Access to Health Care and Control of ABCs of Diabetes

XUANPING ZHANG, PHD
KAI MCKEEVER BULLARD, PHD, MPH
EDWARD W. GREGG, PHD
GLORIA L. BECKLES, MD, MSC

DESMOND E. WILLIAMS, MD, PHD
LAWRENCE E. BARKER, PHD
ANN L. ALBRIGHT, PHD, RD
GIUSEPPINA IMPERATORE, MD, PHD

OBJECTIVE—To examine the relationship between access to health care and diabetes control.

RESEARCH DESIGN AND METHODS—Using data from the National Health and Nutrition Examination Survey, 1999–2008, we identified 1,221 U.S. adults (age 18–64 years) with self-reported diabetes. Access was measured by current health insurance coverage, number of times health care was received over the past year, and routine place to go for health care. Diabetes control measures included the proportion of people with A1C >9%, blood pressure ≥140/90 mmHg, and non-HDL cholesterol ≥130 mg/dL.

RESULTS—An estimated 16.0% of known diabetic adults were uninsured. Diabetes control profiles were worse among uninsured than among insured persons (A1C >9% [34.1 vs. 16.5%, $P = 0.002$], blood pressure ≥140/90 mmHg [31.8 vs. 22.8%, $P < 0.05$], and non-HDL cholesterol ≥130 mg/dL [67.1 vs. 65.4%, $P = 0.7$]). Compared with insured persons, uninsured persons were more likely to have A1C >9% (multivariate-adjusted odds ratio 2.4 [95% CI 1.2–4.7]). Compared with those who reported four or more health care visits in the past year, those who reported no health care visits were more likely to have A1C >9% (5.5 [1.2–26.3]) and blood pressure ≥140/90 mmHg (1.9 [1.1–3.4]).

CONCLUSIONS—In people with diabetes, lack of health care coverage is associated with poor glycemic control. In addition, low use of health care service is associated with poor glucose and blood pressure control.

I n 2010, an estimated 25.8 million people in the U.S. had diabetes (1). People with diabetes are at high risk of a heart attack, a stroke, and other micro- or macrovascular complications (2). While diabetes poses a huge health and economic burden to society, effective diabetes control and management such as control of ABCs of diabetes—glycemic control (A1C control ["A"]), blood pressure control ("B"), and lipid control (cholesterol control ["C"])—can decrease the diabetes burden through prevention or delay of complications (2).

In 2008, 46 million people, or 15.4% of the population in the U.S., lacked health care insurance coverage (3), and between January and September 2010, the estimated number was up to 49.5 million (4).

Access to health care, including insurance coverage, plays a crucial role in the receipt of preventive services (5). Both lack of insurance coverage and inadequate coverage have been associated with lower use of preventive services (6,7). In addition, absence of a physician or usual source of care is a barrier to the control of hypertension (8). Furthermore, lack of health insurance is associated with an increased risk of overall health decline among late-middle-age adults (9). On the contrary, in a randomized controlled trial, access to Medicaid was found to be beneficial to both physical and mental health outcomes (10).

While preventive care practices and diabetes control can delay or prevent complications of diabetes (2), optimal preventive care and control depend on access to health care (11,12). Uninsured people with diabetes are less likely to receive needed care and to effectively manage their disease than those who are insured, and those with inadequate coverage have difficulty obtaining needed care (11,12). Those with insurance coverage are more likely to maintain glycemic control than those without (13,14). Despite these findings, we are unaware of any studies that have examined the relationship between access to health care and control of ABCs of diabetes among persons with diabetes.

Therefore, we explored the relationship between access to health care and multiple diabetes control outcomes. Specifically, we examined how insurance coverage, frequency of health care use, and routine place to go for health care affected glycemic control, blood pressure control, and lipid control in a representative sample of U.S. adults with self-reported diabetes.

RESEARCH DESIGN AND METHODS

Data source
We used data from the 1999–2008 National Health and Nutrition Examination Survey (NHANES), cross-sectional national population-based health surveys with personal interviews, medical examinations, and laboratory measurements (15).

