

Access to health care and undiagnosed diabetes along the United States-Mexico border

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ABSTRACT **Objective.** To examine the relationship between access to health care and undiagnosed diabetes among the high-risk, vulnerable population in the border region between the United States of America and Mexico.

Methods. Using survey and fasting plasma glucose data from Phase I of the U.S.-Mexico Border Diabetes Prevention and Control Project (February 2001 to October 2002), this epidemiological study identified 178 adults 18–64 years old with undiagnosed diabetes, 326 with diagnosed diabetes, and 2 966 without diabetes. Access to health care among that sample (n = 3 470), was assessed by type of health insurance coverage (including “none”), number of health care visits over the past year, routine pattern of health care utilization, and country of residence.

Results. People with diabetes who had no insurance and no place to go for routine health care were more likely to be undiagnosed than those with insurance and a place for routine health care (odds ratio [OR] 2.6, 95% confidence interval [CI] 1.0–6.6, and OR 4.5, 95% CI 1.4–14.1, respectively). When stratified by country, the survey data showed that on the U.S. side of the border there were more people with undiagnosed diabetes if they were 1) uninsured versus the insured (28.9%, 95% CI 11.5%–46.3%, versus 9.1%, 95% CI 1.5%–16.7%, respectively) and if they 2) had made no visits or 1–3 visits to a health care facility in the past year versus had made ≥ 4 visits (40.8%, 95% CI 19.6%–62.0%, and 23.4%, 95% CI 9.9%–36.9%, respectively, versus 2.4%, 95% CI –0.9%–5.7%) (all, P < 0.05). No similar pattern was found in Mexico.

Conclusions. Limited access to health care—especially not having health insurance and/or not having a place to receive routine health services—was significantly associated with undiagnosed diabetes in the U.S.-Mexico border region.

Key words Diabetes mellitus, type 2; diagnosis; health services accessibility; border health; United States; Mexico.

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The United States of America and Mexico share a border that links four U.S. and six Mexican states.⁴ The border region, which extends 100 km north and south of the political divide and 3 141 km from the Gulf of Mexico to the Pacific Ocean, links two nations with consider-

able differences in terms of types of health care systems and level of economic development (1). On both sides of the border, undiagnosed diabetes is associated with tremendous human and economic costs.

In the United States, an estimated 5.7 million people with diabetes—24% of the 23.6 million people suffering from diabetes nationwide—were undiagnosed, according to a 2007 study (2). In Mexico, a survey published in 2002 targeting the urban population aged 20 to 69 years indicated 26% of people with diabetes aged 40 years or older and 42% of those aged 20–40 years old were unaware of their condition (3). Complications of diabetes include blindness, kidney failure, cardiovascular disease, and conditions that require lower-limb amputations (4). There are many efficacious and cost-effective interventions that can prevent or delay these complications, but none would be carried out among people with diabetes who are unaware of their condition (4). Therefore, timely detection of diabetes is crucial (5–7).

In the United States, according to U.S. Census Bureau estimates for 2008, 15.4% or 46 million people lacked health insurance (8). By 2009, the estimated number had grown to 52 million (9). In Mexico, data for 2001 from a nationally representative prospective panel study known as the Mexican Health and Aging Study (*Estudio Nacional de Salud y Envejecimiento en México*) indicated 39% of Mexican adults aged 50 years or older were uninsured (10). Although several initiatives have been launched in Mexico to expand health insurance coverage, as well as access to health care, including the conditional cash transfer *Oportunidades* program targeting poor families with children (formerly known as *Progres*a), and the *Seguro Popular de Salud* program targeting the uninsured, they have not resulted in substantial improvements (11). While data for the U.S.-Mexico border region in particular is relatively limited, studies that have been conducted indicate similar gaps in health insurance coverage. In the four U.S. states that border Mexico, the percentage of uninsured was 21% in the counties that border Mexico and 14% in the counties that do not (12).

Studies in both the United States and Mexico indicate that, compared to those with insurance, the uninsured are much less likely to receive routine checkups or

preventive services (13, 14), tend to be more severely ill when diagnosed, and receive less therapeutic care (15). Not only does insurance coverage play a role in access to preventive care (16), but absence of a place to go for routine health care, which is related to lack of health insurance, is also associated with the absence of screening, follow-up care, and pharmacologic treatment for hypertension (17). Limited access to health care not only affects the use of preventive services (18) but also elevates the risk of a decline in overall health (19) and is associated with undiagnosed diabetes along with other health conditions (20).

Limited access to health care is one of the challenges faced by people living in the U.S.-Mexico border region. This study examined how various health care access indicators, including insurance coverage, affects the detection of diabetes among the high-risk, vulnerable population in the U.S.-Mexico border region, and whether the relationship differs between the two countries.

MATERIALS AND METHODS

Data

This epidemiological study used survey and fasting plasma glucose data from Phase I (February 2001 to October 2002) of the U.S.-Mexico Border Diabetes Prevention and Control Project (21). Phase I was a population-based, cross-sectional study of a multistage cluster representative sample of 4 027 adults aged 18 years or older living in the 10 contiguous states of the U.S.-Mexico border region.

