ 11.1 mmol/L (14). The most characteristic symptoms of this condition are polyuria, polydipsia, polyphagia with weight loss, and blurring vision; complications include retinopathy, nephropathy, and neuropathy. People with T2DM face an increased risk of cardiovascular, peripheral vascular, and cerebrovascular disease, which are responsible for morbidity, disability, and premature death (15). However, many people are unaware they have diabetes as the period of hyperglycemia may be asymptomatic for several years; it remains the case that the number of known T2DM cases in a population equals the number of unknown cases (16, 17).

Impaired fasting glycemia (IFG) is an intermediate metabolic state between normal glucose homeostasis and T2DM. IFG is not a clinical diagnosis, although it is a "prediabetes" stage that markedly increases the risk of developing T2DM and adverse outcomes, such as cardiovascular disease (14). The levels of fasting glucose that are criteria for IFG are 100–125 mg/dL (5.6–6.9 mmol/L) (18).

1.1 Diabetes complications

Much of the burden of T2DM comes from the vascular complications of the disease. These complications are classified as macrovascular and microvascular diseases and are a consequence of accelerated atherogenesis. Microvascular complications include neuropathy, nephropathy, and retinopathy. Other complications of diabetes include infections, metabolic difficulties, impotence, autonomic neuropathy, and pregnancy problems. The macrovascular complications include heart disease, stroke, and peripheral vascular disease, which can lead to ulcers, gangrene, and amputation. Patients with diabetes have twice the risk of incident myocardial infarction and stroke as those without the disease (19). Risk factors for diabetes complications include the duration of hyperglycemia, levels of hemoglobin A1c, elevated levels of triglyceride, low high density lipoprotein cholesterol, BMI, waist-to-hip ratio, and smoking (15, 20).

Individuals with impaired fasting glucose or fasting glucose levels of 100–125 mg/dL (5.6–6.9 mmol/L) and/or impaired glucose tolerance of 140–199 mg/dL (7.8–11.0 mmol/L) 2 h postprandial are associated with increased cardiovascular disease and could progress to T2DM, especially if other risk factors exist (21, 22).

1.2 Diabetes mortality

Roglic et al. (23) estimated a global excess mortality attributable to T2DM of 2.9 million deaths for 2000, which was equivalent to 5.2% of all-cause mortality in that year. This number is almost double the 987 000 deaths, or 1.7% of the total mortality reported by the World Health Report for 2002. This report suggests that, globally, routine reporting of death statistics leads to underrecording of the true burden of diabetes.

Death rates in people with diabetes rise with age and are higher in men than in women at all ages. An overall excess of all-cause mortality among patients with T2DM has been documented and is more marked in women than in men (19, 24). The World Health Organization (WHO) multinational study and the Whitehall study found that mortality was twice as high in persons with T2DM in the lowest socioeconomic level as in those in the highest socioeconomic groups (25).

1.3 Diabetes in developing countries

Noncommunicable conditions, including cardiovascular diseases, diabetes, obesity, cancer, and respiratory diseases, account for 59.0% of the 57 million deaths annually and 46.0% of the global burden of chronic diseases (26). An estimated 177 million people worldwide are affected by diabetes, the majority by T2DM. Two-thirds live in the developing world. Nutritional transition, characterized by overeating and a poor and unhealthy diet, and

an increase in sedentary behavior are occurring at a much faster pace in developing countries. Chronic diseases are becoming increasingly prevalent in many of the poorest developing countries, creating a double burden on top of the infectious diseases that continue to afflict these countries (27).

1.4 Diabetes in the United States

In 2004, more than 2.3 million diabetes-related deaths occurred in the United States of America. The age-adjusted death rate was 80.8 deaths per 1 000 000 U.S. standard population, making diabetes the sixth leading cause of death (28). In 2002, diabetes was responsible for 5.0% of all deaths among Hispanics and 2.2% among whites (29) in the United States. The number of individuals diagnosed with T2DM increased more than 2-fold between 1980 and 2004, from 5.8 million to 14.7 million (30). This increase occurred in all age groups, although people 65 years or older accounted for almost 40.0% of the population with diabetes.

Hispanics in the United States are one of the most affected groups, with an overall prevalence of diabetes twice that of non-Hispanics (9.8% vs. 5.0%). In this ethnic group, diabetes tends to occur at younger ages than in the non-Hispanic white population. The state of California has the highest rate of T2DM among younger Hispanics: 3.2% in the 18–44 age group compared with 1.3% in the non-Hispanic group (31). Rates of T2DM are much higher for those who are obese (15.3%) than for those with a BMI of 25 or less (4.6%). The obesity increase of 17 percentage points observed in the U.S. population between the periods 1976–1980 and 1999–2004 has accounted for an 80.0% increase in diabetes prevalence (32).

In 2005, the Behavioral Risk Factor Surveillance System reported that in the U.S.–Mexico border area, 7.1%, 7.5%, 7.3%, and 7.9% of the participants in California, Arizona, New Mexico, and Texas, respectively, said they had been diagnosed with T2DM, a value similar to the nationwide figure of 7.3% (33). Diabetes age-adjusted prevalence in these four states is higher than the national average of 5.1%: 7.5% in California, 6.3% in Arizona, 6.0% in New Mexico, and 8.3% in Texas (30).

Despite the growing number of T2DM cases identified annually, a large number of persons living with diabetes and other metabolic disorders remain undiagnosed in many countries (17). Among the low-income rural adult population in the United States, the rates of unawareness of risk factors for metabolic disorders range from 14.2% to 42.3%, while among the U.S. adult population who have diabetes, the rate of unawareness of the disease is 2.5% (34). Disease unawareness was higher in older adults and was associated with a lack of education and a non-family history of the disease.

1.4.1 Diabetes mortality in the United States

T2DM was the sixth leading cause of death in the United States in 2002 (35), 2003 (33), and 2004 (28), being responsible for 3.0% of all deaths. In 2002, T2DM was responsible for 2.2% of total deaths in whites, 4.4% in blacks, 5.0% in Hispanics, and 6.0% in American Indians (33). In the four U.S. border states, diabetes was the fifth leading cause of death in New Mexico in 2004 (36), the sixth in Texas (37), and seventh in California (38) and Arizona (39).

1.5 Diabetes in Mexico

In Mexico, T2DM was the leading cause of death, causing 13.7% of the total deaths in 2007 (40). Political, cultural, and socioeconomic changes in Mexico over decades have produced changes in the traditional diet and physical activity patterns of Mexico's population; as a consequence, obesity and the number of people with diabetes have increased. An age-standardized diabetes prevalence of 8.2% for the whole population, 13.2% among those ≤ 40 years of age, and 20.0% in the 60- to 69-year-old-group for the country as a whole was reported in Mexico's 2000 National Health Survey (41).

The higher prevalence of T2DM in northern Mexico reflects the interplay between several factors. Migration from semiurban and rural areas to urban areas, a rapid change in socioeconomic status from poor to medium income, and changes from a very active to a sedentary lifestyle, plus exposure to the "western" way of life, have had an effect on the metabolism of the people exposed to these factors, with a consequent increase in obesity and diabetes.

Poverty levels in Mexico have changed considerably in the last 20 years. In 1992, 44.1% were below the poverty level. This percentage increased to 60.8% in 1996 due to a bad economy and the 1994 peso devaluation, and it dropped to 45.9% in 2000 (42). These poverty figures contrast with the increase in obesity in the Mexican population during the last decade, where an improved economy increased the purchasing power of the people, who ate more, but not necessarily healthier, food.

Data on the complications of diabetes in Mexico are limited, but studies of Hispanics of Mexican descent in the United States have found that this group exhibits a greater prevalence of certain diabetes-associated conditions, including obesity and hypercholesterolemia, and higher rates of some adverse complications (43), such as renal failure, amputations, and peripheral vascular disease, compared with non-Hispanic whites.

Data suggest that between one-third and one-half of all cases of T2DM are undiagnosed and patients may have preclinical disease for as long as 12 years before diagnosis (44). At diagnosis, about half of patients have some form of microvascular complications, nephropathy, retinopathy, and neuropathy, and they have a 2- to 4-fold increased risk of developing coronary heart disease compared with their counterparts without diabetes (44).

1.5.1 Diabetes mortality in Mexico

Mortality rates in Mexico increased more than 3-fold between 1970 and 2004. In 1970, the mortality rate was 15.5 per 100 000; in 2004, it was 59.0 per 100 000. In 2007, 13.7% of total deaths were due to diabetes mellitus, making it the leading cause of death in Mexico. In the six northern Mexico border states in the same period, diabetes was responsible for 12.8%, 12.2%, 12.9%, 16.7%, 13.6%, and 15.4% of total deaths in Baja California, Sonora, Chihuahua, Coahuila, Nuevo Leon, and Tamaulipas, respectively (45).

2

The U.S.–Mexico border

As per the La Paz Agreement, Article IV, 1983, the U.S.–Mexico border includes the area extending 60 miles (100 km) on each side of the 1 952-mile (3 400-km) international boundary between the United States and Mexico, from the Gulf of Mexico to the Pacific Ocean. The border area includes the southern portions of four U.S. states (California, Arizona, New Mexico, and Texas) and the northern portions of six states of Mexico (Baja California, Sonora, Chihuahua, Coahuila, Nuevo Leon, and Tamaulipas) (46) and includes all or part of 48 U.S. counties and 80 Mexican municipalities (Appendix 2).

The 2000 census from Mexico and the United States estimated that the total population of the border region was 13 087 452. Of this population, 6 296 497 (48.0%) lived in 25 U.S. counties, and 6 790 955 (52.0%) lived in 13 Mexican border municipalities (47). Of them, 8.5 million were older than 18 years of age, and 95.0% resided in 14 paired, interdependent sister communities (48). The sister cities differ in population density, income, and environmental infrastructure.

Between 1970 and 2000, the populations on both sides of the border experienced rapid growth (49) due to migration from central and southern Mexico and from Central and South America. In 2005, the overall annual population growth rate was 2.8% for the U.S.–Mexico border, higher on both sides than the national rates of each country (1.4% for Mexico and 0.9% for the United States) (50).

The border is characterized by a continuous cultural, political, and economic interaction from north to south and from south to north. Most cities along the U.S. side of the border are heavily influenced culturally, economically, and socially by the populations that live on the Mexican side of the border and vice versa.

2.1 Diabetes on the U.S.–Mexico border

T2DM was a leading cause of death in Mexico and the sixth cause in the United States (51, 52). It was the third leading cause of death in the U.S.–Mexico border region (49). In 1999, in the Mexican border city of Juarez, T2DM was the first cause of death among the productive-age population (53), years before it became the leading national cause of death in Mexico in 2004 (54). In the border region, nearly 4 000 residents died each year as a result of T2DM, with approximately 1 500 deaths on the U.S. side and 2 500 on the Mexican side (49).

2.2 Health coverage and health services on the U.S.–Mexico border

Chronic diseases and associated risk factors account for more than 60.0% of hospitalizations on a given day in any border hospital and pose the major challenge for the healthcare systems in both countries (55). One of these challenges is represented by the fact that even though in Mexico the fourth article of the Constitution guarantees the "right to health protection for everyone," the fast growth of the dynamic and mobile border region has economically overstressed the infrastructure of the healthcare system in northern Mexico, which has not been able to develop at the same pace as the population, resulting in 43.1% of the population having no access to health services in 2005 (56). This phenomenon also applies to people from rural areas that migrate to the big cities of Mexico. In the U.S. border states, the proportion of people without health coverage was 17.2%, 20.9%, 13.7%, and 28.5% in California, Arizona, New Mexico, and Texas, respectively (57), resulting in a unique, largely medically underserved region.

2.3 Characteristics of the southern border of the United States

The U.S. border area contains a mix of Hispanic and non-Hispanic cultures, including Native Americans, who also exist in Mexico. For some states, the Hispanic influence reaches far from the actual border region and encompasses practically the entire state (e.g., New Mexico).

The U.S. southern border counties are among the most impoverished in the country (except San Diego), having experienced three consecutive decades of rising unemployment and declining per capita household income, which have led to further marginalization of vulnerable groups (58). For example, four of the seven poorest cities and five of the poorest counties in the United States are located in Texas along the border (48). Poverty rates are very high even with the economic development that resulted from the North American Free Trade Agreement of 1994 (NAFTA). For example, in some border counties, 60.0% of the residents lived below the federal poverty level (59). Colonias (60), human settlements lacking basic sanitation services, are common on the New Mexico and Texas side of the border and can best be described as developing world communities (lack of water, open sewage, unsanitary living conditions, and major health disparities). Because of these conditions, the U.S. federal government has designated all border counties in the Rio Grande, Texas, area "medically underserved areas" (61). The proportion of Hispanics living in U.S. border counties is ~71.0%, ranging from 26.7% in San Diego County, California, to 95.0% in Maverick County, Texas (62).

Because of the lack of health insurance for a large number of the U.S. Hispanic population, approximately 30.0% of this population cross the border to the Mexican side to receive health and dental services. Approximately 60.0% of the Hispanic population purchases medicine on the Mexican side, since it is 40.0% to 50.0% cheaper than on the U.S. side (63).

2.3.1 Morbidity and mortality on the southern border of the United States

Life expectancy at birth in the United States was 77.5 years in 2002. In the same year, the average infant mortality rate in U.S. border counties ranged from 3.6 to 6.7 per 1 000 registered live births, with the exception of Luna County, New Mexico, which had a rate of 21.0 per 1 000 registered live births (64).

Cardiovascular diseases and cancer are the main causes of death in the U.S. border region. In 2003, the cardiovascular disease mortality rate was 188 deaths per 100 000 population (48). Cancer, the second leading cause of death in the U.S. border region, causes more than 20 000 deaths each year (65). The cancer mortality rate on the U.S. side was 161 per 100 000 population, lower than the U.S. average as a whole (64).

2.4 Characteristics of the northern border of Mexico

The north of Mexico is a vast and heterogeneous geographic space with unique social, economic, and demographic characteristics. The 2000 census estimated there were 17.1 million inhabitants in the six border states and 6.5 million of them lived in the border region. The overall annual population growth rate during the last decade was 3.6%, which is twice the 1.8% national population growth rate. Six of the 14 municipalities presented an annual population growth rate between 0.7% and 4.2% in this same period, and they account for 49.0% of the total population of the border region (66). The total population at the Mexican border increased by 43.0% between 1990 and 2000 (64), causing rapid urban development, increasing the demand for space and basic services (water, sewage, electricity, and gas), placing tremendous pressure on municipal services, creating severe pollution, and leading to a wide variety of health and environmental problems in both the United States and Mexico.

Population growth in the border region was generated by migration of individuals from rural and semirural areas to border cities, looking principally for work in the twin/maquila plants (factories on both sides of the border), construction and services, and other sources of work that are not found in other parts of Mexico.

The northern border region presents lower mortality rates, higher life expectancy, and lower fertility rates than that of Mexico as a whole. Levels of education are higher in this region and living conditions are better than in the rest of Mexico, with the exception of the bigger cities like Mexico City, Guadalajara, and Queretaro.

A special characteristic of the northern part of Mexico is the non-Hispanic influence that extends deeply into the traditional culture of the Mexicans. This influence has resulted in the adoption of many habits traditionally associated with western society among the inhabitants of the region, such as excessive use of cars and high consumption of fast food, even before the NAFTA between Canada, the United States, and Mexico was signed.