Study population
Our analyses were based on data from adults aged 18–64 years who self-reported having diabetes (those who answered "yes" to the following question: "Have you ever been told by a doctor that you have diabetes or sugar diabetes?" excluding women who had diabetes only in their pregnancy). People aged ≥65 years were excluded because they are likely to be covered by Medicare and thus insured. (There were 1,168 adults aged ≥65 years excluded from this study, in which only 23 individuals, <1% of sample [0.57%], reported not having health care insurance.) Among adults aged 18–64 years, 1,221 persons were identified as our analytic population with self-reported diabetes. Analyses of poor glycemic control were restricted to NHANES 1999–2006 (N = 889) because the 2007–2008 A1C data were not available.

Study variables

We measured health care access through insurance coverage, derived from the answer to the question, "Are you covered by health insurance or some other kind of health care plan?" We measured the following: *1*) The number of times the participant received health care during the past 12 months, derived from the question, "During the past 12 months, how many times have you seen a doctor or other healthcare professional about your health at a doctor's office, a clinic, hospital emergency room, at home or some other place?" This variable was categorized as three levels: none, the second-less-frequent health care use category (one to three times per year), and the American Diabetes Association (ADA)-recommended category (more than four times per year) (2). And *2*) Routine place to go for health care, referring to any place to which people were usually going for care, derived from two questions: "Is there a place that you usually go when you are sick or you need advice about your health?" and "What kind of place do you go to most often: is it a clinic, a doctor's office, emergency room, or some other place?" Those who answered "no place" were categorized as "no regular place of care." Those who answered "having a place" were further divided into three categories according to the respondents' choices: hospital emergency room, outpatient department, and other; clinic or healthcare center; and doctor's office or HMO.

Based on ADA recommendations, A1C >9% was defined as poor glycemic control, and blood pressure ≥140/90 mmHg was defined as high blood pressure (2). According to American Heart Association recommendations, non-HDL cholesterol ≥130 mg/dL was defined as high non-HDL cholesterol (16). In this study, the ABCs of diabetes were measured through *1*) A1C (a dichotomized variable of A1C level >9%), *2*) blood pressure ≥140/90 mmHg (a dichotomized variable of systolic blood pressure level ≥140 mmHg and diastolic blood pressure level ≥90 mmHg), and *3*) non-HDL cholesterol levels (a dichotomized variable of non-HDL cholesterol ≥130 mg/dL).

Socioeconomic status, marital status, family history of diabetes, and self-rated health are associated with health care use (17–20). We controlled for seven sociodemographic factors: age, sex, race/ethnicity, marital status, education, family poverty index ratio (PIR), and family history of diabetes. We also used as covariates BMI (measured as kilograms divided by the square of height in meters), smoking status, diabetes medication use, and a dichotomized version of self-rated health ("good or better" versus "fair/poor").

Data analysis

We used multivariate logistic regression models to examine the relationship between access to health care and diabetes control. Independent variables included age, sex, race/ethnicity, marital status, education, family PIR, BMI, self-reported family history of diabetes, diabetes medication use, and self-rated health. Accounting for the possibility of nonlinearity, we explored quadratic relationships of the continuous variables (age and BMI) with each of the outcomes. Squared terms were retained in the model only if statistically significant at $P < 0.05$.

Data were weighted to represent the U.S. diabetic population ages 18–64 years. Analyses were performed, using SAS 9.2 and SUDAAN 10.0.1 (21), to adjust for the complex survey sample design. We conducted two-tailed t tests and considered results significant when P was <0.05.

RESULTS—Respondents (1,221 representing 8,119,276 American adults with diabetes) aged 18–64 years self-reported that they had diabetes. Of these, 962 (representing 6,429,698 American adults with diabetes) were insured (84.0%; an estimate

Table 1—*Selected characteristics of U.S. adults with diabetes aged 18–64 years by insurance status**