The project survey included a questionnaire with 65 questions about diabetes, general health and access to health care, hypertension, physical activity, diet and eating habits, tobacco use, alcohol consumption, reproductive health, socio-cultural aspects, acculturation, education, work history, and demographic characteristics, including ethnicity (21). Bilingual interviewers administered the questionnaire in either English or Spanish, depending on the preference of each individual respondent. Weight and height were measured and used to calculate body mass index (BMI). As per World Health Organization (WHO) standards, BMI categories were defined as follows: underweight < 18.5, normal weight 18.5–24.9, overweight 25–29.9,

and obesity ≥ 30.0 . Systolic and diastolic blood pressure levels were measured in triplicate. Venipuncture was performed after 8-hour fasting to obtain fasting plasma glucose (21).

The current study's analyses were based on project survey data for adults aged 18 to 64 years who had fasted for 8 hours or longer immediately before having their plasma glucose measured ($n = 3\,470$). Persons aged 65 years or older were excluded to screen out recipients of Medicare (a U.S. federal government health care insurance program available to those in that age group). Survey respondents were classified as having diagnosed diabetes if they responded positively to the question "Have you ever been told by a doctor or other health care worker that you have diabetes or high blood sugar?" Women who had diabetes only during pregnancy were excluded. Survey respondents who had not been told that they had diabetes but had a fasting plasma glucose level ≥ 126 mg/dL were classified as having undiagnosed diabetes while those with fasting plasma glucose levels < 126 mg/dL were classified as not having diabetes.

Measures

Access to health care can be measured in terms of availability, organization, financing, utilization, and satisfaction, among other domains (16). The measures of access used in this study pertained to financing and utilization (16). Financing was measured by classifying respondents as either insured or uninsured. Respondents who answered "None" to the question "Which of the following is your primary medical coverage plan?" were classified as uninsured. Utilization was measured by 1) number of times the survey participant received health care during the past year, derived from the answer to the question "How many health care visits have you made in the past 12 months?" and 2) routine pattern of health care utilization, based on the answer to the question "What type of health care facility do you usually use?" For those on the Mexican side of the border, possible answers to the latter question included a) emergency room or urgent care clinic, b) private doctors' offices, c) public clinic (non-urgent care), d) military (i.e., the Mexican Veterans Affairs hospital (*Sedena Marina*), e) Mexican Social Security Institute (*Instituto Mexicano*

de Seguro Social, IMSS), f) Mexican ministry of health (*Secretaría de Salud*), g) Mexican social security for state workers (*Instituto de Seguridad y Servicios Sociales de los Trabajadores del Estado*, ISSSTE), h) pharmacy, and i) no place. For the U.S. side of the border, possible answers included: a) emergency room or urgent care clinic, b) private doctors' office, c) public clinic, d) military (veterans affairs hospital), e) health center, f) pharmacy, and g) no place.

Results were controlled for six socio-demographic factors: age (continuous variable), sex, marital status (dichotomous variable), highest level of education attained (less than high school, high school, and high school plus some college), and occupation (white collar, blue collar, service, and not in the labor force). Covariates included BMI (continuous variable) and a dichotomized version of self-rated health ("good or above" versus "fair/poor").

Data analysis

In the study analysis, SUDAAN statistical software version 9.0.1 (SUDAAN Statistical Software Center, Research Triangle Park, NC, USA) was used to estimate 95% confidence intervals (CIs) to adjust for the complex survey sample design (22), and two-tailed Student's *t*-tests were conducted to determine significance ($P < 0.05$).

Three different approaches were used to examine the relationship between access to health care and undiagnosed diabetes: 1) use of multivariate logistic regression models among all survey respondents with diabetes ("diagnosed" and "undiagnosed") to examine the association between undiagnosed diabetes and health care access indicators; 2) use of the same multivariate logistic regression models among survey respondents who self-reported not having diabetes (including those who did not have diabetes and those who had diabetes but were unaware of their condition) to examine the association between access to health care and actually having diabetes, with age, sex, marital status, education, occupation, BMI, self-rated health, and country of residence as covariates; and 3) testing for interaction between access to health care and country of residence, and, in cases where *P* values for interaction were significant, further examination of the percentage of survey respondents with undi-

agnosed diabetes, by health care access indicator and country of residence.

RESULTS

Among the survey respondents aged 18–64 years old who had fasted for at least 8 hours immediately before having their plasma glucose measured ($n = 3\,470$), the current study identified 178 individuals with undiagnosed diabetes, 326 with diagnosed diabetes, and 2 966 persons without diabetes (Table 1). The mean age for those with diagnosed diabetes was 48.5 years. For those with undiagnosed diabetes and no diabetes, the mean ages were 38.0 years and 35.5 years, respectively. There were no significant differences by sex, marital status, or occupation among the three groups ("no diabetes" "undiagnosed diabetes," "di-

agnosed diabetes"). There was a significant racial/ethnic difference by diabetes status, with Hispanics comprising 98.1% of those with undiagnosed diabetes but only 70.3% of the total population. Although residents of the Mexican side of the border represented only 44.2% of the total study sample, they represented 73.6% of the cases of undiagnosed diabetes. Regardless of diagnostic status, persons with diabetes had, on average, significantly lower educational attainment and were significantly more likely to be obese than persons without diabetes ($P < 0.001$). Those without diabetes had the best self-rated health, followed by those with undiagnosed diabetes and then those with diagnosed diabetes.

