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The Relationship Between County-Level Contextual Characteristics and Use of Diabetes Care Services

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Abstract

Objectives—To examine the relationship between county-level measures of social determinants and use of preventive care among US adults with diagnosed diabetes. To inform future diabetes prevention strategies.

Methods—Data are from the Behavioral Risk Factor Surveillance System (BRFSS) 2004 and 2005 surveys, the National Diabetes Surveillance System, and the Area Resource File. Use of diabetes care services was defined by self-reported receipt of 7 preventive care services. Our study sample included 46 806 respondents with self-reported diagnosed diabetes. Multilevel models were run to assess the association between county-level characteristics and receipt of each of the 7 preventive diabetes care service after controlling for characteristics of individuals. Results were considered significant if $P < .05$.

Results—Controlling for individual-level characteristics, our analyses showed that 7 of the 8 county-level factors examined were significantly associated with use of 1 or more preventive diabetes care services. For example, people with diabetes living in a county with a high uninsurance rate were less likely to have an influenza vaccination, visit a doctor for diabetes care, have an A1c test, or a foot examination; people with diabetes living in a county with a high physician density were more likely to have an A1c test, foot examination, or an eye examination; and people with diabetes living in a county with more people with less than high-school education were less likely to have influenza vaccination, pneumococcal vaccination, or self-care education (all $P < .05$).

Conclusions—Many of the county-level factors examined in this study were found to be significantly associated with use of preventive diabetes care services. County policy makers may need to consider local circumstances to address the disparities in use of these services.

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Keywords

Andersen's model; multilevel models; preventive diabetes care; social determinants

Diabetes is a common and costly chronic disease that requires continuing medical intervention and patient self-management education to prevent acute complications and to reduce the risk of long-term complications.[1] In 2010, diabetes, both diagnosed and undiagnosed, affected an estimated 25.8 million people or 8.3% of the total US population,[2] and that number is projected to reach 64 million by the year 2050.[3] Diabetes increases the risk for mortality and morbidity, including heart disease, stroke, kidney disease, eye disease, neuropathy, influenza and pneumococcal disease, and periodontal disease.[2,4] In addition, in 2007, the total economic burden of medical costs and lost productivity due to diagnosed and undiagnosed diabetes were estimated at $174.4 billion and $18 billion, respectively.[5] Therefore, it is important to provide effective preventive services and interventions to persons with diabetes. Furthermore, preventive care practices such as diet, physical activity, smoking cessation, eye examinations, foot examinations, and yearly checkups can prevent or delay the incidence and progression of diabetes complications. Routine screening for complications are widely recommended,[6] but national data indicated that the frequency of use of preventive diabetes care services was often lower than recommended.[7]

Contextual factors refer to the characteristics of the community where an individual lives, which describe the milieu where health utilization takes place. These contextual factors are considered to shape the resources and opportunities available to individuals in the community.[8] Prior research has found that contextual factors, such as community racial composition, supply of physicians, and insurance coverage rate, were associated with access to health care.[9–11] However, there is limited information on how contextual factors affect the use of preventive diabetes care services. A better understanding of the impact of contextual factors on the use of preventive care services is important for implementing diabetes control strategies and eliminating health disparity, top priorities among the goals of Healthy People 2010 and 2020.[12,13]

In this study, we assessed the association between contextual characteristics and use of 7 preventive diabetes care services[14] among US adults with diagnosed diabetes. The theoretical framework is Andersen's behavioral model of health service utilization,[15] which suggests that improving access to care requires focusing on both individual and contextual characteristics. According to Andersen's model, the components of contextual characteristics are classified in the same way as individual characteristics: *Predisposing conditions* include community factors that are indicative of the probability to seek health care, such as community educational level, employment level, and racial population composition; *enabling conditions* include factors that could make access to health care easier, such as health policy, per capita income, and health care system factors; and *need conditions* refer to the overall need of health care, such as mortality, morbidity, and disability rates. Similarly, the 3 domains of individual characteristics include attributes that *predispose* an individual to seek services, *enable* an individual to obtain health care when needed, and represent the *need* for health care.[16] We hypothesize that contextual characteristics will

affect the use of preventive diabetes care services, independent of characteristics of individuals with diabetes.