	Total sample	Insured	Uninsured	P†
N (%)	1,221	962 (84.0)	259 (16.0)	
Age (years)	50.1 (0.4)	50.4 (0.4)	48.3 (0.8)	0.01
Female	49.5	48.6	54.6	0.19
Race/ethnicity				
NH white	66.4	69.4	50.2	<0.001
NH black	23.0	23.2	22.1	
Mexican American	10.7	7.4	27.7	
Married	59.6	61.5	49.4	0.005
Education attained				
Less than high school	26.2	22.8	44.3	<0.001
High school	25.3	25.3	25.0	
More than high school	48.5	51.9	30.8	
PIR	2.8 (0.1)	3.0 (0.1)	1.8 (0.1)	<0.001
BMI (kg/m²)	34.0 (0.3)	34.4 (0.4)	31.9 (0.6)	<0.001
Fair or poor self-reported health	45.4	42.8	59.1	0.001
Family history of diabetes	78.8	79.4	76.2	0.39
Current smoker	25.9	24.1	35.4	0.007
Diabetes medication use				
None	17.4	16.0	24.9	0.17
Oral medication only	53.5	54.2	50.0	
Insulin only	16.6	16.8	15.7	
Oral medication and insulin	12.5	13.0	9.3	
A1C >9%‖	19.7	16.9	34.1	0.002
Non-HDL cholesterol ≥130 mg/dL	64.7	65.4	67.1	0.70
Blood pressure ≥140/90 mmHg	24.3	22.8	31.8	0.05‡
No. of health care visits in last 12 months				
None	3.7	2.1	12.2	<0.001
1–3	28.8	27.0	38.6	
≥4	67.4	70.9	49.3	
Routine patterns of health care use				
No place	3.1	1.7	10.4	<0.001
Hospital ER, OPD, or other	5.7	5.2	8.2	
Clinic or health care centers	18.3	16.4	28.2	
Doctor's office or HMO	73.0	76.7	53.2	

Data are percent or means (SE) unless otherwise indicated. ER, emergency room; NH, non-Hispanic; OPD, outpatient department. *Data source: NHANES 1999–2008. †P values based on χ² or Wald F test. ‖Analysis was restricted to NHANES 1999–2006 (N = 889) owing to National Center for Health Statistics investigation into 2007–2008 A1C values. ‡P < 0.05.

projected for the U.S. diabetic population aged 18–64 years), and 259 (representing 1,689,578 American adults with diabetes) were uninsured (16.0%) (Table 1). Uninsured persons with diabetes were younger (48.3 vs. 50.4 years of age) and more likely to be Mexican American (27.7 vs. 7.4%), to be less educated (e.g., education attainment less than high school, 44.3 vs. 22.8%, and more than high school, 30.8 vs. 51.9%), to live below the federal poverty level (mean PIR 1.8 vs. 3.0), and to have a lower BMI (31.9 vs. 34.4 kg/m^2) and more likely to report fair or poor health (59.1 vs. 42.8%) than those who were insured. The percentages of diabetes medication use were not different between insured and uninsured groups ($P = 0.17$). In general, uninsured persons had worse diabetes control and management profiles than their insured counterparts: 34.1 vs. 16.9% with A1C >9%, $P = 0.002$; 31.8 vs. 22.8% with blood pressure ≥140/90 mmHg, $P < 0.05$; and 67.1 vs. 65.4% with non-HDL cholesterol ≥130 mg/dL, $P = 0.7$.

Insurance coverage was associated with both frequency of health care use and routine place to go for health care; uninsured persons less frequently than the insured visited a doctor or other health care professional (e.g., 12.2% of uninsured persons reported not visiting a doctor during the past 12 months compared with only 2.1% of insured falling into this category). In the second-less-frequent health care use category (one to three times per year), uninsured were still more likely to fall into this category than insured (38.6 vs. 27%, respectively); on the contrary, in the ADA-recommended category (four or more times per year), uninsured were less likely to fall into this category than insured (49.3 vs. 70.9%). They were more likely to report no routine place to go for health care (10.4 vs. 1.7%, $P < 0.001$). Furthermore, frequency of health care use was associated with diabetes control (Fig. 1). In general, diabetes control profile was improved as the number of health care visits increased. Those who did not report a health care visit had poorer diabetes control outcomes than those who reported health care visits four or more times in the past year: mean A1C 9.1 vs. 7.4%, $P = 0.014$; mean systolic blood pressure 127.6 vs. 126.2 mmHg, $P = 0.56$; mean diastolic blood pressure 79.6 vs. 72.4 mmHg, $P = 0.002$; and mean non-HDL cholesterol 171.3 vs. 146.6 mg/dL, $P < 0.001$, respectively.