The percentage of uninsured was higher among persons with undiagnosed diabetes than among persons with diag-

TABLE 1. Characteristics of U.S.-Mexico border population 18–64 years old, by diabetes group, U.S.-Mexico Border Diabetes Prevention and Control Project, Phase I, February 2001–October 2002^a

Characteristic	Total (<i>n</i> = 3 470)	No diabetes (<i>n</i> = 2 966)	Undiagnosed diabetes (<i>n</i> = 178)	Diagnosed diabetes (<i>n</i> = 326)	<i>P</i> ^b
Age (years) (mean ± SE ^c)	36.8 ± 0.5	35.5 ± 0.5	38.0 ± 1.4	48.5 ± 2.2	< 0.001
Female (%)	50.9	50.9	61.3	46.8	0.184
Hispanic (%)	70.3	69.9	98.1	63.1	< 0.001
Married (%)	69.1	68.9	66.0	72.1	0.776
Highest level of education attained (%)					0.003
Less than high school	44.6	43.3	68.2	47.8	
High school	25.0	25.2	11.7	28.2	
High school plus some college	30.4	31.5	20.1	24.1	
Occupation (%)					0.635
White collar	22.1	21.6	22.9	27.8	
Blue collar	15.1	15.2	14.8	13.8	
Service	26.8	27.4	19.1	24.0	
Not in labor force	36.0	35.9	43.3	34.4	
Country of residence (%)					< 0.001
Mexico	44.2	43.9	73.6	35.8	
Body mass index (%)					< 0.001
18.5–24.9 (normal weight)	28.6	30.4	17.8	14.5	
25.0–29.9 (overweight)	37.6	39.4	30.3	23.0	
≥ 30 (obese)	33.9	30.2	51.9	62.4	
Self-reported health (fair or poor, %)	64.4	32.9	48.2	58.1	0.001
Uninsured (%)	28.6	29.0	33.4	22.6	0.405
Number of health care visits in past year (%)					< 0.001
0	37.8	40.3	39.2	13.4	
1–3	39.5	39.5	36.6	40.8	
≥ 4	22.7	20.2	24.3	45.9	
Routine pattern of health care utilization (%)					< 0.001
No place ^d	17.8	19.3	16.6	3.7	
Emergency room/urgent care	9.1	8.2	17.5	14.8	
Publicly funded care	32.3	32.0	37.3	34.1	
Private care	40.8	40.6	28.7	47.4	

^a Weighted data are used to adjust for the complex survey sample design.

^b Estimated significance ($P < 0.05$) between diabetes groups based on chi-square (χ^2) or Student's *t* test for categorical and continuous variables, respectively.

^c SE: standard error.

^d No place to receive regular, appropriate health services and coordinated care over time.

TABLE 2. Adjusted odds ratios (ORs) and 95% confidence intervals (CIs) for association between health insurance coverage and undiagnosed diabetes, by diabetes group, U.S.-Mexico Border Diabetes Prevention and Control Project, Phase I, February 2001–October 2002

Health care access indicator/covariate	Among persons with diabetes (undiagnosed, <i>n</i> = 178; diagnosed, ^a <i>n</i> = 326)		Among persons reporting no diabetes ^b (undiagnosed, <i>n</i> = 178; no diabetes <i>n</i> = 2 966)	
	OR	95% CI	OR	95% CI
Insurance coverage				
Uninsured	2.6	1.0–6.6	1.3	0.7–2.3
Insured ^c	1.0	NA ^d	1.0	NA
Age	0.9	0.9–1.0	1.0	1.0–1.0
Sex				
Male ^c	1.0	NA	1.0	NA
Female	4.6	1.9–11.0	1.9	1.0–3.7
Marital status				
Married ^c	1.0	NA	1.0	NA
Not married	1.2	0.5–2.7	2.2	1.3–3.8
Highest level of education attained				
Less than high school	1.3	0.4–4.1	1.5	0.6–3.8
High school	1.2	0.3–5.0	0.7	0.3–2.2
High school plus some college ^c	1.0	NA	1.0	NA
Occupation				
White collar ^c	1.0	NA	1.0	NA
Blue collar	0.7	0.2–2.3	0.5	0.2–1.3
Service	0.9	0.2–3.3	0.9	0.3–2.7
Not in labor force	0.5	0.2–1.5	0.6	0.3–1.3
Body mass index				
18.5–24.9 (normal weight) ^c	1.0	NA	1.0	NA
25.0–29.9 (overweight)	2.4	0.8–7.6	1.4	0.7–3.0
≥ 30 (obese)	2.0	0.7–5.8	2.8	1.3–5.8
Self-reported health				
Fair or poor	0.4	0.2–0.8	1.1	0.6–1.9
Good or above ^c	1.0	NA	1.0	NA
Country of residence				
United States ^c	1.0	NA	1.0	NA
Mexico	7.1	2.2–23.0	3.1	1.6–6.2
Goodness-of-fit <i>P</i> ^e	< 0.001		< 0.001	

^a Responding positively to the question "Have you ever been told by a doctor or other health care worker that you have diabetes or high blood sugar?"