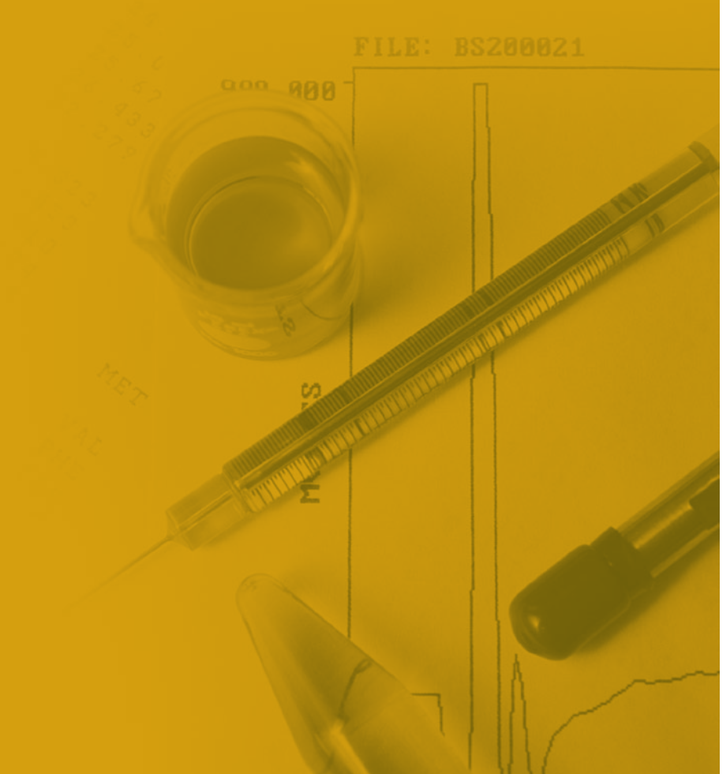
2.4.1 Morbidity and mortality on the northern border of Mexico

Life expectancy at birth on the Mexican border in 2002 was 73.0 years (64). In the same period, the infant mortality rate ranged from 17.9 to 23.9 per 1 000 registered live births (64).

Cardiovascular diseases and cancer are the main causes of death in the border region. In 2003, the cardiovascular disease mortality rate in the Mexican border states was 69 deaths per 100 000 population (48). Cancer is the second leading cause of death, and the mortality rate for this disease was 67 per 100 000 population, higher than that for Mexico as a whole (65).

In summary, when standards of living on both sides of the border are compared with values in their respective country, important differences are observed. Mexican border states have a higher standard of living and a longer life expectancy than the rest of Mexico; however, they also have higher mortality from chronic diseases, including diabetes, cardiovascular diseases, and cancer. In contrast, opposite trends exist on the U.S. side of the border when compared with the rest of the country; poverty and unemployment rates are higher, and health insurance coverage is lower (62). Living conditions on the U.S.–Mexico border have the characteristics of both a developing and a developed country, and this environment has a significant effect on the risk for chronic diseases. There is a need to address the diabetes problem from a behavior change perspective as well as with public policy and environmental changes that support healthier lifestyles.

3



Study Rationale

3.1 Conceptualization

In the late 1980s, mortality rates for T2DM within both U.S and Mexican border communities were higher than the state and national levels (67, 68). Additionally, in the mid-1990s, researchers from the Division of Diabetes Translation (DDT) of the Centers for Disease Control and Prevention (CDC) noticed that diabetes among the Hispanic population was increasing at a faster rate than within the general population (68). They projected that the burden of diabetes among the Hispanic population living in the United States not only would have a tremendous impact on their quality of life and life expectancy but also would place an unmanageable financial strain on the patients and on the health care system. Furthermore, the impact would affect those diagnosed with diabetes as well as their families and the communities where they live and work.

Therefore, in 1995 the DDT researchers established the National Hispanic/Latino Diabetes Initiative for Action (NHLDIA) to serve as the blueprint for the CDC-DDT outreach to the Hispanic population, with prevention and control messages to be delivered through a culturally and linguistically diverse interdisciplinary approach. The NHLDIA principles guided researchers when the U.S.–Mexico Border Diabetes Prevention and Control Project was conceptualized. A key operating principle was that the population to be reached had to be involved in planning the project by prioritizing, promoting, and evaluating the project's activities and accomplishments in order to effectively address and sustain the changes necessary to counteract the disproportionate burden of diabetes within the Hispanic population.

To oversee this binational project, the CDC-DDT convened a group of Hispanic diabetes experts and professionals with different areas of expertise who represented the primary H/L nationalities in the United States and also of persons of Hispanic background living with T2DM. The group provided the DDT researchers with a set of recommendations that addressed the concerns of the group. Of greatest concern was the lack of meaningful information available at that time to accurately measure the burden of T2DM within the Hispanic population. The main recommendation to researchers was "to encourage the oversampling of Hispanic subjects in those states that have large Hispanic populations" by the project scientific committee.

In 1998, the U.S.–Mexico border diabetes collaborative workgroup reached a consensus that the following partners would implement the proposed project: the Pan American Health Organization/World Health Organization (PAHO/WHO); the United States–Mexico Border Health Association; the diabetes prevention and control programs of the state health departments of California, Arizona, New Mexico, and Texas; the diabetes programs of the states of Baja California, Sonora, Chihuahua, Coahuila, Nuevo Leon, and Tamaulipas; Mexico´s Secretariat of Health; the El Paso Diabetes Association; the Paso del Norte Health Foundation; the California Endowment/Project Concern International; and the state border health offices.

The U.S.–Mexico Border Diabetes Prevention and Control Project was funded through a grant from the CDC in 1999. It was established that the project should be carried out in two phases: Phase 1, the Diabetes Prevalence and Risk Factors Household Study, and Phase 2, the Community Intervention Pilot Study, to address the findings with a proposed plan for preventive and proactive intervention that would be culturally appropriate.

This project is unique in that it is the first study to consider the whole U.S.–Mexico border as one functional epidemiologic unit. The CDC, the Mexican Secretariat of Health, and all the other border partners had the same goal: reducing the impact of diabetes among residents living along the U.S.–Mexico border through a model of equal representation and participation, consensus building, and shared leadership within the binational region.

3.2 Study Implementation

PAHO/WHO was selected as the fiduciary and coordinating agency by the collaborative group members, given its recognition and international expertise. At the same time, the group established three committees: executive, intervention, and scientific to assist PAHO with recommendations for planning, implementing, and evaluating activities and strategies to maintain the scientific integrity of the project. Each of these committees created an infrastructure through which all project partners could voice their ideas and concerns and which provided project partners with a sense of belonging and ownership of decisions reached by consensus. Through these committees, the U.S.–Mexico Border Diabetes Prevention and Control Project coordinators successfully facilitated the activities to be carried out by more than 130 institutions in both countries in all 10 border states and within 44 border communities, including partners from academia and community-based providers (Appendix 6, Graphs A6-1 and A6-2).

4

Methodology

4.1 Sampling and data collection

4.1.1 Sampling

A questionnaire was administered to a random sample of 4 027 individuals representative of the noninstitutionalized population aged 18 years or older living in the U.S.–Mexico border region. The sample was selected by using a multistage, cluster sample design that included the following strata: state, county, and ethnicity (Hispanic/non-Hispanic, on the U.S. side). In the United States, census tracts within counties with at least 5 000 inhabitants were divided into two strata based on 1990 population estimates of Hispanic ethnicity using 80.0% as the cut-off point. Within each stratum, census tracts were selected with a probability proportional to their population sizes, followed by block selections with a probability proportional to their population sizes, followed by random selection of households and random selection of an adult household member older than 18 years of age. For the ethnic-specific samples from the U.S. strata, selection was based on a probability proportional to the estimated size of the specific ethnic group living in the sampled area. The population estimates were based on the 1990 U.S. and Mexico censuses. The Mexico sample was also selected by using a similar multistage, cluster sample design that included the following strata: state, county, and municipality using 1995 census data. Within each stratum, areas geoestadistícas básicas (census tract) and manzanas (blocks) were selected with a probability proportional to population size, followed by random selection of households and random selection of an adult household member older than 18 years of age.

Ethical clearance was obtained from the CDC Institutional Review Board as well as from the Ministry of Health of Mexico Ethics Committee. Participants provided informed consent before joining the study.

4.1.2 Data collection

The survey was conducted in 44 selected border communities: 28 in Mexico and 16 in the United States. In the United States and Mexico, blocks within census tracts/areas geoestadistícas básicas were randomly selected and mapped; selected households were identified by a number. Households within blocks/manzanas were then randomly selected and one adult residing in the household was selected to survey. The study included a questionnaire with 65 questions (Appendix 8) about diabetes, general health and access to healthcare, hypertension, physical activity, diet and eating habits, tobacco use, alcohol consumption, reproductive health, social–cultural aspects, acculturation, education, work history, and demographic characteristics. The survey also included anthropometric (weight, height, and waist and hip circumferences) and blood pressure measurements. Participants were asked to wear light clothing; scales (battery operated digital scale, "Tanita" model 2001) were in kilogram mode and were regularly calibrated and weight was recorded to the nearest 0.1 kg. A mercury sphygmomanometer was used to measure blood pressure; three systolic and diastolic pressure readings were recorded over a 5-minute interval with participants resting in the seated position. The mean of the three readings was used in the analyses.

4.1.3 Management of blood samples

Blood samples were collected from participants who self-reported 8–14 hours of fasting by a certified phlebotomist. Blood from each participant was drawn into two vacuum tubes, one containing potassium oxalate and sodium fluoride and the other containing EDTA; the tubes were labeled appropriately. For glucose determination, a sample of 10 mL of venous whole blood was collected in the vacuum tube containing potassium oxalate and sodium fluoride. This sample was centrifuged locally. For the glycosylated haemoglobin, a sample of 5 mL of whole blood was collected in the vacuum tube with EDTA. After collection, the tube was gently rotated, mixing the blood to prevent clotting. All venous blood samples were centrifuged and stored at –20°C locally until they were air transported to the central laboratory in each country. In the United States, all blood specimens were analyzed by the University of Missouri Diabetes Diagnostic Laboratory; in Mexico, the samples were analyzed in the Nuevo Leon State Laboratory.

FPG quantification was done with a Cobas Mira Chemistry System (Roche Diagnosis System, Inc) and the glycohemoglobin A1c level was measured by using the Primus Automated HPLC system, model CLC385 (Primus IV, Primus Co), from Kansas City, Missouri. This is an automated analyzer that uses the principle of boronate affinity high-performance liquid chromatography. Two quality-control procedures for the Primus IV were implemented. Blood samples were split: one sample was kept in the local laboratory, and the second sample was sent to a reference laboratory in each country.

The quality control for FPG included two procedures. First, 2.0% of the samples were randomly selected and analyzed either within assay or between assays; if the coefficient of variation between duplicates was greater than 5.0%, the sample was reanalyzed. Second, four levels of standard controls covering the full range of plasma glucose concentrations for normal and diabetic samples were used. Two of these control pools (BR3 and BR4) were commercial lyophilized serum controls from Bio-Rad laboratories. The other two controls (IHH5 and IHL5) were prepared in-house and stored. Country laboratories of reference exchanged 20 samples every 3 months for simultaneous quality control. After blood samples were drawn from participants, only those who resided on the U.S. side of the border received a monetary incentive.

The project was approved by the CDC Institutional Review Board and the Ethics Committee of the Ministry of Health in Mexico. All project participants signed an informed consent form before the survey was administered and were duly informed about all procedures.

4.2 Data management

An automated data collection scanning procedure was used (NSC Design Expert) to scan the questionnaires, which were purposely formatted and printed to respond to the needs of the equipment (NSC scanning tools). This operation allowed for continuous data monitoring. However, the household questionnaires were previously reviewed manually to prevent entering inconsistencies and out-of-range responses. Laboratory and physical examination data were entered into an electronic file using Access software and then merged with scanned data. ASCII files were imported into SAS, and data analysis was carried out using SAS-callable SUDAAN (Survey Data Analysis), version 9.0 (RTI International, NC 2004).

Both the scanned and laboratory data were subjected to quality controls by rescanning and retesting a subset of 20 surveys and blood samples selected at random every 3 months. Cleaning was done to look for missing values, inconsistencies, and out-of-range values. When important data were missed in the data set, the questionnaires were reviewed extensively and if important information was missed, participants were contacted by phone in the United States and personally in Mexico to collect the data when possible. Agreement between replicates of laboratory results was measured by estimating the Pearson correlation coefficient.

4.3 Data analysis

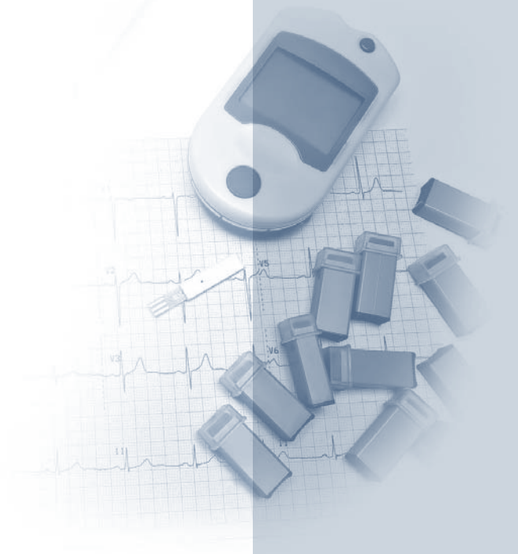
Based on the objectives of the study, to identify the real prevalence of T2DM along the U.S.–Mexico border and its risk factors among those living in the border area, the following definitions were used in the data analysis:

Diabetes: Persons who reported that they were told by a health professional that they had diabetes or whose measured FPG was greater than or equal to 126 mg/dL. Women who reported they had diabetes only during pregnancy were excluded.

Undiagnosed diabetes: Persons who reported not being told by a health professional that they had diabetes but whose FPG was greater than or equal to 126 mg/dL.

Prediabetes: Persons who reported not being told by a health professional that they had diabetes but whose FPG level was between 100 and 125 mg/dL.

Gestational diabetes: Women who reported having been told by a healthcare professional that they had diabetes only during pregnancy.



Body mass index (BMI): Defined as weight in kg divided by height in square meters; participants were further classified according to one of three categories:

a. Normal: BMI between18.5 and 24.9 kg/m2

b. Overweight: BMI between 25.0 and 29.9 kg/m2

c. Obese: BMI ≥ 30.0 kg/m2

Family history of diabetes: Persons who reported they had a first-degree relative with T2DM (mother, father, sibling).

Hypertension: Persons who had a systolic blood pressure ≥ 140 mmHg or a diastolic blood pressure ≥ 90 mmHg.

Physical activity: Physical activities performed:

a. Leisure time (yes/no)

b. Physical activities done as job activities (heavy, moderate, or sedentary).

Smoking: Persons who reported having smoked more than 100 cigarettes in their lifetime and who currently smoke.

Knowledge about prevention: Persons who reported they had heard or read information about diabetes prevention in the last 12 months.

Diabetes self-management: Persons with diabetes who reported having annual checkups; persons who reported checking their blood glucose in the last 12 months; persons who reported having annual foot and eye exams; and persons who reported using medication for their diabetes.

Healthcare use: Persons who answered the following questions either affirmatively or with a specific response:

a. Have you visited a doctor in the past 12 months? (yes/no)

b. What type of medical facility do you use?

c. Which of the following is your primary medical coverage program?

From the 65 variables included in the study, the first analysis included those variables related to demographic information; prevalence of diabetes, undiagnosed diabetes, prediabetes, and gestational diabetes; and prevalence of risk factors such as family history of diabetes, BMI, hypertension, smoking, alcohol consumption, physical activity, access to health services, and self-management of the disease. General knowledge of diabetes was also considered. Diet, migration history, and acculturation were not analyzed.

The sampling design of the study was without replacement. Variance estimates were based on Taylor series expansion. A weight (w_{ijkl}) was assigned to each observation, which was considered equal to the inverse of the probability ($\hat{p}$) of selection of the participant. A poststratification adjustment was performed to account for the nonresponse rate:

$$\hat{p} = \sum w_{ijkl} y_{ijkl} / \sum w_{ijkl} \quad \text{and} \quad w_{ijkl} = 1/p_{ijkl}$$

The design effect was estimated as the ratio of the variance of the estimate under the complex survey to the variance of the estimate under simple random sampling. The 95.0% confidence intervals (CI) for percentages and means were calculated by using weighted estimates. Year 2000 census data from the United States were used for the age standardizations.

4 • METHODOLOGY

4.4 Field work

The instrument and procedure were field-tested to check operational feasibility in two border sister cities: El Paso, Texas, and Juarez, Chihuahua, in June 2000.