Access to health care was associated with diabetes control (Table 2). From our unadjusted model (model 1), we found
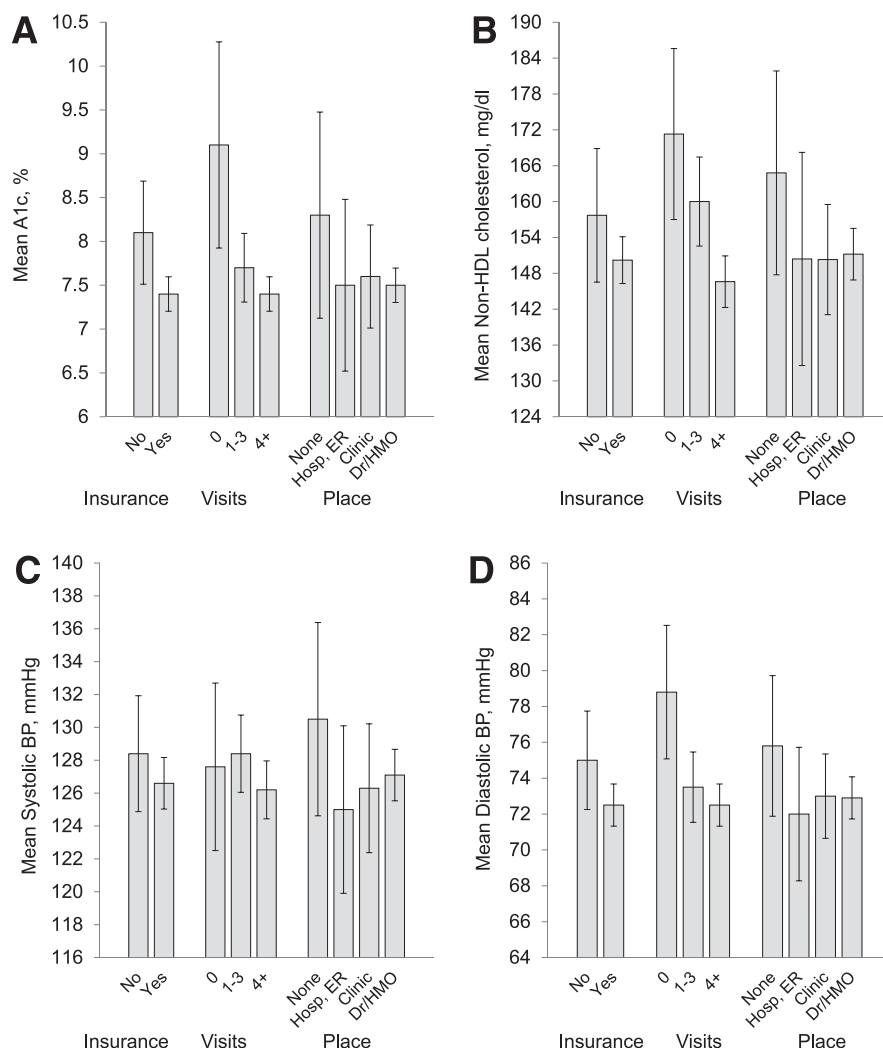

Figure 1—*Multivariate-adjusted predicted means (95% CI) of diabetes control indicators associated with health care access in U.S. adults with diabetes aged 18–64 years. A: y-axis, mean A1C (%); x-axis, access to care. B: y-axis, mean non-HDL cholesterol (mg/dL); x-axis, access to care. C: y-axis, mean systolic blood pressure (BP) (mmHg); x-axis, access to care. D: y-axis, mean diastolic blood pressure (mmHg); x-axis, access to care. Predicted means calculated from separate linear regression models of A1C (A), non-HDL cholesterol (B), systolic blood pressure (C), and diastolic blood pressure (D) associated with health care access indicators, adjusting for age, sex, race, marital status, education, family PIR, BMI, smoking status, family history of diabetes, diabetes medication use, and self-reported health. Analysis of A1C was restricted to NHANES 1999–2006. Clin, clinics; Dr, doctor; Hosp ER, hospital emergency room.*

that compared with those who were insured, their uninsured counterparts were more likely to have an A1C level >9% (odds ratio [OR] 2.5 [95% CI 1.6–4.2]) and to have blood pressure ≥140/90 mmHg (1.6 [1.0–2.5]). Compared with those who reported a health care visit four or more times in the past year, those who reported none had 3.8 times higher odds of having A1C >9% (4.8 [1.6–14.1]). Compared with those who used doctors' offices or HMO facilities for routine care, those who reported no regular place for care had 1.7 times higher odds of having A1C >9% (2.7 [1.1–6.8]).