^b Including those who did not have diabetes and those who had diabetes but were unaware of their condition.

^c Reference group.

^d NA: not applicable.

^e Based on Wald F-test for the model with 14 degrees of freedom.

nosed diabetes but the difference was not statistically significant. However, persons with undiagnosed diabetes were more likely than those with diagnosed diabetes to report not having made any health care visits in the past year (39.2% versus 13.4%) and not having a place to go for routine health care (16.6% versus 3.7%) ($P < 0.01$ for both indicators).

The multivariate logistic analyses (Tables 2, 3, and 4) examined the relationship between access to health care and undiagnosed diabetes. After adjusting for age, sex, marital status, education, occupation, BMI, self-rated health, and country of residence, it was determined that persons with undiagnosed diabetes were significantly more likely than those with diagnosed diabetes to report being uninsured (OR 2.6, 95% CI 1.0–6.6) and having no place to go for routine health care services (OR 4.5, 95% CI 1.4–14.1).

Interactions between living on the U.S. side of the border and having insurance were significant for both the diabetic population and those not reporting diabetes ($P = 0.004$ and 0.045 , respectively) (Table 5). For the diabetic population, the interaction between living on the U.S. side of the border and number of health care visits made in the past year was also significant ($P = 0.027$) (Table 5). The percentage of those with undiagnosed diabetes in the U.S. border region diabetic population was significantly higher among the uninsured than among the insured (28.8%, 95% CI 11.5%–46.3% versus 9.1%, 95% CI 1.5%–16.7%; $P < 0.05$) (Table 5). Furthermore, on the U.S. side of the border, the number of health care visits made in the past year was significantly associated with undiagnosed diabetes: among those who had not made any health care visits in the past year, 40.8% (95% CI 19.6%–

62.0%) were undiagnosed, whereas among those who had made 1 to 3 visits, 23.4% (95% CI 9.9%–36.9%) were undiagnosed; among those who received care 4 times or more, 2.4% (95% CI –0.9%–5.7%) were undiagnosed. Among survey respondents living on the U.S. side of the border who self-reported not having diabetes, the percentage of those with undiagnosed diabetes was significantly higher among the uninsured than among the insured (3.9%, 95% CI 1.0%–6.8% versus 1.1%, 95% CI 0.3%–1.9%; $P < 0.05$).

Among the survey respondents living on the Mexican side of the border, this pattern did not exist, although the percentage of undiagnosed diabetes was generally higher in each population category versus the U.S. side of the border. However, there were some variations in the percentage of undiagnosed diabetes on the Mexican side of the border by type

TABLE 3. Adjusted odds ratio (ORs) and 95% confidence intervals (CIs) for association between number of health care visits during past year and undiagnosed diabetes, by diabetes group, U.S.-Mexico Border Diabetes Prevention and Control Project, Phase I, February 2001–October 2002

Health care access indicator/covariate	Among persons with diabetes (undiagnosed, <i>n</i> = 178; diagnosed, ^a <i>n</i> = 326)		Among persons reporting no diabetes ^b (undiagnosed, <i>n</i> = 178; no diabetes <i>n</i> = 2 966)	
	OR	95% CI	OR	95% CI
Number of health care visits in past year				
0	1.6	0.7–3.7	0.8	0.4–1.6
1–3 ^c	1.0	NA ^d	1.0	NA
≥ 4	0.4	0.1–1.2	0.8	0.4–1.6
Age	1.0	0.9–1.0	1.0	1.0–1.0
Sex				
Male ^c	1.0	NA	1.0	NA
Female	3.8	1.6–9.1	2.0	0.9–4.0
Marital status				
Married ^c	1.0	NA	1.0	NA
Not married	1.3	0.6–2.8	2.2	1.3–3.9
Highest level of education attained				
Less than high school	1.6	0.5–4.7	1.7	0.6–4.3
High school	1.1	0.2–4.6	0.8	0.3–2.4
High school plus some college ^e	1.0	NA	1.0	NA
Occupation				
White collar ^c	1.0	NA	1.0	NA
Blue collar	0.8	0.3–2.9	0.5	0.2–1.3
Service	1.1	0.3–3.8	0.9	0.3–2.8
Not in labor force	0.7	0.2–2.0	0.6	0.3–1.3
Body mass index				
18.5–24.9 (normal weight) ^c	1.0	NA	1.0	NA
25.0–29.9 (overweight)	2.5	0.8–7.8	1.4	0.7–3.1
≥ 30 (obese)	2.1	0.7–6.4	2.9	1.4–6.1
Self-reported health				
Fair or poor	0.3	0.2–0.8	1.1	0.6–1.9
Good or above ^c	1.0	NA	1.0	NA
Country of residence				
United States ^c	1.0	NA	1.0	NA
Mexico	5.6	2.0–15.8	3.1	1.6–6.2
Goodness-of-fit <i>P</i> ^e	< 0.001		< 0.001	

^a Responding positively to the question "Have you ever been told by a doctor or other health care worker that you have diabetes or high blood sugar?"