Methods

Data source

We used 2004 and 2005 Behavioral Risk Factor Surveillance System (BRFSS) data because when we began this study, county-level diabetes prevalence data (the "need" variable) were only available from the CDC National Diabetes Surveillance System for 2004 and 2005. The BRFSS is an annual state-based, random-digit–dialed telephone survey of the noninstitutionalized, US civilian population 18 years and older. The BRFSS gathers data on preventive health practices and risk behaviors that are linked to chronic diseases, injuries, and preventable infectious diseases. Weighting has been applied to each record to account for differences in selection, nonresponse, and noncoverage in BRFSS. Detailed information on interview response rates, item nonresponse rates, and demographic comparisons of BRFSS sample and the whole US population are described in the 2004 and 2005 BRFSS Summary Data Quality Report.[17,18] The BRFSS questionnaire consists of 3 sections: a core survey, optional modules, and state-added questions.[19] In the 2004 and 2005 BRFSS Core Questionnaires, respondents in all states were asked, "Have you ever been told by a doctor that you have diabetes?" An optional diabetes module designed to collect data on individual's clinical characteristics and diabetes-specific preventive care practices was administered to respondents with diagnosed diabetes in 47 states in 2004, and in 40 states in 2005. Using county Federal Information Processing Standard codes, we merged the 2004 and 2005 BRFSS data with the 2004 and 2005 county-level diabetes prevalence data from the CDC National Diabetes Surveillance System,[20] and county-level characteristics from the Health Resources and Services Administration's Area Resource File (2010 edition), a national county-level health resource information database.[21] Our study sample included 46 806 respondents in the 2004–2005 BRFSS with self-reported diagnosed diabetes.

Variables

Outcome measures—Use of diabetes services was defined by the use of preventive care practices recommended by the American Diabetes Association.[14] The outcomes examined in this study were use of 7 preventive diabetes care services. In the 2004 and 2005 BRFSS Core Questionnaires, all respondents were asked whether they had received an influenza vaccination in the past 12 months (yes/no), and whether they had ever had a pneumococcal vaccination (yes/no). Information on use of the other 5 preventive diabetes care services was obtained from the 2004 and 2005 BRFSS Diabetes Modules. These preventive diabetes care services include seeing a doctor for diabetes (yes/no), checking A1c (yes/no), having a foot examination (yes/no), and a dilated eye examination (yes/no) in the past 12 months, and whether they had ever taken a course or class in how to manage their diabetes (yes/no).

Respondents were classified as having seen a doctor for diabetes if they answered at least once to the question "About how many times in the past 12 months have you seen a doctor, nurse, or other health professional for your diabetes?" Respondents were classified as having checked A1c if they answered that they had been checked at least once to the question "A

test for ‘A one C’ measures the average level of blood sugar over the past 3 months. About how many times in the past 12 months has a doctor, nurse, or other health professional checked you for ‘A one C’?” Respondents were classified as having had a foot examination in the past 12 months if they answered at least once to the question “About how many times in the past 12 months has a health professional checked your feet for any sores or irritations?” Respondents were classified as having had an annual dilated eye examination if they answered they had a dilated eye examination “within the past month,” or “within the past year” to the question “When was the last time you had an eye examination in which the pupils were dilated? This would have made you temporarily sensitive to bright light.”

Contextual characteristics measures—According to the Andersen model introduced earlier and prior research,[11,22,23] we operationalized the 3 components of contextual characteristics that determine use of services at the county level: (1) *Predisposing factors* were median age, percentage of black population, and proportion of people aged 25 years and older with less than high-school education (“less than high-school education rate” for short) of the county; (2) *Enabling factors* were median household income (in $1000), unemployment rate, the number of physicians (total active MDs in the county, excluding federal MDs) per 1000 population (“physician density” for short), and proportion of people without health care insurance coverage (“uninsurance rate” for short) in the county. These county-level contextual characteristics were extracted from the Area Resource File; (3) One *need factor* was the estimated county-level diabetes prevalence. This variable was obtained from the CDC National Diabetes Surveillance System (The county level prevalence of diagnosed diabetes was estimated using data from the BRFSS and data from the US Census Bureau’s Population Estimates Program).[20]

Individual characteristics measures—Similarly, predisposing, enabling, and need factors at the individual level were included: (1) *predisposing* factors were age, sex, race/ethnicity (non-Hispanic white, black, Hispanic, and other), marital status (married vs others), and education attainment (<high school, high school, and >high school); (2) *enabling factors* were annual household income (<$15 000, $15 000–$24 999, $25 000–$34 999, $35 000–$49 999, and ≥$50 000), employment status (employed, retired, and unemployed), having health insurance (yes/no), and having a personal doctor (yes/no); and (3) the *need factor* was the self-rated general health status (excellent/very good, good, and fair/poor), as reported by BRFSS.