After we adjusted for race/ethnicity (model 2), we found that health insurance coverage and having at least one health care visit in the past year were still associated with glycemic control as shown in model 1. Regardless of ethnicity, access to health care independently accounted for variations in glycemic control.

After adjustments for age, sex, marital status, education, family PIR, BMI, family history of diabetes, smoking status, diabetes medication use, and self-rated health (model 3), we found that compared with those who were insured, their uninsured counterparts were more likely to have A1C level >9%

Table 2—ORs (95% CI) of diabetes management/control associated with health care access indicators, each modeled separately, in U.S. adults with diabetes aged 18–64 years (NHANES 1999–2008)*

	Poor glycemic control‖	High non-HDL	High blood pressure
Model 1: unadjusted			
Health insurance coverage			
Uninsured	2.5 (1.6–4.2)†	1.1 (0.7–1.6)	1.6 (1.0–2.5)†
Insured	1.0	1.0	1.0
Health care visits in last 12 months			
None	4.8 (1.6–14.1)†	1.9 (0.8–4.4)	1.5 (0.8–2.8)
1–3	1.6 (1.0–2.7)	1.2 (0.9–1.7)	1.4 (1.0–2.0)
≥4	1.0	1.0	1.0
Routine pattern of use			
No place	2.7 (1.1–6.8)†	1.4 (0.6–3.4)	1.1 (0.5–2.5)
Hospital ER, OPD, or other	1.4 (0.5–3.8)	1.1 (0.6–2.2)	1.5 (0.8–2.7)
Clinic or health care center	1.3 (0.7–2.4)	0.9 (0.6–1.4)	1.4 (0.9–2.2)
Doctor's office or HMO	1.0	1.0	1.0
Model 2: model 1 plus ethnicity			
Health insurance coverage			
Uninsured	2.4 (1.4–4.1)†	1.0 (0.7–1.5)	1.5 (1.0–2.4)
Insured	1.0	1.0	1.0
Health care visits in last 12 months			
None	4.8 (1.6–14.9)†	1.7 (0.7–4.1)	1.6 (0.8–3.0)
1–3	1.6 (0.9–2.7)	1.2 (0.8–1.7)	1.4 (1.0–2.0)
≥4	1.0	1.0	1.0
Routine pattern of use			
No place	2.2 (0.8–5.6)	1.2 (0.5–3.0)	1.0 (0.5–2.3)
Hospital ER, OPD, or other	1.2 (0.4–3.5)	1.1 (0.6–2.1)	1.2 (0.7–2.2)
Clinic or health care center	1.1 (0.6–2.1)	0.9 (0.6–1.3)	1.3 (0.8–2.1)
Doctor's office or HMO	1.0	1.0	1.0
Model 3: model 2 plus covariates‡			
Health insurance coverage			
Uninsured	2.4 (1.2–4.7)†	0.9 (0.6–1.3)	1.6 (0.9–2.6)
Insured	1.0	1.0	1.0
Health care visits in last 12 months			
None	5.5 (1.2–26.3)†	2.0 (0.8–5.2)	1.9 (1.1–3.4)†
1–3	1.5 (0.9–2.7)	1.3 (0.8–1.9)	1.4 (1.0–2.0)
≥4	1.0	1.0	1.0
Routine pattern of use			
No place	2.3 (0.7–8.2)	1.6 (0.6–4.8)	1.5 (0.6–3.7)
Hospital ER, OPD, or other	1.3 (0.5–3.9)	0.8 (0.4–1.6)	1.0 (0.5–2.2)
Clinic or health care center	1.2 (0.6–2.3)	0.9 (0.5–1.4)	1.3 (0.7–2.4)
Doctor's office or HMO	1.0	1.0	1.0

Glycemic control: A1C >9%. High non-HDL cholesterol control: ≥130 mg/dL. High blood pressure: systolic blood pressure ≥140 mmHg or diastolic blood pressure ≥90 mmHg. ER, emergency room; OPD, outpatient department. *Estimated from logistic regression models. ‖Data restricted to NHANES 1999–2006 (N = 889). †CI does not contain the value of 1. ‡Covariates included age, sex, race, marital status, education, family PIR, BMI, smoking status, family history of diabetes, diabetes medication, and self-reported health.