^b Including those who did not have diabetes and those who had diabetes but were unaware of their condition.

^c Reference group.

^d NA: not applicable.

^e Based on Wald F-test for the model with 15 degrees of freedom.

of health care facility used. For example, the percentage undiagnosed was significantly higher among those who reported no place to receive health care versus those who reported usually using an emergency room/urgent care clinic or publicly-funded facility for routine health care services (61.2%, 95% CI 43.6%–78.4% versus 62.4%, 95% CI 44.2%–80.6% and 35.6%, 95% CI 23.3%–47.9%, respectively) (all, *P* < 0.01). Among Mexican adults who reported not having diabetes, the percentage of those with undiagnosed diabetes was significantly lower among those who used private care (3.5%, 95% CI 1.0%–6.0%) and those who used publicly funded care (5.6%, 95% CI 3.4%–7.8%) versus those who usually used emergency room/urgent care for routine health care services (19.4%, 95% CI 7.6%–31.2%) (all, *P* < 0.01).

DISCUSSION

Persons with undiagnosed diabetes are at high risk for diabetes-related complications (2, 5). Interventions that can reduce the risk of or at least delay the development of diabetes complications require timely diagnosis of the diabetes, which in turn requires access to routine health care services. Based on a representative sample of adult residents of the U.S.-Mexico border region, findings from the current study showed that lack of access to health care was significantly associated with elevated risk of having undiagnosed diabetes, and undiagnosed diabetes was associated with a lack of both health insurance and a place to receive routine health care. When analyzing the data by country of residence, the results showed that, on the U.S. side of

the border, limited access to health care due to lack of either health insurance or a place to receive routine health care was significantly associated with undiagnosed diabetes. On the Mexican side of the border, however, there was no association between these variables.

Previous studies found no relationship between education or income and risk of having undiagnosed diabetes (23, 24). However, these studies did not consider the effect of access to health care (another aspect of socioeconomic status) on diagnosis of diabetes. A recent study (25) using data from the U.S. Centers for Disease Control and Prevention's Behavioral Risk Factor Surveillance System (BRFSS) (1998–2001) found that persons of lower socioeconomic status were at greater risk for not receiving preventive care than those at other socioeconomic levels, and

TABLE 4. Adjusted odds ratios (ORs) and 95% confidence intervals (CIs) for association between routine pattern of health care utilization and undiagnosed diabetes, by diabetes group, U.S.-Mexico Border Diabetes Prevention and Control Project, Phase I, February 2001–October 2002

Health care access indicator/covariate	Among persons with diabetes (undiagnosed, <i>n</i> = 178; diagnosed, ^a <i>n</i> = 326)		Among persons reporting no diabetes ^b (undiagnosed, <i>n</i> = 178; no diabetes <i>n</i> = 2 966)	
	OR	95% CI	OR	95% CI
Routine pattern of health care utilization				
No place ^c	4.5	1.4–14.1	1.7	0.7–4.0
Emergency room/urgent care	1.5	0.5–4.5	4.6	1.9–11.2
Publicly funded care	0.7	0.3–1.9	1.5	0.8–3.1
Private care ^d	1.0	NA ^e	1.0	NA
Age	0.9	0.9–1.0	1.0	1.0–1.0
Sex				
Male ^d	1.0	NA	1.0	NA
Female	3.4	1.4–8.4	1.9	0.9–3.7
Marital status				
Married ^d	1.0	NA	1.0	NA
Not married	1.1	0.5–2.4	2.1	1.2–3.7
Highest level of education attained				
Less than high school	2.0	0.7–5.9	1.6	0.6–4.0
High school	1.3	0.3–5.6	0.7	0.2–2.3
High school plus some college ^d	1.0	NA	1.0	NA
Occupation				
White collar ^d	1.0	NA	1.0	NA
Blue collar	0.6	0.2–2.3	0.5	0.2–1.2
Service	0.8	0.3–2.9	0.9	0.3–2.7
Not in labor force	0.5	0.2–1.6	0.6	0.3–1.3
Body mass index				
18.5–24.9 (normal weight) ^d	1.0	NA	1.0	NA
25.0–29.9 (overweight)	2.8	0.9–8.4	1.5	0.7–3.3
≥ 30 (obese)	2.3	0.8–6.6	2.9	
Self-reported health				
Fair or poor	0.3	0.2–0.8	1.1	0.6–1.9
Good or above ^d	1.0	NA	1.0	NA
Country of residence				
United States ^d	1.0	NA	1.0	NA
Mexico	7.0	1.9–25.5	3.0	1.5–6.4
Goodness-of-fit <i>P</i> ^f	< 0.001		< 0.001	

^a Responding positively to the question "Have you ever been told by a doctor or other health care worker that you have diabetes or high blood sugar?"

^b Including those who did not have diabetes and those who had diabetes but were unaware of their condition.

^c No place to receive regular, appropriate health services and coordinated care over time.

^d Reference group.

^e NA: not applicable.