In order to conduct the study, local and state agencies were contracted, and such agencies were required to have a local supervisor to oversee project activities. Local supervisors were responsible for hiring a person to map each one of the selected census blocks and households according to the study design. A team of interviewers was trained and contracted to contact eligible participants, conduct the interviews, and take anthropometric measurements; a certified phlebotomist was recruited to take the blood samples for FPG and hemoglobin A1c. The local agency also needed to contract a local laboratory to manage and ship blood samples to the designated laboratories. On the U.S. side of the border, all the materials (operation manuals, survey instrument, and consent form) were developed in both English and Spanish and were culturally tailored for the border community. Local project staff was bilingual.

Training related to diabetes disease principles, general aspects of the survey, instructions for the interviewers, questionnaire administration, anthropometric measurements, blood pressure measurements, laboratory tests, and project dynamics were given to state supervisors, who then replicated the training to local supervisors and interviewers to ensure standardization of the study methods and assessments. More than 250 persons were trained in a 13-month period across the U.S.–Mexico border, including physicians, nurses, medical and university students, and community health workers. All interviewers were certified in taking blood pressure readings before being sent into the field.

4.5 Anecdotal experiences related to the field work

Working in the field took unpredictable turns and, for safety reasons, interviewers worked in pairs. In remote and rural areas, interviewers were threatened by dogs; in wealthy neighborhoods, residents called the local police department because interviewers looked suspicious or "too Hispanic"; and in a few instances, interviewers were threatened with firearms. Before working in the field, interviewers were advised that "if a block looks unsafe or makes you feel unsafe, do not go in."

As an additional obstacle, dry ice is a commodity not easily found in isolated and small communities. Consequently, some participants' blood samples could not be used.

To reduce implementation barriers, implementing a campaign of community awareness to explain the study objectives and activities was found to be very effective. The communication plan guided local coordinators to properly target the desired potential participants with a clear, coordinated, memorable, and effective message that facilitated project activities.

Other barriers to project implementation included high turnover rates at all levels, an inequity in human and financial resources between countries that made binational coordination very complex, and timelines that were exceedingly difficult to adhere to.

5 Results

5.1 Demographics

The study sample population analyzed comprised 4,020 adults residing in the border region in 2001–2002 who were considered representative of a total U.S.–Mexico border region population of 7,449,596 ≥ 18 years of age. The mean age of respondents was 41.4 years: 36.4 years for the Mexican side and 44.4 years for the U.S. side. Overall in the border region, 64.0% were younger than 45 years and 11.8% were older than 64 years. However, the age distribution differed between countries, showing a larger proportion of young people among residents of the Mexican states compared with the U.S. states (74.7% vs. 56.3%). Only 5.8% of Mexico border residents were older than 64 years of age, whereas 16.0% of U.S. border residents were older than 64 years **(Figure 1, Table A1)**.

All subjects residing in the Mexican border area reported being of Hispanic origin while 43.6% percent of those residing in the U.S. border area considered themselves of Hispanic origin **(Figure 2 and Table A1.)**. The distribution of Hispanics in the U.S. border region varied by state, with the largest proportion in Texas (75.6%) and the smallest share in California (18.1%).

Almost 97.0% of the border population had received some level of schooling. Residents on the Mexican side reported fewer years of schooling than their U.S. counterparts. Most Mexican residents had attended primary and middle school (67.2%), but only 10.3% had finished high school and only 7.5% had completed college; 22.4% of U.S. residents had finished middle school, 36.5% had finished high school, and 35.2% had finished college. Those who never attended school represented 6.4% of participants on the Mexican side and 0.9% of those on the U.S. side **(Figure 3)**.

FIGURE 1. Age distribution of U.S.–Mexico border population, 2001–2002.

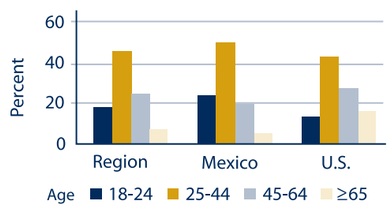
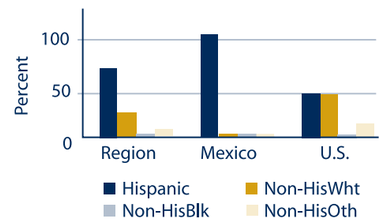


FIGURE 2. Distribution of U.S.–Mexico border population by ethnicity, 2001–2002.



Among respondents, 39.0% were employed, 27.0% were students or homemakers, 4.4% were unemployed, and 8.8% reported being retired. The unemployment rate reported was higher among U.S. than among Mexican residents (5.2% vs. 3.1%). The proportion of retirees of both sexes was higher among U.S. residents, reflecting an older population structure with a 3-fold larger percentage aged 65 years or older compared with Mexico.

Most border region residents were born in Mexico (57.3%). Only two-thirds of those who resided in the U.S. border area were born in the United States, while 98.7% of the Mexican border residents were born in Mexico. On either side of the border, 43.0% indicated that they had been born in a border state. Chihuahua and Tamaulipas were the most common places of birth among Mexican border residents, and California and Texas were the most common among U.S. border residents. Other common birthplaces among border residents were Jalisco (6.0%) and Sinaloa (5.7%) for the Mexican side and Ohio (2.0%) for the U.S. side.

5.2 Diabetes prevalence

5.2.1 Diagnosed diabetes

Overall, the crude prevalence of diagnosed diabetes was 14.9% (95% CI: 12.5–17.6), which represented 1 109 339 persons. After adjusting by age, the prevalence was 19.5% (95% CI: 16.8–22.6) in the Mexico border area and 16.1% (95% CI: 13.5–19.2) in the U.S. border area **(Figure 4)**.

Women in the Mexican border region showed a 44.0% higher age-adjusted prevalence of diabetes than those in the U.S. border region (19.2% vs. 13.3%). Prevalence increased with age on both sides of the border, with steeper increases among women in Mexico. For age groups 18–44 years, 45–64 years, and ≥ 65 years, respectively, in Mexico, the border age-specific prevalence estimates were 7.7%, 28.7%, and 37.1%; for the U.S. border, the estimates were 7.5%, 18.1%, and 24.4%. Women in Mexico also showed higher age-specific diabetes prevalence than women in the United States in the same age groups **(Figure 5)**.

Men residing on either side of the border showed an age-adjusted prevalence of 19.5% in Mexico and 16.1% in the United States. As with women, prevalence of diabetes among men increased with age, but the increases were steeper among men residing on the U.S. side. Among men in Mexico, prevalence by age group was 9.3% in the youngest group, 29.1% among those 45–64 years of age, and 28.5% in the oldest group; men in the United States showed more dramatic increases: 3.6%, 32.7%, and 48.7% **(Figure 6)**.

The prevalence of diabetes among men younger than 45 years in the U.S. border region was 2.6 times lower than among men in the same age group on the Mexican side, but this ratio decreased and reversed as the population aged. The U.S. border male residents older than 65 years showed a 1.7 times higher prevalence than that of their counterparts in the Mexican side of the border.

FIGURE 3. Distribution of U.S.–Mexico border population by level of education, 2001–2002.

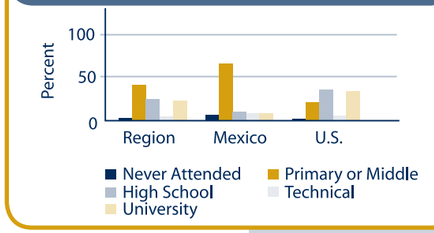


FIGURE 4. Age-adjusted* prevalence of diabetes among the U.S.–Mexico border population, 2001–2002.

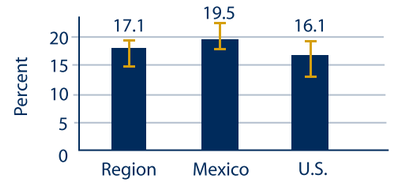


FIGURE 5. Age-specific prevalence of diabetes among the U.S.–Mexico border female population, 2001–2002.

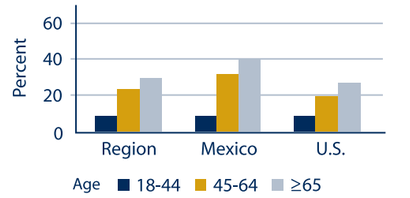


FIGURE 6. Age-specific prevalence of diabetes among the U.S.–Mexico border male population, 2001-2002.

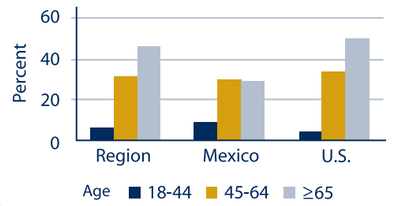


FIGURE 7. Age-adjusted* prevalence of undiagnosed diabetes among the U.S.–Mexico border population, 2001–2002.

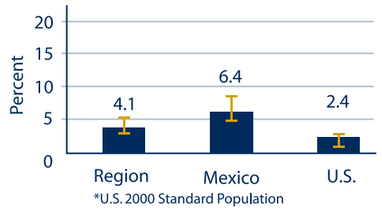
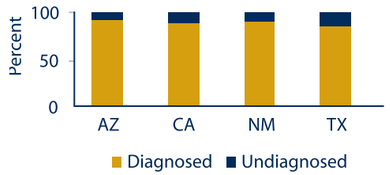
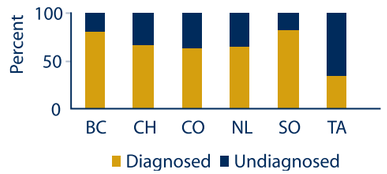


FIGURE 8. Prevalence (%) of undiagnosed diabetes among U.S. border population with diabetes by state, 2001–2002.



Note: AZ: Arizona, CA: California, NM: New Mexico, TX: Texas.

FIGURE 9. Prevalence (%) of undiagnosed diabetes among Mexican border population by state, 2001–2002.



Note: BC: Baja California, CH: Chihuahua, CO: Coahuila, NL: Nuevo Leon, SO: Sonora, TA: Tamaulipas.

The highest age-adjusted prevalences of diabetes were observed among populations of the border states of Tamaulipas (28.2%) and Arizona (19.9%), and the lowest were in the states of New Mexico (12.7%) and California (13.6%). Arizona showed the greatest gender difference (24.7% for men vs. 15.5% for women) and the highest age-specific values: 74.2% (standard error: 16.2%) for men 45–64 years of age and 69.1% (standard error: 16.8%) for those older than 64 years. By contrast, prevalence of diabetes among women in Arizona was 30.3% among those older than 64 years of age. However, Arizona women younger than 45 years showed the second highest value (12.4%) in the region after Tamaulipas (15.0%).

Table 1. Prevalence (%) of Unawareness of the Condition in the U.S.-Mexico Border Population with Diabetes for 2001-02

Age (years)	Population All	Men	Women	Mexico Border	U.S. Border
18-44	32.4	42.8	26.8	56.8	8.5
45-64	15.3	9.8	21.2	25.2	10.3
65+	15.5	16.3	14.2	12.9	16.1
Total	21.8	21.0	22.6	40.2	11.6

5.2.2 Undiagnosed diabetes

In 2001–2002, the prevalence of undiagnosed diabetes was 3.8% (95% CI: 3.0–4.9), representing 256,223 adults in the border region population. The crude rate of undiagnosed diabetes among Mexican border participants was 6.5% (95.0% CI: 4.8–8.6) and 2.2% (95.0% CI: 1.4–3.2) for U.S. border participants. The age-adjusted prevalence in the Mexican border population was higher than in the U.S. border population: 6.4% vs. 2.4% **(Figure 7)**.

Among the U.S. border population, the prevalence of undiagnosed diabetes was highest among older men (8.3%); among the Mexican border population, the prevalence was highest among women 45–64 years of age (8.9%). The age-adjusted prevalence of undiagnosed diabetes was highest in Tamaulipas (15.5%); in the other border states, the age-adjusted prevalence varied between 1.5% (New Mexico) and 5.6% (Nuevo Leon).

5.2.3 Unawareness of disease status in the total diabetic population

Nearly 22.0% of the total diabetic population in the border region were unaware they had the condition **(Table 1)**. Among people living on the Mexican side of the border, unawareness of their condition decreased as they aged, from 25.2% at 45–64 years to 12.9% at 65 years or older. By contrast, among people on the U.S. border, the percentage increased from 8.5% among those in the 18- to 44-year age group to 16.1% in those 65 years of age or older. Among men with diabetes, the percentage unaware of their condition was higher in the younger age group, at 43.0%; the value was 9.8% in the 45- to 64-year age group and 16.3% in those 65 years or older; among women, the percentage of unawareness decreased with age.

Among the border states, the percentages of diabetic adults unaware of their condition were higher in Mexico than in the United States and were highest in Tamaulipas (65.4%) and Coahuila (37.1%) **(Figures 8 and 9)**.

5.3 Diabetes risk factors

5.3.1 Prediabetes

The crude prevalence of prediabetes (fasting glucose: 100–125 mg/dL or 5.6–6.9 mmol/L) was 12.5% (95.0% CI: 10.1–15.4) in the U.S.–Mexico border region. The crude prevalence on the Mexican border was 13.5% (95.0% CI: 11.1–16.5), similar to that on the U.S. side [11.8% (95.0% CI: 8.4–16.4)]. The age-adjusted prevalence of diabetes was 2.0% higher on the Mexican side than on the U.S. side of the border (13.0% vs.15.0%) **(Figure 10)**.

Just as prevalence of diabetes rose with age, so did prevalence of prediabetes. The increase with age was steeper in the Mexico border population: 11.8%, 18.6%, and 19.1%, respectively, for the 18–44, 45–64, and 65 or older age groups; in the U.S. border population, it was 10.0%, 14.3%, and 13.8%, respectively, for the same age groups **(Figure 11)**.

As women on the U.S. border aged, the prevalence of diabetes increased progressively in the three age groups from 8.9% to 13.7% to 17.8% **(Figure 12)**, while among women on the Mexican border the prevalence of prediabetes increased and then decreased after 64 years of age (12.3%, 17.7%, and 9.9%).

Among men, the pattern of increase in prediabetes with advancing age differed from that of women. Among Mexican men on the border, the prevalence of prediabetes increased with age (11.3%, 19.7%, and 32.6% for the three age-specific groups); among U.S. males, it decreased after 64 years of age (11.1%, 15.1%, and 9.8% for the same age groups). Among men, the age-adjusted prevalence of prediabetes in the Mexican state of Tamaulipas was the highest (19.4%), followed by the U.S. state of New Mexico (14.8%). The lowest values of age-adjusted prevalence of prediabetes were observed in Chihuahua (10.0%) and Texas (11.6%). In seven of the 10 border state areas, men had a higher prevalence of prediabetes than women, with Sonora at the top of the list at an 8.3 percentage point difference between men and women (17.3% men vs. 9.0% women).

Table 2. Prevalence rates (%) of gestational diabetes in the U.S.–Mexico border population, 2001–2002

Age (years)	Border-wide	Border Mexico	U.S.
18-44	6.7	2.8	11.6
45-64	2.1	1.6	2.3
65+	0.01	0.0	0.01
Total*	3.9	1.8	6.4

*Age-adjusted to U.S. 2000 Census Population

5.3.2 Gestational diabetes mellitus

In this study the prevalence of gestational diabetes mellitus was self-reported by participating women who had been told by a physician they had diabetes mellitus only during pregnancy. The crude prevalence of gestational diabetes mellitus was 4.4% (95.0% CI: 3.2–6.2). Older women demonstrated very poor recall about having experienced gestational diabetes; only 2.1% among those aged 45–64 years, and 0.01% among those older than 64 years remembered having been told they had this condition during their pregnancies. Women younger than 45 years of age reported a prevalence of 6.7% **(Table 2)**. The ratio between the United States and Mexico was 3.5 (with the United States at 6.4% and Mexico at 1.8%). For each side of the border, Sonora and Texas populations

FIGURE 10. Age-adjusted* prevalence of prediabetes among the U.S.–Mexico border population, 2001–2002.