(OR 2.4 [95% CI 1.2–4.7]). Frequency of health care use was related to both glycemic control and blood pressure control. Compared with those who reported four or more health care visits in the past year, those who reported none had a higher likelihood to have A1C >9% (5.5 [1.2–26.3]) and to have blood pressure ≥140/90 mmHg (1.9 [1.1–3.4]). In the multivariate model 3, having a routine place to go for health care was no longer significantly associated with poor glycemic control.

CONCLUSIONS—Using a nationally representative sample of U.S. adults with diabetes, we found that lack of access to health care was associated with diabetes control. We found that the diabetes control profile was related to health insurance coverage and number of health care visits. Those who were uninsured reported fewer health care visits and were more likely not to have a usual source of care than those who were insured. Furthermore, the uninsured were more likely to have worse diabetes control profiles.

A previous study demonstrated that although diabetes processes of care and intermediate outcomes improved over time between 1988 and 2002, the difference in diabetes control between insured and uninsured populations persisted (22). Consistent with this study, our study found similar associations between access to health care and diabetes control. Although not all associations were statistically significant, the combined effect appeared strong in the association of access to health care with diabetes control.

For prevention and management of diabetes complications, a Position Statement of the ADA addressed the importance of routine diabetes visits for testing and screening (2). Access to health care is associated with the frequency of health care use among patients with chronic conditions (5,23). Our study further demonstrated that access to health care is associated with both the frequency of health care use and health care outcomes. Diabetes complications control and management depend on a continuing interaction between health care providers and patients. Through this interaction, patients and health care providers share information, which tends to improve diabetes care and control. Lack of access to health care could make this interaction difficult, thereby bringing about negative health outcomes.

It is well-known that having a regular doctor or having a usual source of care is important to health outcomes, and the former is further associated with receiving preventive care (24,25). In our unadjusted model, those who reported no place to go were less likely to control their A1C than those who used doctor offices or HMO facilities for their health care. However, this association was no longer significant in the multivariate model.

Race/ethnicity has been found to be related to poor access to health care (26,27). In the U.S., Hispanics have been found to have significantly less access to health care than non-Hispanics (28–30). One study found that even though access to health care differed among Caucasians, African Americans, and Mexican Americans, the health status and outcomes for adults with type 2 diabetes did not significantly differ among these groups, and health status seemed not to be influenced by access to health care (31). Although our study also

found that Hispanics had less access, we also demonstrated that the uninsured had worse glycemic control profiles than those who were insured. When we adjusted for race/ethnicity in our model, the results from the adjusted model remained almost the same as those from the unadjusted model, indicating that the association of access to health care with glycemic control was independent of race/ethnicity. These findings have never been reported before, and our study makes significant contribution to the public health literature.

In our multivariate models, it was noticeable that lack of health insurance coverage and not having a health care visit in the past year were mainly associated with glycemic control. In model 3, only the lack of health care visits was significantly associated with blood pressure control. A tentative explanation could be that many low-cost generic medications to treat hyperlipidemia lipids and hypertension are available, but insulin, a primary tool to treat hyperglycemia, may still be very expensive and, therefore, less accessible. This, in turn, made the association of access to health care with glycemic control more visible (32).

Our study has both strengths and limitations. Strengths include nationally representative data and having controlled for sociodemographic, anthropometric, and health status. Limitations include the relatively small sample of persons in some categories of health care use and routine place to go for health care. Access to health care is better considered as a multidimensional concept with five domains: availability, organization, financing, use, and satisfaction (33). However, our data source only addressed two of these five domains (financing and use). This study used data from NHANES 1999–2008. Because the National Center for Health Statistics withdrew the 2007–2008 A1C data from public release recently, our analyses of poor glycemic control were restricted to NHANES 1999–2006 ($N = 889$). The decrease in sample size (from $N = 1,221$ to $N = 889$) might have affected the association of poor glycemic control with access to health care. If the 2007–2008 A1C data were available and used in our analyses, we might have enhanced our analytic power and strengthened other associations of poor glycemic control with access to health care from marginally significant to significant.

Our findings indicate that limited access to health care—especially low frequency of use of health care service—is associated with poor glycemic control and blood pressure control, suggesting that access to health care is critical to the control of risk factors among U.S. adults with diabetes. Our analyses imply that there is a need to improve access to health care among persons with diabetes on the one hand and provide important baseline data from which to evaluate the effects of health reform on the other.

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