^f Based on Wald F-test for the model with 16 degrees of freedom.

those without health insurance coverage had the greatest risk of not receiving preventive care. One study that specifically examined the effect of access to health care on diabetes diagnosis (20) found an association between limited access and being undiagnosed. In line with those findings, the results of the current study suggest that, at least for those residing on the U.S. side of the border, limited access to health care due to lack of health insurance and/or lack of a place to receive routine health care has a significant effect on the detection of diabetes.

When the study analysis was repeated, stratifying the data by country of residence, the results suggested that type of health care system might account for the difference in the association between ac-

cess to health care and the detection of diabetes. Among those living on the Mexican side of the border, the percentage of undiagnosed diabetes was higher in all categories (see Table 5) versus those living on the U.S. side of the border. However, there was no significant association among those living on the Mexican side of the border between access to health care and diagnosis of diabetes. In contrast, among those living on the U.S. side of the border, access to health care was associated with detection of diabetes (i.e., respondents with a place to receive routine health care had less likelihood of having undiagnosed diabetes). This pattern appeared not only among the diabetic population but also among people who reported not having diabetes. An increase

in patients' willingness to seek insurance and use health care upon receipt of a diagnosis of diabetes may have driven these findings, as shown in studies on use of health care services after diagnosis of diabetes versus several years prior (26–29), which found an increase in health care utilization. Similar to a previous study (20) that found that undiagnosed status could be attributed to a lack of access to health care, the current findings indicated that, at least for those on the U.S. side of the border, access to health care plays a crucial role in determining whether or not diabetes is detected.

Based on the country-stratified data, the differences in the association between access to health care and diabetes detection on the U.S. versus the Mexican side of the

TABLE 5. Percentage of study participants with undiagnosed diabetes by country of residence, diabetes groups, and health care access indicator, U.S.-Mexico Border Diabetes Prevention and Control Project, Phase I, February 2001–October 2002^a

Health care access indicator	Among persons with diabetes					Among persons reporting no diabetes ^b				
	Mexico (undiagnosed, <i>n</i> = 116; diagnosed, ^c <i>n</i> = 172)		United States (undiagnosed, <i>n</i> = 62; diagnosed, ^c <i>n</i> = 154)		<i>P</i> ^e	Mexico (undiagnosed, <i>n</i> = 116; no diabetes, <i>n</i> = 1 650)		United States (undiagnosed, <i>n</i> = 62; no diabetes, <i>n</i> = 1 316)		<i>P</i> ^e
	%	95% CI ^d	%	95% CI		%	95% CI	%	95% CI	
Insurance coverage										
Uninsured	37.8	22.7–52.9	28.9	11.5–46.3	0.004	5.3	2.0–8.6	3.9	1.0–6.8	0.045
Insured	44.2	33.0–55.4	9.1	1.5–16.7		6.2	4.2–8.6	1.1	0.3–1.9	
Number of health care visits in past year										
None	43.3	28.2–58.4	40.8	19.6–62.0	0.027	5.1	2.6–7.6	2.6	0.4–4.8	0.24
1–3	42.3	28.6–56.0	23.4	9.9–36.9		6.7	3.4–10.0	2.7	0.9–4.5	
≥ 4	43.6	29.1–58.1	2.4	–0.9–5.7		7.8	3.3–12.3	0.7	–0.1–1.5	
Routine pattern of health care utilization										
No place ^f	61.2	43.6–78.4	36.5	8.5–64.5	0.45	6.6	1.9–11.3	2.0	–0.4–4.4	0.46
Emergency room/urgent care	62.4	44.2–80.6	17.0	0.9–33.1		19.4	7.6–31.2	3.2	–0.3–6.7	
Publicly funded care	35.6	23.3–47.9	13.5	–5.7–32.7		5.6	3.4–7.8	2.6	–0.1–5.3	
Private care	44.7	29.8–59.6	12.2	4.2–20.2		3.5	1.0–6.0	1.6	0.4–2.8	

^a Represented as predicted marginals estimated from separate logistic regression models for each health care access indicator, adjusted for age, sex, marital status, education, occupation, body mass index, self-rated health (“fair or poor” versus “good or above”), country of residence, and country × health care access interaction. Each estimate refers to a separate logistic regression.

^b Including those who did not have diabetes and those who had diabetes but were unaware of their condition.

^c Responding positively to the question “Have you ever been told by a doctor or other health care worker that you have diabetes or high blood sugar?”

^d CI: confidence interval.

^e Estimated significance ($P < 0.05$) for interaction based on interaction term test.

^f No place to receive regular, appropriate health services and coordinated care over time.

border may be attributable to the type of health care systems in the two countries. When survey respondents' responses about routine patterns of health care utilization were analyzed, four main categories emerged: 1) “none” (i.e., having no place to receive routine health care), 2) emergency room or urgent care, 3) publicly funded care, and 4) private care. While the categories “having no place to receive routine health care” and “use of private care” are self-explanatory and have definitions common to both sides of the border, the “emergency room/urgent care” and “publicly funded care” categories have different, country-specific criteria. For example, in the United States, the “publicly funded” category included public clinics funded by Medicare or Medicaid, Veteran Affairs facilities, and health centers operated by communities, whereas in Mexico this category included

public clinics, the Veteran Affairs hospital (*Sedena Marina*), and health centers operated by the IMSS, the ministry of health, and the ISSSTE. According to other studies, differences in health care systems may account for variations in the association between health care access and various health outcomes (10, 14, 30).