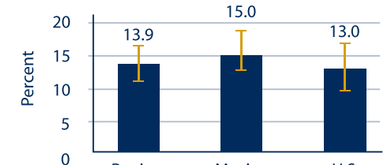


FIGURE 11. Age-specific prevalence of prediabetes in the U.S.–Mexico border population, 2001–2002.

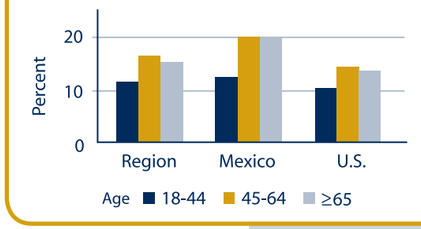
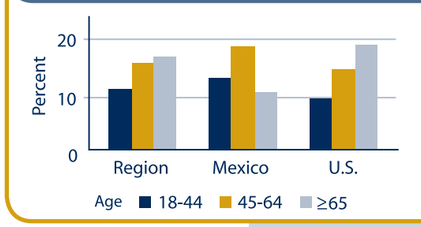


FIGURE 12. Age-specific prevalence of prediabetes among women in the U.S.–Mexico border population, 2001–2002.



showed the highest age-adjusted prevalence of gestational diabetes (2.6% vs. 11.0%). The lowest values were observed in Nuevo Leon (0.3%) and New Mexico (1.4%). When the same information was analyzed with the inclusion of diabetes during any time of a woman's life and not just during pregnancy, the crude prevalence of diabetes during pregnancy increased to 8.7% (95.0% CI: 6.4–11.7), with an age-adjusted value of 8.0% (95.0% CI: 6.0–10.4), and the United States to Mexico prevalence ratio increased to 4.0 (the United States at 12.1% vs. Mexico at 3.0%). Among women younger than 45 years who recalled having had from diabetes during pregnancy but not exclusively within that period, the values were 4.9% in Mexico and 20.8% in the United States. Tamaulipas in Mexico (4.9%) and Texas in the United States (13.5%) had the highest age-adjusted prevalence of diabetes during pregnancy.

5.3.3 Place of birth

Subjects were asked about their place of birth and classified as native if they were born and resided in the same country and as foreign if they were born and resided in a different country. In the border region, among both diabetic and nondiabetic persons, 19.0% were classified as foreign residents. Women showed a higher prevalence of being foreign than men, and being foreign was more prevalent among women with diabetes than among their counterparts without the disease (24.1% vs. 22.8%), while the opposite was observed among men (18.2% of nondiabetic men were foreign vs. 8.2% of diabetic men). The Mexico border foreign-born population without diabetes had an age-adjusted prevalence of 1.7% and the U.S. population had a prevalence of 33.6%. Among Mexican women on the U.S.–Mexico border, 0.8% were foreign born, while 2.6% of men were foreign born. On the U.S. side, 36.4% of women and 30.7% of men were foreign born. The higher prevalence of being foreign born in the United States was especially notable among younger women (37.8%) and older men (42.4%). The age-adjusted prevalence among U.S. male residents with diabetes was 27.7% (95.0% CI: 20.1–36.9), while among women it was 42.4% (95.0% CI: 34.7–50.5). The 45- to 64-year-old U.S. residents with diabetes showed the highest prevalence of foreign status (with women at 51.6% and men at 26.8%), while among residents without diabetes in the same age group the percentages were 40.0% and 21.9%, respectively.

New Mexico on the U.S. side of the border showed the greatest difference in age-adjusted rates for native-born participants between persons with and without diabetes, with values of 50.8% and 78.7%, respectively. Texas residents showed the smallest difference in native-born status between the two groups (people with diabetes at 58.4% and people without diabetes at 56.4%). Most people without diabetes and all those with diabetes who resided on the Mexican side of the border were classified as natives.

FIGURE 13. Prevalence of family history in the U.S.–Mexico border population, 2001–2002.

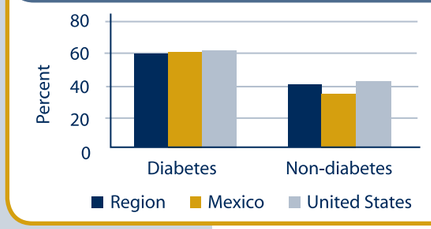


Table 3. Prevalence (%) of family history of diabetes in the U.S.–Mexico border population, 2001–2002

Region	Diabetic population			Non-diabetic population		
	All	Men	Women	All	Men	Women
Border	58.1*	64.2	52.4	38.8	35.2	42.1
Mexico	58.6	60.0	57.1	33.4	29.2	37.3
U.S.	60.1	67.2	54.0	40.6	35.8	45.1

* Values are age-adjusted to the U.S. 2000 census population.

5.3.4 Family history

The reported family histories of diabetes in the border region were 61.0% and 37.5% among residents with and without diabetes, respectively (with respective age-adjusted values of 58.1% and 38.8%). The difference in age-adjusted prevalence was greater on the Mexican side of the border than on the U.S. side. Mexicans reported a positive family history of diabetes at a rate of 33.4% among residents without diabetes and 58.6% among the population with diabetes. In the United States, these values were 60.1% and 40.6%, respectively **(Figure 13)**.

Women without diabetes showed a greater family-history prevalence than men. The opposite was observed among residents with diabetes, who showed greater rates among women. Those who resided in the U.S. border region showed higher prevalence of family history of diabetes than those residing on the Mexican side of the border **(Table 3)**.

The population with diabetes in the state of Baja California had the highest age-adjusted percent of a positive family history of diabetes in the Mexican region, with 75.4% of the residents with diabetes and 28.9% among those without diabetes. Participants from Tamaulipas reported the lowest prevalence of a family history with values of 49.2% among people with diabetes and 36.0% among those without diabetes. New Mexico had the highest values among U.S. residents with diabetes, with a value of 77.4% (men at 83.2% and women at 73.8%).

Borderwide, 15.7% of residents with diabetes reported having their father as the family member with diabetes, whereas 39.2% reported their mother and 35.0% reported a sibling. On the Mexican side, these percentages were 20.1%, 35.5%, and 33.7%, respectively, whereas in the U.S. border population values were 13.1%, 41.4%, and 35.8% **(Table 4)**.

Table 4. Prevalence (%) of Family History of Diabetes by Diabetes Status and Type of Blood Relative in the U.S.-Mexico Border Population for 2001-02

Region	Residents with diabetes			Residents without diabetes		
	Father	Mother	Sibling	Father	Mother	Sibling
Border	15.7*	39.2	35.0	14.9	20.8	15.2
Mexico	20.1	35.5	33.7	14.1	18.4	12.3
U.S.	13.1	41.4	35.8	15.4	22.7	17.2

*Values are age-adjusted to U.S. 2000 Census population

5.3.5 Hypertension

The rate of hypertension was defined as a systolic blood pressure ≥ 140 mmHg or a diastolic blood pressure ≥ 90 mmHg, and it was higher among residents with diabetes (36.3% vs. 22.2%). At the same time, among residents with diabetes the rates for hypertension were 10.9% lower than those self-reported and 4.8% higher than among those without diabetes.

In the border region, the prevalence of self-reported hypertension among residents without diabetes was 17.4% (95.0% CI: 14.8–20.3), with an age-adjusted value of 21.8% (95% CI: 19.1–24.9). Border participants with diabetes showed a prevalence of 47.2%, with an age-adjusted value of 44.4% (95.0% CI: 38.1–50.9). Women showed higher age-adjusted rates than men in participants without diabetes (23.1% vs. 20.5%) and in those with diabetes (47.0% vs. 41.6%). Almost one-fourth of Mexican participants without diabetes reported having hypertension (24.9%), and the proportion was more than one-third (38.1%) among participants with diabetes; on the U.S. side of the border, the values were 20.6% and 57.9%, respectively.

As presented in Figure 14, overall U.S. men with T2DM had greater age-adjusted rates of hypertension than U.S. women (61.7% vs. 54.6%), and the age-specific prevalence of hypertension was highest among 45- to 64-year old women with T2DM (65.6%). Hypertension prevalence increased as the population aged, but these increases were steeper in the U.S. population younger than 64 years, while slighter increases were observed among Mexican participants older than 64 years. Overall, increases were

higher among persons with diabetes than among those without diabetes.

In the Mexican border region, participants from the state of Baja California had the highest age-adjusted prevalence of self-reported hypertension among persons with diabetes (50.3%). The latter percentage almost doubled that found among those without diabetes, and the difference between women and men with diabetes was only 4.4 percentage points (51.9% for women vs. 47.5% for men). In Sonora, persons with diabetes also had a higher prevalence of hypertension than did those without diabetes (32.8% vs. 19.3%). Among those younger than 45 years, persons with and without diabetes showed wide differences: 47.1% in residents with diabetes vs. 8.2% among residents without diabetes. These differences decreased after age 45 years, and values were higher among border residents without diabetes (44.6% vs. 64.3%). Participants from three of the four U.S. states surpassed Baja California's prevalence of hypertension. The age-adjusted prevalence in Texas border participants was 62.4% among participants with diabetes and was 3.4 times greater than in those persons without diabetes (18.5%). In Arizona, the prevalence of hypertension among participants with diabetes (54.9%) was twice that of the residents without diabetes, while the prevalence in New Mexico of 54.7% was almost double that of those without diabetes (28.0%). Almost all men with diabetes older than 64 years of age in New Mexico were hypertensive (96.0%), a value surpassing by 2.5 times the prevalence observed among participants without diabetes in the same age group (37.7%).

FIGURE 14. Prevalence of hypertension among the U.S.–Mexico border diabetic population, 2001–2002.

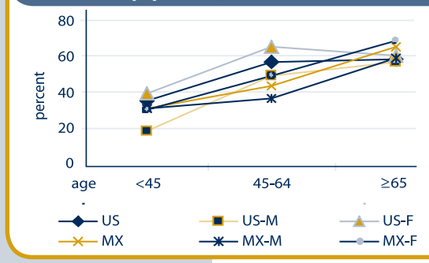


FIGURE 15. Age-specific prevalence of hypertension (systolic blood pressure ≥ 140 mmHg, diastolic blood pressure ≥ 90 mmHg) among the U.S.– Mexico border population, 2001–2002.

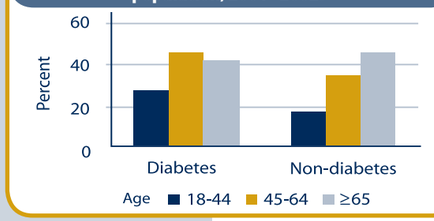


Table 5. Prevalence (%) of hypertension in the U.S.–Mexico border population, 2001–2002

Region	Population with diabetes			Population without diabetes		
	All	Men	Women	All	Men	Women
Border	35.2*	41.2	29.5	23.7	31.0	23.8
Mexico	35.3	38.1	32.5	36.7	42.5	31.2
U.S.	35.2	41.7	29.6	23.5	31.2	22.0

Note: hypertension: systolic blood pressure ≥ 140 mmHg, diastolic blood pressure ≥ 90 mmHg. *Values are age-adjusted to U.S. 2000 census population.

Hypertension assessed by trained personnel was greater among people with diabetes (36.3% for persons with diabetes vs. 22.2% for persons without diabetes). Self-reported hypertension differed greatly from the measured prevalence. The prevalence of measured hypertension was 4.8 percentage points higher than the self-reported value in persons without diabetes and 10.9 percentage points lower in people with diabetes. Measured hypertension among men with diabetes showed higher values than in women, with the most notable gender difference among participants with diabetes in the U.S. border region **(Table 5).**

In the border region, the increases with age of assessed hypertension grew faster among participants with diabetes than in those without diabetes **(Figure 15)**.

The prevalence of assessed hypertension in the population with diabetes overall was lower than what was self-reported. Age-adjusted percentages of measured hypertension among participants with diabetes on the Mexican side of the border showed the highest prevalence in Nuevo Leon (54.0%), followed by Chihuahua (48.0%) and Baja California (38.0%). Persons with diabetes also showed the highest prevalence of assessed hypertension within the oldest male population in Tamaulipas (71.3%) and within the youngest male population in Sonora (74.4%). In almost all U.S. border state areas, persons with diabetes had twice the prevalence of hypertension as those without diabetes, and men showed higher values than women, except in Arizona. In New Mexico, participants with diabetes had the highest value for hypertension (47.8%), while those in Texas showed the lowest value (36.1%).

5.3.6 Overweight and obesity

Levels of abnormal weight measured by BMI (weight/height2) showed that persons with diabetes had a lower prevalence of overweight (BMI = 25–29) than persons without diabetes (29.7% vs. 41.2%) but showed greater prevalence of obesity (BMI ≥ 30) (49.0% vs. 30.6%). In the border region, regardless of diabetes status, men showed a higher prevalence of overweight while women showed a higher prevalence of obesity. Age-specific prevalences of overweight were higher, with steeper increases among persons without diabetes, while the prevalence of obesity was higher and increased more slowly among persons with diabetes, suggesting that many with diabetes reach adulthood already obese **(Figures 16 and 17)**.

Obesity prevalence among the U.S. border population with diabetes was higher than that among the Mexican border population (57.5% vs. 45.5%), with a large difference between people with and without diabetes in the United States (57.5% vs. 29.3%). The mean BMI among U.S. participants with diabetes was 32.3% (95.0% CI: 31.2–33.5) and in Mexico it was 30.0% (95.0% CI: 29.3–30.8); among participants without diabetes, the same groups had values of 28.7% and 28.4%, respectively. Among the Mexican population with diabetes, the highest prevalence of obesity was among older women and younger men; in the United States, the greatest overall prevalence of obesity was among those 45 to 64 years old (72.9%) **(Figures 18 and 19).**

However, when evaluating prevalence values by gender, men in the United States developed obesity earlier, as indicated by a higher percentage among the 18- to 44-year age group with diabetes (81.9%) than among those in the 45- to 64-year age group (75.9%). Although Mexican men's age-specific prevalence (45.1% vs. 34.4%, respectively, for participants with and without diabetes) was much lower than that for men in the United States, obesity among men on both sides of the border starts at a younger age than it does for women.

Nuevo Leon in Mexico and Arizona in the United States had the highest adjusted prevalences of obesity among participants on the border with diabetes (64.6% and 61.2%) as well as the greatest differences in obesity between persons with and without diabetes (24.7% and 23.8%, respectively). The states with the lowest obesity prevalences among persons with diabetes were Chihuahua (42.3%) in Mexico and New Mexico (40.1%) in the United States **(Figures 20 and 21)**. Among persons 18 to 45 years of age with diabetes, Nuevo Leon in Mexico and Texas on the U.S. side

FIGURE 16. Age-specific prevalence of obesity (body mass index ≥ 30) among the U.S.–Mexico border population, 2001–2002.

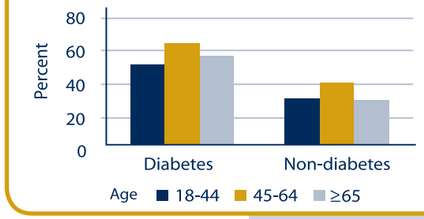


FIGURE 17. Age-specific prevalence of overweight (body mass index 25–30) among the U.S.–Mexico border population, 2001–2002.

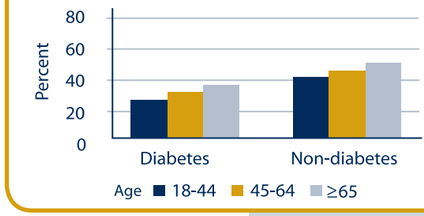


FIGURE 18. Age-specific prevalence of obesity (body mass index ≥ 30) among the Mexican border population, 2001–2002.

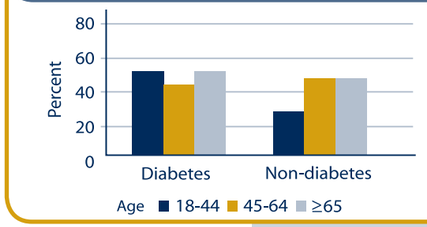


FIGURE 19. Age-specific prevalence of obesity (body mass index ≥ 30) among the U.S. border population, 2001–2002.

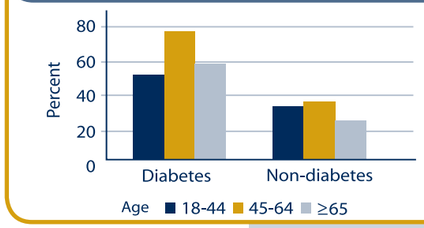
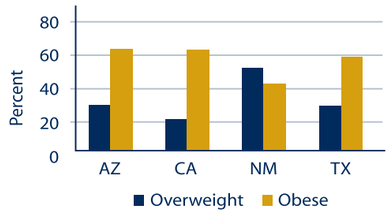
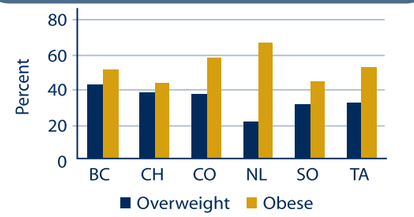


FIGURE 20. Prevalence of overweight (body mass index 25–30) and obesity (body mass index ≥ 30) among diabetic U.S. border population by state, 2001-2002.



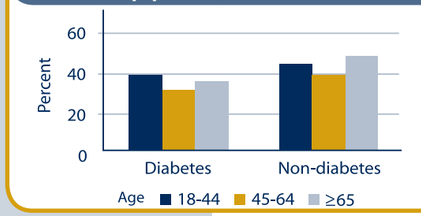
Note: AZ: Arizona, CA: California, NM: New Mexico, TX: Texas.

FIGURE 21. Prevalence of overweight (body mass index 25–30) and obesity (body mass index ≥ 30) among diabetic Mexican border population by state 2001-2002.



Note: BC: Baja California, CH: Chihuahua, CO: Coahuila, NL: Nuevo Leon, SO: Sonora, TA: Tamaulipas.

FIGURE 22. Age-specific prevalence of physical activity (participation in any leisure activity) among the U.S.–Mexico border population, 2001–2002.



showed the highest age-specific obesity percentages (74.1% and 54.9%), with a prevalence of 94.0% in Texas and 100% in the Nuevo León male population of that age.

Levels of adiposity measured by waist circumference larger than 88 cm in women and larger than 102 cm in men were observed among persons without diabetes at a value of 42.0% and at a value of 59.6% among persons with diabetes. Participants with diabetes had an age-adjusted prevalence of abnormal weight of 58.9% in Mexico and of 67.1% in the United States. Among participants without diabetes in both Mexico and the United States these values were 47.4% and 39.6%, respectively.

A high prevalence of abnormal weight was observed among 18- to 44-year-olds of both genders in Mexico but only among women in the United States **(Table 6)**.

Just as BMI index denoted obesity, the waist circumference also showed a significantly higher prevalence of abnormal weight levels among the 18- to 44-year-old participants with diabetes in U.S. men, but not in U.S. women, confirming that along the border obesity among men with diabetes is occurring earlier in life than among U.S. women. The waist-to-hip ratio index showed an almost 9 percentage point higher prevalence of abnormal levels of weight than did the waist circumference index (68.2% vs. 59.6%) among the population of the U.S.–Mexico border with diabetes. The waist-to-hip ratio index among persons without diabetes showed a 16.7% higher rate of abnormal levels of weight compared with the waist circumference index (58.7% vs. 42.0%). It also confirmed the presence of a greater prevalence of overweight among young U.S. men (93.5%) than among U.S. women (36.2%).

5.3.7 Physical activity

Physical activity, defined as regularly participating in any leisure activity and physical work showed only an 8 percentage point difference between persons with and without diabetes in the entire border region (31.7% vs. 39.7%) **(Figure 22)**.

When considering only the U.S. border population, a 0.9% difference was noted between persons without and with diabetes (51.1% vs. 52.0%) who participated in regular leisure physical activity. Moreover, U.S. women with diabetes were more involved in such physical activity than their Mexican counterparts (58.3% vs. 42.7%); among persons without diabetes, men showed a higher prevalence of physical activity than women (55.9% vs. 48.3%). Among persons without diabetes, younger and older age categories showed higher percentages of physical activity, confirming a more sedentary lifestyle among those 44 to 64 years old. By contrast, persons with diabetes changed their proportions of physical activity with age. Men increased or maintained their physical activity rates as they got older, while women decreased it, with the steepest decrease among Mexican women. All Mexican border states showed a lower prevalence of physical activity than in the United States. The highest percentage observed for leisure time physical activity on the Mexican side of the border was in Sonora, which reported a proportion of 37.1% among persons without diabetes and a prevalence of 27.4% among participants with diabetes. Tamaulipas had a prevalence of 34.8% but only among women with diabetes. For the U.S. border states, Arizona and California had the greatest prevalence of physical activity among persons with diabetes (57.5% and 45.2%, respectively). The lowest percent of physical activity among participants with diabetes was observed in New Mexico (37.7%). However, New Mexico had the highest prevalence of physical activity among persons without diabetes (62.4%).

When physical activity was measured as a job-related activity, only 13.8% of participants without diabetes and 19.1% of persons with diabetes in the border population were engaged in jobs requiring vigorous physical activity, and the prevalence was greater among men than women (28.8% vs. 10.0%) **(Figure 23)**.

Mexican participants showed a slightly higher prevalence of job-related physical activity than U.S. participants (14.7% vs. 12.8%); women residing in the United States showed higher percentages than men as well as a higher prevalence than women residing in Mexico (16.8% vs. 3.5%) **(Figure 24)**. The prevalence of physically inactive jobs was higher in the U.S. population among people with diabetes and among men. Inactivity almost doubled after 65 years of age in all groups except among women without diabetes.

5.3.8 Smoking

The prevalence of smoking in the border region varied between 24.2% among participants without diabetes and 27.3% among persons with diabetes. Men smoked at about the same rate, independently of whether they had diabetes (31.1% and 32.1%, respectively, for those without and with diabetes), and their prevalence was higher than that for women (31.1% vs. 17.7% among persons without diabetes and 32.1% vs. 22.6% among persons with diabetes). Participants with diabetes in both countries smoked at the same proportion (30.0%), but women residing in the United States smoked 1.6 times more than women residing in Mexico **(Figure 25)**.

Mexican women with and without diabetes smoked at the same rate, while among women residing in the U.S. border region those without diabetes smoked about 30.0% less than those with diabetes (19.2% vs. 27.2%). The prevalence of smoking decreased with age in the United States, was maintained among Mexican men with diabetes, and decreased among Mexican

FIGURE 23. Prevalence of job-related vigorous physical activity among the diabetic U.S.–Mexico border population, 2001–2002.

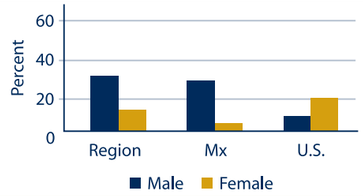


FIGURE 24. Prevalence of job-related inactivity among the diabetic U.S.–Mexico border population, 2001–2002.

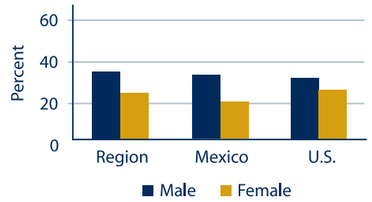


FIGURE 25. Prevalence of smoking among the diabetic U.S.–Mexico border population, 2001–2002.

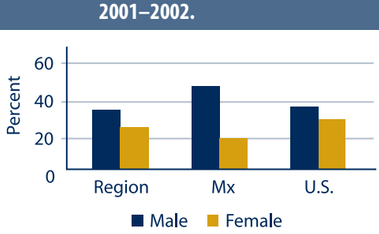


FIGURE 26. Age-specific prevalence of smoking among diabetic U.S.–Mexico border population, 2001–2002.

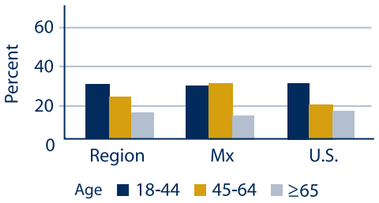
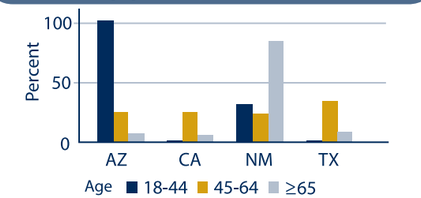


Table 6 Prevalence (%) of abnormal body mass and adiposity in the U.S.–Mexico border population, 2001–2002

Index*	Residents with diabetes			Residentes without diabetes		
	Region	Mexico	U.S.	Region	Mexico	U.S.
BMI = 25-29 (W/H²)	29.7†	36.3	25.7	41.2	39.3	41.3
BMI ≥ 30 (W/H²)	49.0	45.5	57.5	30.6	33.5	29.3
Waist circumference:	59.6	58.9	67.1	42.0	47.4	39.6
f > 88cm; m > 102cm						
Waist-to-hip ratio	68.2	66.0	73.8	58.7	61.5	58.2
f > 0.80; m > 0.90						

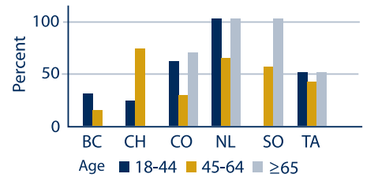
* BMI: body mass index, W: weight (kg), H: height (m), f: female, m: male.
† Values are age adjusted to 2000 U.S. census population.

FIGURE 27. Age-specific prevalence of smoking among diabetic men, U.S. border population, 2001–2002.



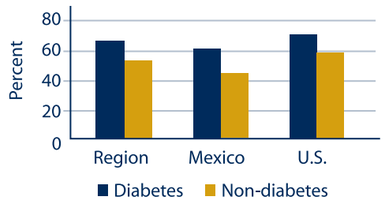
Note: AZ: Arizona, CA: California, NM: New Mexico, TX: Texas.

FIGURE 28. Age-specific prevalence of smoking among diabetic men, Mexican border population, 2001–2002.



Note: BC: Baja California, CH: Chihuahua, CO: Coahuila, NL: Nuevo Leon, SO: Sonora, TA: Tamaulipas.

FIGURE 29. Prevalence of diabetes prevention awareness among the U.S.–Mexico border population, 2001–2002.



women with diabetes to almost none in those older than 64 years **(Figure 26)**.

In the Mexican border region, Nuevo Leon showed the highest rate of smoking among participants with diabetes (43.8%), while Arizona showed the highest value (36.0%) in the U.S. region. Despite limited data, it was observed that in Arizona 100% of 18- to 44-year-old men with diabetes smoked, while none of the same age group in Texas did **(Figures 27 and 28)**.

Three of the six border states in Mexico showed that the young population with diabetes in the 18- to 44-year age group smoked at proportions higher than 50.0%, and in the state of Nuevo Leon the entire young population with diabetes reported smoking habitually.

5.3.9 Knowledge about disease prevention, self-management, and treatment

The U.S.–Mexico border population with diabetes showed poor knowledge about diabetes treatment and prevention, but there were substantial differences among border participants from each country. U.S. participants with diabetes showed a higher proportion of persons who had heard or read that diabetes could be prevented (66.3% vs. 57.0%), and a smaller proportion believed that medical treatment was the only effective measure (2.9% vs. 11.0%) **(Figure 29)**. Although 71.9% of Mexican participants with diabetes knew that diabetes could be prevented through self-management of risk behaviors, 18.6% still did not know what to do to prevent it. By contrast, in the United States a smaller proportion (9.5%) did not know what preventive measures could be taken against diabetes. The most common preventive measures mentioned by persons with diabetes were good nutrition and physical activity. In the United States, 27.4% of residents with diabetes mentioned both, 26.2% mentioned nutrition only, and 4.8% mentioned physical activity only; in Mexico, the proportions were 15.3%, 23.2%, and 6.3% respectively **(Figure 30)**. Approximately 56% of persons with diabetes were advised to change their diet in Mexico compared with 71.9% in the United States.

Although more than two-thirds of those who had from diabetes reported they had seen a physician in the previous 12 months, only 13.8% of Mexican border participants with diabetes reported that their blood sugar was checked, while almost two-thirds of U.S. participants (61.6%) did so **(Figures 31 and 32)**.

FIGURE 30. Prevalence of preventive measures for diabetes among the U.S.–Mexico border population, 2001–2002.

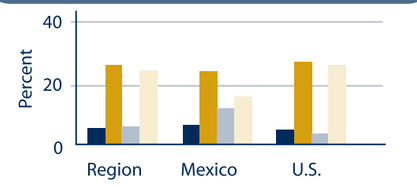
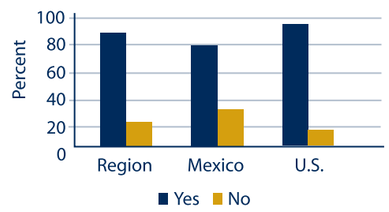


FIGURE 31. Prevalence of health check-ups among the U.U.S.–Mexico border population with diabetes, 2001–2002.



Forty percent of diabetic participants in the border region reported having an eye exam in the previous 12 months. While 52.0% of participants in the United States reported having eye exams, only 16.4% of Mexicans reported doing so. Similarly, the proportion who had had a foot exam in the previous 12 months was 31.8%, with 44.7% in the United States and only 9.8% in Mexico **(Figure 33)**.

Among Mexican residents with diabetes, the most common medical conditions were circulatory problems and ulcers (33.8% and 23.1%, respectively), while among U.S. border residents with diabetes, circulatory problems and eye disease were the most common medical complaints (19.2% and 16.3%, respectively).

The most common type of medication used for glycemic control was an oral hypoglycemic drug (43.3% in Mexico and 45.6% in the United States). Insulin was more commonly used by U.S. residents than by those who resided in Mexico (23.6% vs. 3.1% respectively) **(Figure 34)**.

5.4 Access to care

Eighty percent of adults with diabetes had some type of healthcare insurance coverage in the United States, while 78.0% of those in Mexico had such coverage **(Figure 35)**. Private insurance and healthcare management organizations were the most common health plans used by U.S. border residents. In Mexico, the common coverage for Mexican border residents was provided by the Mexican Institute of Social Services (IMSS) and the Health Secretariat (SSA) and Institute of Social Services for State Employees (ISSSTE). Health services were most commonly received through the IMSS clinics in Mexico and through private doctors or clinics in the United States **(Figure 35)**.

FIGURE 32. Prevalence of blood glucose checks among the U.S.–Mexico border population with diabetes, 2001–2002.

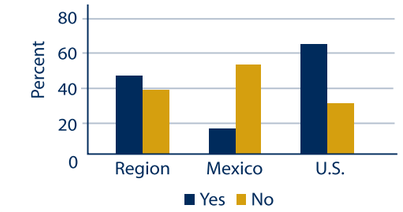


FIGURE 33. Prevalence of eye and foot exams among the U.S.–Mexico border population with diabetes, 2001–2002.

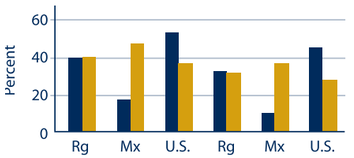


FIGURE 34. Type of medication used among the U.S.–Mexico border population with diabetes, 2001–2002.

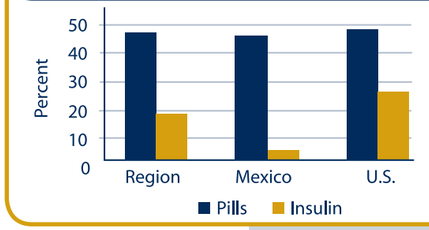
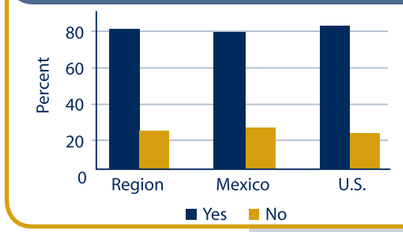


FIGURE 35. Prevalence of health coverage for the U.S.–Mexico border population with diabetes, 2001–2002.