The current study had several limitations. First, the relatively small number of persons in the sample with undiagnosed diabetes made it difficult to analyze differences by subgroup (e.g., sex or ethnicity). Second, the study's measures of health care access did not take into account availability, organization, or satisfaction. Third, diabetes status was identified by self-report as well as lab data, allowing for the possibility of recall bias.

Nevertheless, the current study's analyses clearly indicate that limited access to health care—especially among

those without health insurance and/or a place to receive routine health care services—is associated with undiagnosed diabetes. To increase the timeliness of diabetes detection and thereby prevent diabetes-related complications and their associated economic and human costs, routine health care must be made more accessible to those who currently lack access to it. While the specific characteristics of this demographic group may differ between the two sides of the U.S.-Mexico border region, there is an urgent need in both the United States and Mexico to address the health care access gap.

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REFERENCES

- Ruiz-Beltran M, Kamau JK. The socioeconomic and cultural impediments to well-being along the US-Mexico border. *J Community Health*. 2001;26(2):123–32.
- U.S. Centers for Disease Control and Prevention. National diabetes fact sheet: general information and national estimates on diabetes in the United States, 2007 [page on the Internet]. Atlanta, GA: U.S. Department of Health and Human Services, CDC; 2008. Available from: http://www.cdc.gov/diabetes/pubs/pdf/ndfs_2007.pdf. Accessed 15 October 2009.
- Aguilar-Salinas CA, Rojas R, Gómez-Pérez FJ, García E, Valles V, Ríos-Torres JM, et al. Prevalence and characteristics of early-onset type 2 diabetes in Mexico. *Am J Med*. 2002; 113(7):569–74.
- American Diabetes Association. Standards of medical care in diabetes—2007. *Diabetes Care*. 2007;30(1 Suppl):S4–41.
- American Diabetes Association. Screening for type 2 diabetes. *Diabetes Care*. 2004;27(1 Suppl):S11–14.
- International Diabetes Federation. Global guideline for type 2 diabetes [page on the Internet]. Brussels: IDF; 2009. Available from: http://www.idf.org/Global_guideline. Accessed 10 August 2009.
- World Health Organization. Definition, diagnosis and classification of diabetes mellitus and its complications. Report of a WHO Consultation. Part 1: Diagnosis and classification of diabetes mellitus. Geneva: WHO; 1999. (WHO/NCD/NCS/99.2.) Available from: http://whqlibdoc.who.int/hq/1999/WHO_NCD_NCS_99.2.pdf. Accessed 10 August 2009.
- DeNavas-Walt C, Proctor BD, Smith JC, U.S. Census Bureau. Income, poverty, and health