6

Conclusions

6.1 Total diabetes

The crude prevalence of diagnosed T2DM was 14.9%, which represented 1 109 339 residents who had T2DM. Women along the northern Mexican border showed a 44.0% higher age-adjusted prevalence of diabetes than those residing along the U.S. southern border (19.2% vs. 13.3%), while men residing on the Mexican side had a higher age-adjusted prevalence than those residing on the U.S. side of the border (19.5% vs. 16.1%). The findings of this study show that the prevalence of T2DM in the U.S.–Mexico border region almost doubled the national prevalence for each country, which was 7.5% for Mexico and 6.3% for the United States during the same study period (April 2001 to November 2002).

6.2 Undiagnosed diabetes

The prevalence of undiagnosed diabetes along the U.S.–Mexico border was 3.8% (95% CI: 3.0–4.9), representing 256 223 adults in the population, meaning that 22.0% of those affected with T2DM were unaware of the condition. The age-adjusted prevalence of undiagnosed diabetes for the northern Mexican border was 6.4% and for the U.S. southern border it was 2.4%.

6.3 Diabetes risk factors

6.3.1 Prediabetes

The crude prevalence of prediabetes (borderline glucose levels) was 12.5% on the U.S.–Mexico border. The crude prevalence on the Mexican side of the border was 13.5% and on the U.S. side it was 11.8%, so more than 836 000 inhabitants of the border region had prediabetes.

6.3.2 Gestational diabetes mellitus

The crude prevalence of T2DM during pregnancy was 4.4%. The ratio of the U.S. to the Mexican side of the border was 3.5 (with the United States at 6.4% and Mexico at 1.8%).

6.3.3 Place of birth

Subjects were asked about their place of birth and classified as native if they were born and resided in the same country and as foreign if they were born and resided in a different country. In the border region, among both diabetics and nondiabetic persons, 19.0% were classified as foreign residents. Women showed a higher prevalence of being foreign than men, and being foreign was more prevalent among women with diabetes than among their counterparts without the disease (24.1% vs. 22.8%), while the opposite was observed among men (18.2% of nondiabetic men were foreign vs. 8.2% of diabetic men).

6.3.4 Family history of diabetes

The reported positive family history of diabetes prevalence was 38.8% and 58.1%, respectively (age adjusted), among residents without and with T2DM. These percentages mean that four of 10 U.S.–Mexico border participants without diabetes had at least one family member who had diabetes, and six of 10 with diabetes had at least one family member with diabetes.

6.3.5 Hypertension

The age-adjusted prevalence of self-reported hypertension among nondiabetic participants was 21.8%, and among persons with diabetes the age-adjusted prevalence was 44.4%. Women showed higher age-adjusted rates than men in both groups without diabetes (23.1% vs. 20.5%) and with diabetes (47.0% and 41.6%). Almost one-fourth of Mexican residents without diabetes reported having hypertension (24.9%), compared with more than one-third among residents with diabetes (38.1%). On the U.S. side of the border values were 20.6% and 57.9%, respectively. On the U.S. border, men with diabetes had greater age-adjusted rates of hypertension than women (61.7% vs. 54.6%).

6.3.6 Overweight and obesity

Along the U.S.–Mexico border, the prevalence of obesity was higher than the national figures for each country. Persons with diabetes had a greater prevalence of obesity: six of 10 U.S.–Mexico border inhabitants with diabetes were obese and three of 10 were overweight, while among person without diabetes the rate of overweight was higher (29.7% vs. 41.2%). Men showed a higher prevalence of overweight while women showed a higher prevalence of obesity, regardless of diabetes status.

6.3.7 Physical activity

Self-reported physical activity among residents of the U.S.–Mexico border did not meet the recommendations of the American College of Sports Medicine, the Centers for Disease Control and Prevention, and the Secretariat of Health of Mexico; all three recommend doing moderately intense cardiovascular exercise for 30 minutes a day, 5 days a week, or doing vigorously intense cardiovascular exercise 20 minutes a day, 3 days a week. The difference in physical activity performed by persons with and without diabetes along the entire border was only 8.0% (31.7% vs. 39.7%). Self-reported physical activity among border residents reflected higher rates than the Mexican national figures but lower rates than the U.S. national figures.

6.3.8 Smoking

Self-reported smoking habits among U.S.–Mexico border inhabitants reflected higher rates than the national figures for both countries. The prevalence of smoking varied between persons without and with diabetes in the border region: 24.2% and 27.3%, respectively. Among men, those with and without diabetes smoked at the same rate (31.0%); they also smoked more than women. The same proportion of residents with T2DM in both countries smoked, but women residing in the United States smoked 1.6 times more than women residing in Mexico.

6.3.9 Knowledge about disease prevention, self-management, and treatment

In general, U.S.–Mexico border inhabitants with diabetes showed poor knowledge about diabetes prevention and management, but there were substantial differences between countries. Seven of 10 U.S.–Mexico border inhabitants with diabetes had read or heard about diabetes prevention; this proportion was higher in the United States. Six of 10 inhabitants of the border area who had T2DM knew that it could be prevented by self-management and healthy behavior.

Twenty percent of the inhabitants in the U.S.–Mexico border area who had diabetes did not have health insurance, and 80.0% had visited a doctor during the previous year. Four of 10 U.S.–Mexico border inhabitants who had diabetes had self-monitored their blood sugar levels in the previous 12 months: 13.8% on the Mexican side and 62.0% on the U.S. side.

Only 40.0% of residents with T2DM reported having at least one eye exam in the last year and only 32.0% reported a foot exam in the previous 12 months. Oral hypoglycemic drugs were the most common type of medication used for glycemic control: 40.0% on both sides of the border. Insulin was more commonly used by U.S. residents (23.6%) than by those who resided in Mexico (3.1%). Among participants with T2DM on the U.S. border, 30.0% reported buying their medicines at a Mexican pharmacy.

Lessons learned

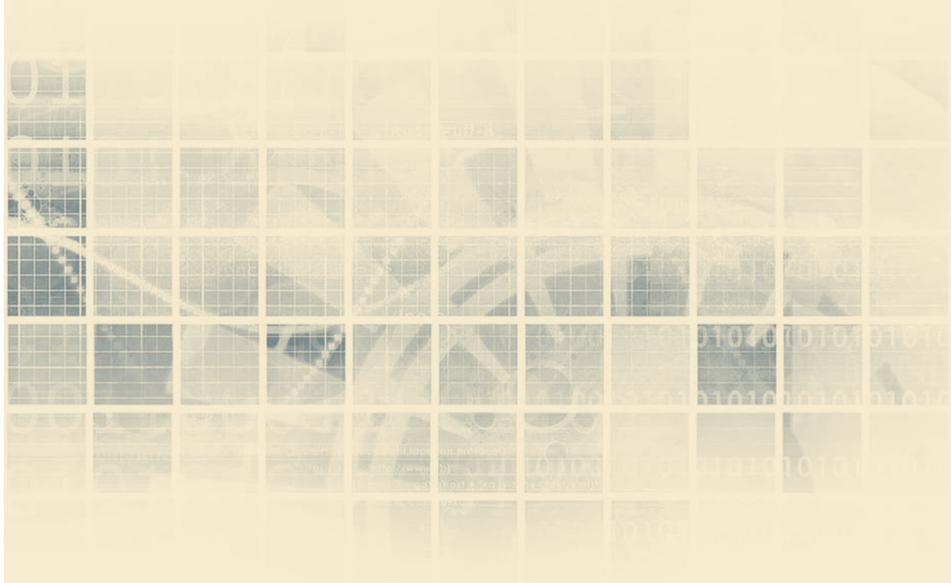
7

In this study, the U.S.–Mexico border region was approached and interpreted as one epidemiologic unit. Historically, the border has proved to be impermeable to political institutions such as systems of law and regulations; however, this border is less impermeable to the movement of people, goods, and services.

The populations on both sides of the U.S.–Mexico border are different in many ways, but they also have a lot in common. Thus, the differences and similarities were taken into consideration through the use of culturally appropriate language and approaches when this study was designed and implemented. Sociocultural issues need to be considered when designing and implementing binational activities and programs to address the diabetes epidemic as well as other chronic diseases.

One lesson learned is based on the collaborative nature of the project. This study would not have been possible without the invaluable guidance and expertise of the committee members from both countries who ever more generously lent their support to the efforts at hand as their sense of ownership of the project grew, who trusted in their institutions and their ability to strengthen their own capacities, and who, while recognizing that they were part of the problem, also knew that they could be part of the solution. The bipartite governance that provided project leadership could not have reached fruition without the willing participation of everyone involved in the project. Clearly, cooperative efforts are essential for projects such as this to be successful and to have long-term effects.

The evidence generated by this study clearly shows that using the same methodology and a representative sample of the population on the border is indispensable to have comparable data for advocacy, awareness, policy, and program changes to improve public health on the border.



8

Recommendations

Findings in this study show that diabetes prevalence along the U.S.–Mexico border is greater than the prevalence reported in other parts of either the United States or Mexico. The total crude prevalence of diabetes (whether previously diagnosed or not) in this study was 14.9% (95% CI: 12.5–17.6) on the U.S.–Mexico border, which was much higher than the 7.5% crude national prevalence reported for Mexico (41) and 6.3% for the United States (69) during the same period (April 2001 to November 2002) and among adults ≥ 20 years of age. After adjusting by age, using the 2000 U.S. standard population, the prevalence was 19.5% (95.0% CI: 16.8–22.6) in the Mexican border area and 16.1% (95.0% CI: 13.5–19.2) in the U.S. border area.

The high prevalence of diabetes in this study could be explained by a multifactoral model in which the predisposition to diabetes is determined by different combinations of genetic variants and environmental factors, whereas the genetically predisposed individuals will not develop diabetes unless they are also exposed to the pertinent environmental risk factors (70). Hispanics, the majority population on the U.S.–Mexico border, are also considered to have a particular predisposition, possibly with a genetic basis (71), to develop insulin resistance and diabetes when exposed to "adverse" conditions (70); thus, the higher prevalence of T2DM on the border.

With the high percentage of obese adults documented in this border study, the U.S.–Mexico border region could be considered an obesogenic region , defined as "the sum of influences that the surroundings, opportunities, or conditions of life have on promoting obesity in individuals or populations. This plays an important role in determining both nutrition and physical activity" (72). Most Hispanics in the United States belong to the medium and lower socioeconomic classes. Research has shown that the lower the economic status, the poorer the availability of high-quality, reasonably priced foods. Limited availability and access to "healthy" foods could also influence the nutrition of individuals, and this may encourage weight gain due to "unhealthy" eating practices (73, 74).

The other important factor in the growing problem of obesity and diabetes is the increasing imbalance between calories consumed and those expended, so the lower the physical activity the greater the subsequent weight gain. Leisure time physical activity is also related to socioeconomic status. The lower the socioeconomic status, the lower the safety in the respective neighborhoods and the decreased availability and access to a built or natural environment that encourages or supports an active lifestyle (75). In the border region, these factors occur on both sides of the border and are most common in the cities on the Mexican side of the border, where there is an increasing problem with violence and injuries. Cities and communities with higher risk factors are less supportive of the development of healthy lifestyles among their inhabitants.

8.1 Improve quality and access to healthcare

Health systems in Mexico and the United States are structured differently and have different resources. In Mexico, it is important that health professionals receive continuing education in the latest research and findings on chronic diseases, and they must learn to work in multiprofessional teams and on integrating different levels of care to ensure that individuals are educated on how to prevent development of the disease if they are at risk and that those with diabetes receive the recommended care. In the United States, most Hispanics do not have regular access to health services, and most of the prevention programs depend on federal funds. Physicians are in limited supply nationally and even more so in the border area; limitations of language (Spanish) and a lack of cultural sensibility are common. On the U.S. side, it could be important to give some type of incentives to U.S. physicians to practice on the border and train them in cultural sensitivity, if needed.

- Strengthen access to healthcare for persons living with diabetes who do not have health care along the U.S.–Mexico border by providing information on eligibility to community health centers and on how to take advantage of new health reforms in the United States. In Mexico, provide information on how to enroll in the Seguro Popular if people do not qualify for the IMSS, the ISSSTE, SSA Pensiones Civiles del Estado, or healthcare in the private sector.
- Healthcare institutions along the border must guarantee the adequate quality and availability of diabetes care resources for their patients with diabetes, including services, workforce, and medical monitoring and laboratory equipment as well as medications.
- Healthcare facilities can implement up-to-date diabetes guidelines including appropriate medication, laboratory exams, and fostering a healthcare team competent in diabetes according to patients' needs. Importance must be given to ensuring prevention of complications by appropriately examining eyes and feet and conducting necessary laboratory exams as well as referring patients to appropriate specialists in a timely manner. Nurses and primary care physicians need to be more diligent in checking for warning signs of retinopathy, urine abnormalities, and foot problems.
- Healthcare institutions can improve the services they provide to diabetes patients such as diabetes classes on important topics (nutrition, portion size, physical activity, preventing complications, coping with stress, properly managing glucose, etc.). Encourage diabetes support groups. Provide or have information available on how to obtain footwear, glucometers, and eyeglasses.
- There should be diabetes certification and continuing education credits for all healthcare professionals who come in contact with patients living with diabetes in order to develop the necessary skills and knowledge to identify patients at risk and to treat and manage patients living with diabetes.
- Promote the competencies for chronic disease practice in all diabetes programs. These competencies include building support, designing and evaluating programs, influencing policies and system change, managing people, managing programs and resources, and using public health science.

- Review and update medical and other allied health school curricula in order to produce and improve a healthcare workforce able to meet the diabetes challenge.

Along the border, the amount of work that health care professionals in diabetes have to endure is overwhelming and there is a large turnover and job abandonment of healthcare professionals who leave in search of better working conditions and increased monetary reimbursement. Create incentives at the border to retain healthcare professionals.

8.2 Improve outreach to identify people with undiagnosed diabetes and those at risk

Incorporate community health workers to improve patient education and follow-up to ensure adequate management of diabetes, including maintaining glucose at appropriate levels, keeping clinic appointments, and taking medication to control the disease and prevent or delay complications.

Improve diabetes and risk factor screenings in all communities and by healthcare professionals in all healthcare institutions, especially for persons with a family history of diabetes.

Support interventions in the workplace to establish wellness programs for those at risk that prompt employees to check themselves for the clustering of risk factors, to increase physical activity, and to eat a healthier diet. These activities will help people with diabetes to control the disease.

- Promote screenings at the workplace, health fairs, and community events.
- Endorse annual checkups for the community at large.

8.3 Strengthen community preventive actions and health promotion

The community needs be informed that diabetes could be prevented or delayed with appropriate diet and physical exercise and that the disease does not develop simply because of family history but is also a consequence of behavior; people need to make the right decisions. Patients with diabetes need to know about the importance self-care has on the development of the disease. Limited or inaccessible information provided by healthcare personnel or a patient's fears in asking about the disease and its consequences are important factors in the progress of the disease. This problem could be solved with community health workers or nurses working only on educating patients about chronic diseases in both countries.

- Create a "culture of health" through the stages early in life so people will have the information to recognize and avoid unhealthy behaviors with regard to chronic diseases and will be able to identify risk factors and symptoms before it is too late.
- Strengthen leadership and capacity among community organizations to promote healthy living.
- Strengthen education and empower the population so they know what diabetes is and can identify and prevent its risk factors and symptoms.
- Advocate for reducing disparities in healthcare coverage.
- Launch a borderwide creative, innovative, culturally appropriate campaign for the border population on diabetes awareness that includes three key messages:

  1) Diabetes is a serious disease, 2) diabetes can be prevented and controlled, and 3) the time is now for a healthy lifestyle.
- Include diabetes and healthy lifestyles as priority topics in all health promotion programs on the border.

8.4 Improve the environment and social determinants to foster healthy lifestyles

- Create an interdisciplinary, interagency, multilevel network of organizations working to counter chronic diseases.
- Support networks and networking among patients, family members, community members, and care providers.
- Provide incentives to companies that have wellness programs for their employees.
- Encourage school districts to include health topics in their curricula appropriate to grade levels to prevent chronic diseases, increase time allowed for physical activity, provide healthy food choices, and provide nutrition and food preparation classes to school cafeteria personnel. To continue these processes in the home setting, include the family. Commit children to reduced television and game time.
- Engage city planning officials to incorporate sidewalks and ciclovías (bikeways) in new projects, and involve city park and recreation officials to clean and maintain existing parks and develop more of them in strategic sites in the community.
- Strengthen leadership and capacity among community organizations.
- Promote the creation of healthy schools and healthy environments along the border centered on physical activity and healthy food choices.
- Work with the media to foster buy-in to inform the community about the diabetes problem, to develop creative messages toward healthy behaviors, to increase dissemination of successful interventions, and to negotiate air time.
- Reduce air time of unhealthy products that are presented at prime time and during sports events.
- Promote nutrition labeling on all products and restaurant menus.
- Positive incentives (for example, tax breaks) for persons who purchase exercise equipment or enroll in gyms as well as for companies that have wellness programs, purchase exercise equipment, or provide in-house classes for employees or employee memberships at local gyms.

8.5 Advocate for policy and environmental health changes

- Create a policy framework to facilitate and encourage the prevention of chronic diseases.
- Work with legislators to establish laws and regulations related to preventing chronic diseases.
- Promote education policies to ensure that school environmental facilities have healthy choices available.
- Ensure that decision makers on the U.S.–Mexico border are fully informed with up-to-date science and evidence-based information on diabetes.
- Support stronger leadership by policy makers, advocates, and health professionals to promote change.
- Foster better communication between policy makers and healthcare professionals.
- Provide tax benefits to food industries that produce healthy products.
- Recognize restaurants and cafeterias that offer healthy food choices.
- Provide tax breaks for companies that have healthy foods as well as space, time, and equipment for exercise.

One important recommendation from this study is that the complex methodology designed and used proved to be very effective in a binational cross-border situation, and it will be very helpful when designing other studies to address chronic diseases such as hypertension, heart disease, and cancer.

In summary, strategies for diabetes prevention must include the following: 1) legislation that enforces the creation of supportive environments for better health; 2) active and responsible community organizations and key leaders that suggest and support changes for a better environment; 3) health systems with resources, well-integrated levels of care, and motivated and prepared personnel; 4) informed members of the community and patients on primary and secondary health prevention of diabetes; and 5) academic institutions that generate new and reliable information that could be used for public policy making and for monitoring the burden of the disease and its risk factors. With all these components working in close and coordinated communication, diabetes control will be more effective.

9 Other studies on diabetes along the U.S.—Mexico border

Because of the very special nature of this study, its design, implementation, and analysis took longer than expected. Different situations had to be considered in implementation of the study, and during this time several regional studies and projects were implemented along the U.S.–Mexico border area.

A literature review of the projects and experiences in the control and prevention of diabetes along the U.S.–Mexico border was diverse, including interventions to improve self-management and projects on preventing and controlling diabetes; there were fewer projects on mental health and depression and on access to health services [see Appendix 7 (77–102)].

10 Acknowledgments

We would like to acknowledge the Intervention and Scientific Committee members for their unending commitment to the United States–Mexico Border Diabetes Prevention and Control Project. The expertise of every member has contributed to the success of the project. This effort could not have been accomplished without the invaluable contribution of all participants, to whom we gratefully extend our heartfelt thanks.

We also extend a special thank you to those who are no longer with us but whose professional commitment improved the health of border residents: Mr. Erick Rene Aranda Medrano, surveyor and phlebotomist in Ciudad Juarez, Chihuahua; Mr. Akin Popula, local supervisor in Harlingen, Texas; Mr. Oscar J. Velazquez Monroy, director of the Epidemiology Department of the National Health Department of Mexico.

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10.1 List of institutions and organizations involved in the Binational Diabetes Prevalence Study

The prevalence study would not have been possible without the participation of the following institutions:

Mexico

- Ministry of Health of Mexico
- Ciudad Juarez Autonomous University
- Ciudad Juarez Diabetes Association
- Local Health Departments in all Border Cities
- Mexican Diabetes Association of Nogales, Sonora
- Mexican Diabetes Association of the State of Chihuahua
- Mexican National Center for Epidemiology Surveillance and Disease Control
- Monterrey State Laboratory
- State Diabetes Prevention and Control Program in Baja California
- State Diabetes Prevention and Control Program in Chihuahua
- State Diabetes Prevention and Control Program in Coahuila
- State Diabetes Prevention and Control Program in Nuevo Leon
- State Diabetes Prevention and Control Program in Sonora
- State Diabetes Prevention and Control Program in Tamaulipas

United States

- United States Department of Health and Human Services
- Health Resources and Services Administration
- Centers for Disease Control and Prevention
- Arizona Department of Health Services
- California Department of Health Care Services
- New Mexico Department of Health
- Texas Department of State Health Services
- Pan American Health Organization
- U.S.–Mexico Border Health Association
- Paso del Norte Health Foundation
- Border Health Research
- Border Health Foundation
- The California Endowment
- Project Concern International
- California Diabetes Control Program
- Arizona Diabetes Prevention and Control Program
- New Mexico Diabetes Prevention and Control Program
- Texas Diabetes Prevention and Control Program
- El Paso Diabetes Association
- University of Missouri, School of Medicine
- Center for Border Health Research
- Primus Corporation
- R.E. Thomason Hospital, El Paso, Texas
- Rio Grande Council of Governments
- New Mexico State University at Las Cruces
- Doña Ana County Community College
- Arizona Office of Border Health
- Local Border Health Departments
- County of San Diego Public Health Laboratory
- Gateway Community Health Center
- Southwest Arizona Health Education
- University of Texas at El Paso, School of Public Health, Houston
- College of Public Health of the University of Arizona
- Western Arizona Area Health Education Center
- American Institute of Research
- National Diabetes Today Training Center Office of International Health and Human Services
- Home Choice Nurses

10.2 List of individuals who collaborated on the Binational Diabetes Prevalence Study

United States		*Mexico*
Aida Giachelo	Jake Brisbon	Adriana Peña de la Cruz
Alberto Barcelo	Jan Marie Ozias	Agustin Lara
Alberto Garza	Jaume Canela	Arturo Berber
Alberto Noriega	Jim Noffsinger	Bertha C Castellano Muñoz
Alfonso Ruiz	Joan Bomback	Carlos Aguilar Salinas
Ana Alfaro Correa	Joaquin Salcedo	Cristina Maya
Andrea Gerger	Juan Carlos Zevallos	Eleazar Vera
Andrew Winter	Kevin Boberg	Emma Mora
Angel Roca	Lisa Staiten	Francisco Martínez
Ann Albright	Lorely Ambriz Irigoyen	Francisco Vera González
Ann Pauli	Luis Escobedo	Gilberto García Portales
Aubin Tyler	Luis A. Gutierrez	Héctor Garza Hernández
Beatriz Apodaca	Maia Ingram	Héctor López González
Betsy Rodriguez	Marcia Strickland	Jaime Rojero
Beverly Judie	Maria Frontini	Juan Antonio Manriquez
Blanca Lomeli	María Teresa Cerqueira	Juan Manuel Frayre
Bruce Jacobs	Martha Londoño	Laiza Fuentes Chaparro
Carlos Castillo Salgado	Martha Stineff	Laura Morales
Carmen Cutter	Mary Lou Bivian Chavez	Leonardo Muñoz
Carmen Ramirez	Melchor Ortiz	María del Rosario Grijalva
Cassandra de Leon	Miguel Treviño	Mario Acosta
Cecilia Rosales	Mike Bristow	Martín Rosas Peralta
Chris Peters	Mike Landen	Ramón Valdez Real
Corazon Halasan	Otila Garcia	
Daniel Green	Patricia Thompson-Reid	
Daniel Gutiérrez	Pete Hoffman	
Dara Murphy	Phillip Huang	
David K. Espey	Rebeca Ramos	
David Stevens	Richard Walling	
Dejian Lai	Rita Díaz- Kenney	
Enrique Loyola	Rodolfo Valdez	
Frank Vinicor	Roger Chene	
Gary He	Rosalba Ruiz	
Gerardo de Cosio	Ross Merritt	
Gloria Beckles	Steven Lowenstein	
Gordon Cook	Sylvia Robles	
Guillermo Mendoza	Thomas Dowson	
Heidi Krapfl	Tim Flood	
Hsiao-Mei Wiedmeyer	Virginia Talley	

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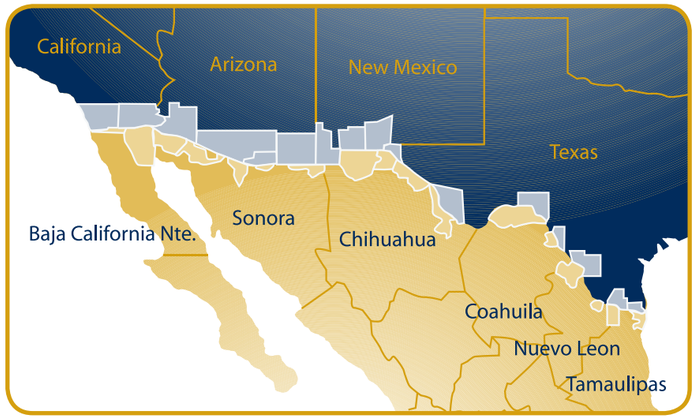
Appendix 1 Characteristics of participants in the U.S.–Mexico Diabetes Prevalence Study

TABLE A1. Studied population by country and border region: percentage and 95% confidence interval

Characteristic	Country		
	Border Region	United States	Mexico
Sample size analyzed	4020	2120	1900
Age (years)			
18-24	17.8 (14.7-21.3)	13.3 (9.3-18.7)	24.1 (20.4-28.1)
25-44	46.1 (42.4-49.9)	43.0 (37.0-49.3)	50.6 (47.2-53.9)
45-64	24.3 (21.6-27.3)	27.7 (23.4-32.4)	19.6 (17.1-22.4)
>64	11.8 (9.4-14.7)	16.0 (12.1-20.9)	5.75 (4.5-7.3)
Don't know/Refuse/Missing	0	0	0
Mean(standard deviation)	41.1 (44)	44.4 (47)	36.4 (28)
Sex			
Male	48.9 (44.6-53.2)	48.2 (41.4-55.1)	49.8 (45.8-53.8)
Female	51.1 (46.8-55.5)	51.8 (44.9-58.6)	50.2 (46.2-54.2)
Refuse/Missing	0	0	
Race/Ethnicity			
Hispanic	67.0 (61.6-71.9)	43.6 (37.5-49.2)	100.0
Non-Hispanic White	24.6 (20.0-30.0)	42.1 (35.0-49.4)	0.0
Non-Hispanic Black	2.1(1.0-4.6)	3.6 (1.6-7.7)	0.0
Non-Hispanic Other	6.3 (3.8-10.2)	10.7(6.5-17.2)	0.0
Don't know/refused/missing	0	0	0
Language preferences			
English	38.4 (33.2-43.9)	65.6 (59.1-71.5)	0.0
Spanish	61.4 (55.9-66.6)	34.1 (28.2-40.6)	100.0 (99.7-100.0)
No preference	0.2 (0.1-0.6)	0.3 (0.1-0.9)	0.0 (0.0-0.3)
Refuse/Missing	0	0	0
Education status			
Never attended	3.2 (2.4-4.2)	0.9 (0.5-1.8)	6.4 (4.8-8.5)
Primary or Middle	41.0 (36.9-45.2)	22.4 (18.3-27.2)	67.2 (63.0-71.1)
High School	25.7 (22.2-29.5)	36.5 (31.1-42.3)	10.3 (8.0-13.1)
Technical	6.3 (5.1-7.8)	4.7(3.2-6.8)	8.6 (6.7-11.0)
University/College	23.7 (19.5-28.4)	35.2(28.7-42.1)	7.5 (5.6-10.0)
Don't know/Refused	0.1(0.02-0.3)	0.1(0.0-0.5)	0.0
Missing	0.1(0.0-0.9)	0.2(0.0-1.5)	0.0
Employment status			
Employed	39.1 (35.1-43.4)	34.6 (28.8-40.9)	45.6 (41.0-50.2)
Unemployed	4.4 (3.2-6.0)	5.2 (3.4-7.9)	3.1 (2.0-5.0)
Homemaker or Student	27.0 (24.2-30.0)	21.0 (17.2-25.2)	35.5 (32.2-39.0)
Never worked	0.0	0.0	0.0 (0.0-0.1)
Retired	8.1 (6.2-10.5)	12.1 (9.0-16.0)	2.4 (1.5-3.7)
Other	20.9(16.1-26.8)	26.6 (19.0-35.8)	12.9 (10.0-16.6)
Don't know/Refused	0.1(0.1-0.4)	0.1(0.0-0.4)	0.2(0.0-0.7)
Missing	0.4(0.2-1.0)	0.5(0.1-1.6)	0.3(0.1-1.0)
Marital Status			
Single	21.1 (17.4-25.3)	21.9 (16.2-28.9)	20.0 (16.9-23.4)
Married	67.2 (62.5-71.6)	63.9 (56.2-70.8)	72.0 (68.5-75.2)
Widowed	11.4 (9.5-13.6)	13.9 (10.9-17.6)	7.8 (6.5-9.5)
Don't know	0.2 (0.1-0.7)	0.3(0.1-1.1)	0.0
Missing	0.1(0.0-0.3)	0.0	0.2(0.1-0.8)
Country of Birth			
Mexico	57.3 (52.1-62.3)	28.0 (22.7-34.1)	98.7 (97.4-99.3)
United States	39.6 (34.7-44.7)	66.8 (60.7-72.4)	1.2 (0.6-2.4)
Other	2.6 (1.7-4.1)	4.4 (2.8-6.8)	0.1 (0.0-1.2)
Missing	0.5 (0.2-1.2)	0.8 (0.3-2.0)	0.0
Border State of Birth			
UNITED STATES			
Arizona	3.9 (2.4-6.2)	6.6 (4.1-10.5)	0.0
California	11.6 (8.1-16.3)	19.5 (13.9-26.7)	0.3 (0.1-1.1)
New Mexico	1.0 (0.8-1.4)	1.8 (1.3-2.4)	0.1 (0.0-0.5)
Texas	9.3 (7.3-11.8)	15.4 (12.0-19.5)	0.7 (0.3-2.0)
MEXICO			
Baja California	7.7 (5.8-10.1)	4.1 (2.0-8.2)	12.7 (10.0-16.1)
Chihuahua	9.3 (7.5-11.5)	5.0 (3.6-7.1)	15.3 (11.8-19.6)
Coahuila	2.9 (2.3-3.7)	1.0 (0.4-2.3)	5.6 (4.6-6.8)
Nuevo Leon	1.0 (0.7-1.6)	1.1 (0.6-2.0)	1.0 (0.7-1.5)
Sonora	5.6 (4.4-7.1)	3.9 (2.5-6.1)	8.0 (6.2-10.2)
Tamaulipas	7.2 (6.0-8.6)	1.5 (0.9-2.5)	15.2 (12.7-18.1)
Other states	40.6	41.1	60.1

Appendix 2

Map A2. Counties selected for sampling study participants in the U.S.–Mexico Border Diabetes Prevalence Project 2001–2002



Appendix 3

TABLE A3. The 10 leading causes of death in the U.S.–Mexico border region

Mexico				United States			
Cause of Death	National	State	Municipalities	Cause of Death	National	State	County
1. Diseases of the heart	109.0	148.0	165.3	1. Diseases of the heart	151.4	141.5	125.7
2. Malignant neoplasms	87.0	106.2	111.2	2. Malignant neoplasms	138.3	128.2	119.6
3. Diabetes mellitus	77.6	81.2	101.7	3. Cerebro-vascular diseases	33.7	35.0	31.1
4. Accidents	42.2	45.0	54.0	4. Chronic obstructive pulmonary diseases	27.2	27.4	24.1
5. Cerebro-vascular diseases	40.6	46.0	48.6	5. Accidents	30.2	28.6	28.1
6. Chronic liver disease and cirrhosis	42.4	30.5	36.4	6. Diabetes mellitus	16.5	16.3	17.9
7. Chronic obstructive pulmonary diseases	17.6	20.9	18.9	7. Pneumonia and influenza	12.6	14.0	12.8
8. Pneumonia and influenza	16.2	15.9	17.2	8. Alzheimer's disease	8.5	8.4	10.3
9. Diseases originating in perinatal period	16.2	13.8	16.2	9. Chronic liver disease and cirrhosis	7.6	9.8	10.6
10. Homicide	12.3	10.3	15.6	10. Suicide	9.5	9.3	9.9

Source: Mexico: General Directorate of Epidemiology, Health Secretariat; deaths per 100 000 inhabitants, Census Instituto Nacional de Estadística y Geografía, 2000. United States: National Center for Health Statistics, Centers for Disease Control and Prevention. Note: For both countries, death rates are age-adjusted to the WHO world standard population 2000.