- insurance coverage in the United States: 2008. Current population reports. Washington, D.C.: U.S. Government Printing Office; 2009. Available from: <http://www.census.gov/prod/2009pubs/p60-236.pdf>. Accessed 11 September 2009.
9. Center for American Progress. Dramatic increase in the uninsured rate in every state. Washington, D.C.: CAP; 2009. Available from: http://www.americanprogress.org/issues/2009/05/pdf/uninsured_rate.pdf. Accessed 3 September 2009.
 10. Pagán JA, Puig A. Differences in access to health care services between insured and uninsured adults with diabetes in Mexico. *Diabetes Care*. 2005;28(2):425–6.
 11. Homedes N, Ugalde A. Twenty-five years of convoluted health reforms in Mexico. *PLoS Med*. 2009;6(8):e1000124.
 12. La Fe Policy Research and Education Center. U.S./Mexico border fact sheet: access to health care. San Antonio, TX: LFPREC; 2009. Available from: <http://www.lafepolicycenter.org/documents/US%20MX%20BORDER%20ACCESS%20TO%20HC.11%2018%202008.BRF.pdf>. Accessed 10 September 2009.
 13. Ayanian JZ, Zaslavsky AM, Weissman JS, Schneider EC, Ginsburg JA. Undiagnosed hypertension and hypercholesterolemia among uninsured and insured adults in the Third National Health and Nutrition Examination Survey. *Am J Public Health*. 2003;93(12):2051–4.
 14. Pagán JA, Puig A, Soldo BJ. Health insurance coverage and the use of preventive services by Mexican adults. *Health Econ*. 2007;16(12):1359–69.
 15. Hadley J. Sicker and poorer—the consequences of being uninsured: a review of the research on the relationship between health insurance, medical care use, health, work, and income. *Med Care Res Rev*. 2003;60(2 Suppl):35–75.
 16. Millman M, ed. Access to health care in America. Washington, D.C.: National Academy Press; 1993.
 17. Moy E, Bartman BA, Weir MR. Access to hypertensive care. Effects of income, insurance, and source of care. *Arch Intern Med*. 1995;155(14):1497–502.
 18. DeVoe JE, Fryer GE, Phillips R, Green L. Receipt of preventive care among adults: insurance status and usual source of care. *Am J Public Health*. 2003;93(5):786–91.
 19. Baker DW, Sudano JJ, Albert JM, Borawski EA, Dor A. Lack of health insurance and decline in overall health in late middle age. *N Engl J Med*. 2001;345(15):1106–12.
 20. Zhang X, Geiss LS, Cheng YJ, Beckles GL, Gregg EW, Kahn HS. The missed patient with diabetes: how access to health care affects the detection of diabetes. *Diabetes Care*. 2008;31(9):1748–53.
 21. U.S. Centers for Disease Control and Prevention. U.S.-Mexico Border Diabetes Prevention and Control Project [page on the Internet]. Atlanta, GA: CDC; 2009. Available from: <http://www.cdc.gov/diabetes/projects/border.htm>. Accessed 11 September 2009.
 22. Frane J. SUDAAN: professional software for survey data analysis. Research Triangle Park, NC: Research Triangle Institute; 1989.
 23. Bourdel-Marchasson I, Helmer C, Barberger-Gateau P, Peuchant E, Fevrier B, Ritchie K, et al. Characteristics of undiagnosed diabetes in community-dwelling French elderly: the 3C study. *Diabetes Res Clin Pract*. 2007;76(2):257–64.
 24. Wilder RP, Majumdar SR, Klarenbach SW, Jacobs P. Socio-economic status and undiagnosed diabetes. *Diabetes Res Clin Pract*. 2005;70(1):26–30.
 25. Oladele CR, Barnett E. Racial/ethnic and social class differences in preventive care practices among persons with diabetes. *BMC Public Health*. 2006;6(10):259.
 26. Nichols GA, Glauber HS, Brown JB. Type 2 diabetes: incremental medical care costs during the 8 years preceding diagnosis. *Diabetes Care*. 2000;23(11):1654–9.
 27. Nichols GA, Brown JB. Higher medical care costs accompany impaired fasting glucose. *Diabetes Care*. 2005;28(9):2223–9.
 28. Zhang Y, Dall TM, Chen Y, Baldwin A, Yang W, Mann S, et al. Medical cost associated with prediabetes. *Popul Health Manag*. 2009;12(3):157–63.
 29. Zhang Y, Dall TM, Mann SE, Chen Y, Martin J, Moore V, et al. The economic costs of undiagnosed diabetes. *Popul Health Manag*. 2009;12(2):95–101.
 30. Landeck M, Garza C. Utilization of physician health care services in Mexico by U.S. Hispanic border residents. *Health Mark Q*. 2002;20(1):3–16.

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RESUMEN

Acceso a la atención de salud y diabetes no diagnosticada a lo largo de la frontera México-Estados Unidos

Objetivo. Examinar la relación entre el acceso a la atención de salud y la diabetes no diagnosticada en la población de alto riesgo y vulnerable de la zona fronteriza entre México y los Estados Unidos.

Métodos. Mediante el uso de los datos de la encuesta y de la glucosa plasmática en ayunas de la fase I del Proyecto de Prevención y Control de la Diabetes en la Frontera México-Estados Unidos (de febrero del 2001 a octubre del 2002), en este estudio epidemiológico se identificaron 178 adultos de 18 a 64 años con diabetes no diagnosticada, 326 con diabetes diagnosticada y 2 966 sin diabetes. Se evaluó el acceso a la atención de salud en dicha muestra ($n = 3\ 470$), mediante el tipo de cobertura del seguro de salud (incluida “ninguna”), el número de consultas de atención de salud en el último año, las características de utilización de los servicios de salud y el país de residencia.

Resultados. La probabilidad de no tener un diagnóstico fue mayor en las personas que padecían diabetes y que no tenían seguro ni ningún lugar al que acudir para recibir la atención de salud que en las que sí contaban con seguro y un lugar para recibir atención de salud (razón de momios [OR], 2,6, intervalo de confianza [IC] del 95% 1,0–6,6, y OR de 4,5, IC 95% 1,4–14,1, respectivamente). Al estratificar los datos por país, los datos de la encuesta mostraron que, en el lado estadounidense de la frontera, había un mayor número de personas con diabetes no diagnosticada si: 1) no tenían seguro, frente a los asegurados (28,9%, IC 95% 11,5%–46,3%, en comparación con el 9,1%, IC 95% 1,5%–16,7%, respectivamente), y si: 2) no habían tenido consultas o habían tenido de una a tres consultas en un centro de atención de salud en el último año, en comparación con ≥ 4 consultas (40,8%, IC 95% 19,6%–62,0%, y 23,4%, IC 95% 9,9%–36,9%, respectivamente, en comparación con el 2,4%, IC 95% –0,9%–5,7%) (todos, $p < 0.05$). No se observó una pauta parecida en México.

Conclusión. En la región fronteriza entre México y los Estados Unidos, el acceso limitado a la atención de salud, especialmente si no se cuenta con un seguro de salud o no se tiene un lugar al que acudir para recibir atención de salud, mostró una relación significativa con la diabetes no diagnosticada.

Palabras clave

Diabetes mellitus tipo 2; diagnóstico; accesibilidad a los servicios de salud; salud fronteriza; Estados Unidos; México.