Appendix 4

TABLE A4. Diabetes mortality annualized crude rates per 100 000 population in U.S.–Mexico border region, 1992–1994 and1995–1997

United States			Mexico		
State/County	Rate 1992-1994	Rate 1995-1997	Rate 1992-1994	Rate 1995-1997	State/Municipality
United States	*20.8*	*23.1*	*33.3*	*37.1*	*Mexico*
California	13.2	16.4	35.7	37.1	**Baja California**
San Diego	10.6	13.9	31.1	32.7	Tijuana
Imperial	10.7	11.0	43.0	47.9	Mexicali
Arizona	17.6	21.5	36.3	39.3	**Sonora**
Yuma	20.6	16.9	45.4	50.4	San Luis Rio Colorado
Santa Cruz	12.8	17.1	37.1	35.0	Nogales
Cochise	21.2	24.0	31.9	28.8	Agua Prieta
New Mexico	24.4	24.8	35.9	42.0	**Chihuahua**
Luna	43.4	34.4	20.2	37.9	Ascencion
Dona Ana	23.8	30.3	49.7	51.0	Juarez
Texas	23.3	24.6	35.9	42.0	**Chihuahua**
El Paso	25.6	29.4	49.7	51.0	Juarez
Texas	23.3	24.6	46.2	49.2	**Coahuila**
Maverick	30.6	39.4	66.0	62.3	Piedras Negras
Texas	23.3	24.6	32.6	33.3	**Nuevo Leon**
Webb	32.5	42.5	50.1	43.3	Anahuac
Texas	23.3	24.6	39.6	42.5	**Tamaulipas**
Webb	32.5	26.7	56.4	50.8	Nuevo Laredo
Cameron	30.0	34.3	45.0	40.7	Matamoros

Sources: PAHO Mortality Profiles of the sister communities on the United States-Mexico Border. 1992-1994, Pan American Health Organization, Washington, DC 1999 and 2000

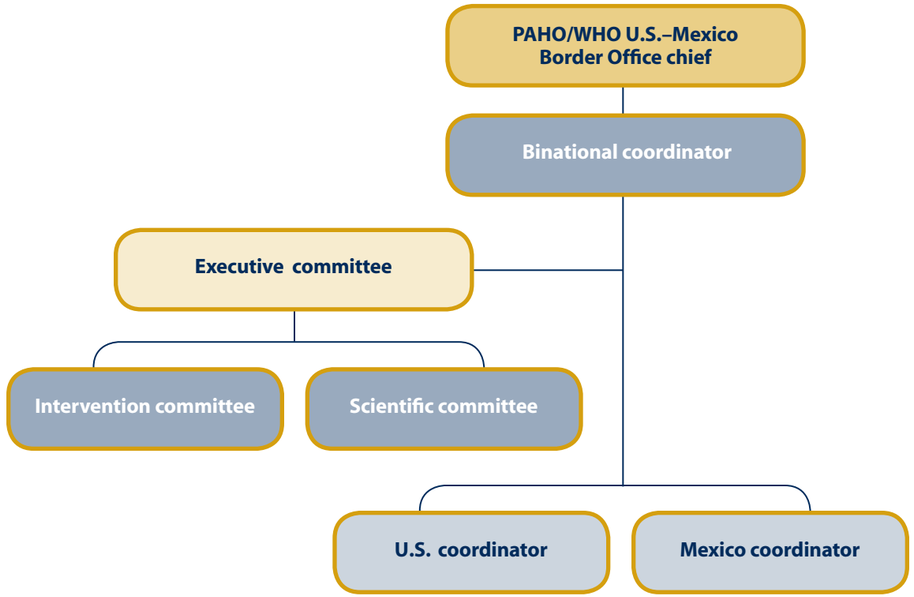
Appendix 5

TABLE A5. U.S.–Mexico border communities and municipalities that participated in the U.S.–Mexico Border Diabetes Prevention and Control Project

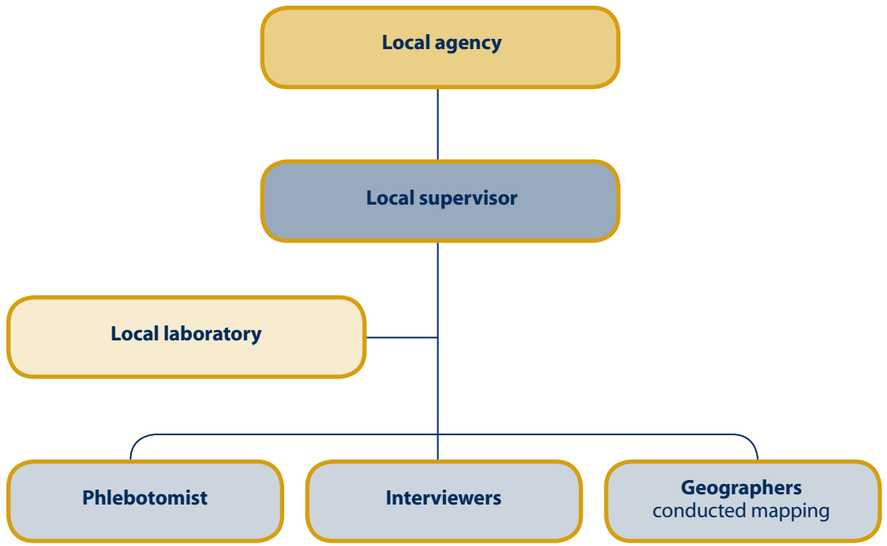
State	Counties/Municipalities
California	Imperial, San Diego
Baja California	Tecate, Tijuana, Mexicali, Algodones
Arizona	Yuma, Pima, Cochise, Santa Cruz
Sonora	Agua Prieta, Altar, Caborca, Cananea, Luis B. Sanchez, Naco, Nogales, Puerto Peñasco, SLRC, Sonoita
New Mexico	Doña Ana, Luna, Hidalgo
Chihuahua	Juarez, Guadalupe, Praxedis, Ascension, Ojinaga
Texas	El Paso, Presidio, Hidalgo, Cameron, Webb, Maverick, Valverde
Coahuila	Piedras Negras, Nava, Acuña
Nuevo Leon	Anahuac
Tamaulipas	Matamoros, Camargo, Miguel Aleman, Nuevo Laredo, Reynosa

Appendix 6

GRAPH A6-1. U.S.–Mexico Border Diabetes Prevention and Control Project coordination chart (phase I)



GRAPH A6-2. Local governance infrastructure created to conduct the prevalence study



Appendix 7

TABLE A7. Articles and projects on diabetes along the U.S.–Mexico border

Article/intervention	Responsible institution	Objective of the study/ intervention	Region	Reference
The impact of diabetes on adult employment and earnings of Mexican Americans: findings from a community-based study	The University of Texas Pan American College of Social and Behavioral Sciences	To analyze the impact of diabetes on the employment and earnings outcomes of adults 45 years of age or older.	Southwest of the United States	Bastida and Pagán, 2002 (77)
Prevalence of diabetes mellitus and related conditions in a south Texas Mexican American sample	The University of Texas Pan American Center on Aging and Health	To compare diabetics with nondiabetics with respect to hospitalization, reasons for hospitalization, and other related medical conditions.	South of Texas	Bastida et al., 2001 (78)
Dosage effect of diabetes self-management education for Mexican Americans	The Starr County Border Health Initiative	Compare two diabetes self-management interventions on Mexican Americans: one extended and one compressed.	Starr County, Texas	Brown et al., 2005 (79)
The Animadora Project: identifying factors related to the promotion of physical activity among Mexican Americans with diabetes	University of Arizona, Tucson, Arizona	Identifying factors related to the promotion of physical activity among Mexican Americans with diabetes, self-efficacy, and social support.	Tucson, Arizona	Ingram et al., 2009 (80)
Improvement in diabetes care of underinsured patients enrolled in Project Dulce	The Whittier Institute for Diabetes, San Diego, California	To improve clinical diabetes care, patient knowledge, and treatment satisfaction and to reduce health-adverse culture-based beliefs in underserved and underinsured populations with diabetes.	San Diego, California	Philis-Tsimikas et al., 2004 (81)
Health beliefs of Mexican Americans with type 2 diabetes: The Starr County border health initiative	University of Texas at Austin, Starr County, Texas	To compare two culturally competent diabetes self-management interventions designed for Mexican Americans.	Starr County, Texas	Brown et al., 2007 (82)
Diabetes is a community issue: the critical elements of a successful outreach and education model on the U.S.–Mexico border	University of Arizona, Tucson, Arizona	To prove that self-management education and support have great potential to affect diabetes control on the U.S.–Mexico border.	Tucson, Arizona	Ingram et al., 2005. (83)

Article/intervention	Responsible institution	Objective of the study/ intervention	Region	Reference
Border health strategic initiative: overview and introduction to a community-based model for diabetes prevention and control	University of Arizona, Tucson, Arizona	Development and Implementation of a comprehensive, community-based approach to diabetes prevention and control.	Yuma and Santa Cruz Counties, Arizona	Cohen and Ingram, 2005 (84)
Reducing diabetes and heart disease among U.S.–Mexico border communities	University of Arizona, Southwest Center for Community Health	Increase the capacity of communities along the U.S.–Mexico border for reducing diabetes, heart disease, and other chronic conditions. Ongoing.	Arizona–Mexico border	Lebowitz, 2006 (85)
Comprehensive diabetes intervention research project	University of Arizona, Canyon Ranch Center for Prevention and Health Promotion	To implement and evaluate multiple strategies to prevent and control diabetes. Ongoing.	Arizona–Mexico border	Staten, 2005 (86)
The impact of promotoras on social support and glycemic control among members of a farm worker community on the U.S.–Mexico border	University of Arizona	Describe the effect of a promotora-driven intervention to build social support as a means to affect self-management behaviors and clinical outcomes.	Arizona–Mexico border	Ingram et al., 2007 (87)
Analysis of behavioral risk factor surveillance system data to assess the health of Hispanic Americans with diabetes in El Paso County, Texas	University of Texas at El Paso	To determine and describe the health of Hispanic Americans who live in El Paso County, Texas, particularly the multidimensional self-management practices of those with diabetes.	El Paso County, Texas	Martinez and Bader, 2007 (88)
Health–illness transition experiences among Mexican immigrant women with diabetes	University of Arizona, Tucson, Arizona	Report findings from an intervention study designed to facilitate health–illness transition in Mexican immigrant women with type 2 diabetes who reside in the Arizona–Sonora region	Arizona–Sonora region	McEwen et al., 2007 (89)
Networking structure and attitudes toward collaboration in a community partnership for diabetes control on the U.S.–Mexico border	University of Arizona School of Public Administration and Policy	To provide an examination of a health policy network operating in a single, small community along the U.S.–Mexico border.	South of Arizona	Provan et al., 2005 (90)

Article/intervention	Responsible institution	Objective of the study/ intervention	Region	Reference
Advancing diabetes self-management in the Mexican American population: a community health worker model in a primary care setting	La Clinica de La Raza	To pilot test the effectiveness of health promotores trained in the transtheoretical model of change to provide diabetes management education and support to Mexican Americans in a primary care setting.	Oakland, California	Thompson et al., 2007 (91)
Access to healthcare among Latinos of Mexican descent in colonias in two Texas counties	University of Texas Pan American, Edinburgh	To document the challenges encountered by one ethnic subpopulation—Latinos of Mexican descent living in colonias.	Two counties in southern Texas	Ortiz et al., 2004 (92)
A health survey of a colonia located on the west Texas, U.S.–Mexico border	University of Texas at El Paso	To conduct a health survey of residents of a colonia community in El Paso, Texas.	El Paso County, Texas	Anders et al., 2008 (93)
Promotora diabetes intervention for Mexican Americans	University of Texas at El Paso	Determine the effectiveness of an intervention led by promotoras on the glycemic control, diabetes knowledge, and diabetes health beliefs of Mexican Americans with type 2 diabetes living in El Paso, Texas.	El Paso County, Texas	Lujan et al., 2007 (94)
Developing and adapting a family-based diabetes program at the U.S.–Mexico border	University of Arizona, Campesinos sin Fronteras, and Mariposa Community Health Center	To enhance family members' social support of patients with diabetes and to increase the range of primary prevention behaviors associated with diabetes in family members of patients with diabetes.	Yuma and Santa Cruz, Arizona	Teufel-Shone et al., 2005 (95)
SONRISA: a curriculum toolbox for promotores to address mental health and diabetes	Campesinos sin Fronteras, Compañeros en la Salud, Platicamos Salud, Western Health Education Center	To provide SONRISA, a mental health curriculum toolbox, an innovative, integrated approach to training promotores to address depression among their clients with chronic illnesses.	Yuma and Santa Cruz, Arizona	Reinschmidt and Chong, 2007 (96)

Article/intervention	Responsible institution	Objective of the study/ intervention	Region	Reference
Clinical depressive symptoms and diabetes in a binational border population	Texas A & M, Health Science Center, Universidad Autónoma de Tamaulipas, Mexico; South Texas Institutes of Health, McAllen, Texas	To examine the prevalence and correlates of clinical depressive symptoms in Hispanics of Mexican origin with type 2 diabetes living on both sides of the Texas–Mexico border.	Lower Rio Grande Valley in south Texas and Reynosa, Tamaulipas	Mier et al., 2008 (97)
Eficiencia técnica de la atención al paciente con diabetes en el primer nivel	Instituto Mexicano del Seguro Social/ Universidad Autónoma de Nuevo León	Cuantificar en un primer nivel al eficiencia técnica de la atención al paciente con diabetes y distinguir la provisión de servicios y los resultados en salud	Monterrey, Nuevo León	Salinas-Martínez et al., 2009 (98)
Necesidades en salud del diabético usuario del primer nivel de atención	Instituto Mexicano del Seguro Social, Universidad Autónoma de Nuevo León	Determinar la magnitud y jerarquizar la necesidad de salud satisfecha del diabético tipo 2 usuario del primer nivel de atención	Monterrey, Nuevo León	Salinas-Martínez AM et al., 2001 (99)
Importancia del apoyo familiar en el control de la glucemia	Instituto Mexicano del Seguro Social, Durango, Durango	Determinar la importancia del apoyo familiar en el control de la glucemia en diabéticos no insulino dependientes	Durango, Durango	Rodríguez-Morán and Guerreo-Romero, 1997 (100)
Apego al tratamiento farmacológico en paciente con diagnóstico de diabetes mellitas tipo 2	Instituto Mexicano del Seguro Social, Chihuahua, Chihuahua	Establecer la frecuencia de apego al tratamiento farmacológico en pacientes diabéticos tipo 2, relacionarla con el control metabólico, e identificar factores que influyen para el no apego.	Chihuahua, Chihuahua	Durán-Varela et al., 2001 (101)
Pasos Adelante: the effectiveness of a community-based chronic disease-prevention program	University of Arizona	A 12-week program adapted from the National Heart, Lung and Blood Institute "Su corazón, su vida" aimed at preventing diabetes, cardiovascular disease, and associated risk factors. Evaluation results showed a significant increase in rigorous walking and shift in diet.	Arizona–Mexico border counties	Staten et al., 2005 (102)