Statistical analysis

First, we examined frequency distributions of individual factors and contextual factors according to the receipt of preventive diabetes care services. Second, we conducted multilevel model analyses. Because BRFSS is a complex survey that involves unequal sampling probabilities and stratification, a multilevel model to these data should account for correlations between counties and the complex design. Standard statistical software for survey data (eg, SUDAAN, SAS, and Stata) does not include this type of model. Thus, we used the Generalized Linear Latent and Mixed Models[24] implemented in the Stata 11 (College Park, Texas) with the user-written command GLLAMM.[25] The multilevel model analyses were implemented in 3 steps.

Step 1: The sampling weights were standardized to sum to the effective sample size.

Step 2: A multilevel model that accounts for these weights and includes random intercepts by county was fit. In this model, all the individual-level covariates and county-level covariates were included as fixed effects.

Step 3: A sandwich estimator was used to correct the standard errors accounting for the sample stratification.

We ran a separate multilevel model for each of the 7 outcomes. We rescaled the contextual variables and age of persons with diabetes by 2 times the standard deviations in multivariate models to make the results more interpretable. A unit change in the parameter corresponds to a 2 standard deviations change in the outcome variable. Results were considered significant if $P < .05$. Before fitting the multilevel models, we checked for collinearity and found none as all correlation coefficients were less than 0.6.[23] Our analytical sample sizes were 37 431, 36 048, 35 415, 33 322, 35 319, 35 878, and 36 219 observations in the influenza vaccination, pneumococcal vaccination, doctor's visit, A1c test, foot examination, eye examination, and self-care education models, respectively.

Results

Table 1 presents the descriptive statistics of individual characteristics by use of preventive diabetes care services. Consistent with the Andersen model, individual-level predisposing, enabling, and need factors enabled or impeded individuals' use of diabetes care services. Among the predisposing factors, the education level and race were significantly associated with all the 7 preventive diabetes care services; age was significantly associated with 5 and marital status was significantly associated with 4 preventive diabetes care services. Among the enabling factors, income, health insurance coverage, and having a personal doctor were all significantly associated with all the 7 preventive diabetes care services; employment status was significant for 6 preventive diabetes care services. The need factor health status was significant for 5 preventive diabetes care services ($P < .05$) (Table 1).

Table 2 presents county-level characteristics by use of preventive diabetes care services and shows how the sociodemographic composition of a community may predispose and how the availability of financial and health service resources may enable or impede use of diabetes care services. People with diabetes living in counties with an older median-age population were more likely to receive an influenza vaccination, pneumococcal vaccination, doctor's visit, A1c test, foot examination, or an eye examination ($P < .05$), while those living in counties with a younger median-age population were more likely to receive self-care education ($P < .001$). Those living in counties with a high percentage of black population were less likely to receive an influenza or a pneumococcal vaccination, or A1c test, yet were more likely to visit a doctor for diabetes care, have a foot examination, or an eye examination. Those living in counties with a high percentage of people with less than a high-school education were less likely to receive all the preventive care services except for visiting a doctor for diabetes care ($P < .05$). In addition, people with diabetes living in counties with a high median household income were more likely to have an A1c test, foot examination, eye examination, or self-care education ($P < .05$). Those living in counties with

a high unemployment rate were less likely to use all of the preventive diabetes care services except visiting a doctor for diabetes care ($P < .05$). Those living in counties with a high rates of uninsurance were less likely to use all the preventive diabetes care services, except self-care education ($P < .05$). Those living in counties with a high physician density were more likely to receive a foot examination, an eye examination, or diabetes self-care education ($P < .05$). Finally, people with diabetes living in counties with a high diabetes prevalence were less likely to receive an influenza vaccination or diabetes self-care education ($P < .05$) and more likely to visit a doctor for diabetes care ($P < .001$) (Table 2).

Table 3 presents the results of the multilevel logistic regression models for the effect of contextual characteristics on use of preventive diabetes care services, controlling for all individual-level characteristics. First, in terms of predisposing factors, people with diabetes living in counties with an older median age were less likely to receive an influenza vaccination (adjusted odds ratio [AOR] = 0.91, 95% confidence interval [CI]: 0.85–0.99) or self-care education (AOR = 0.92, 95% CI: 0.86–0.99). People with diabetes living in counties with a high proportion of black people were less likely to receive an A1c test (AOR = 0.80, 95% CI: 0.71–0.89), or self-care education (AOR = 0.89, 95% CI: 0.82–0.97). People with diabetes living in counties with a high proportion of people with less than a high-school education were less likely to receive influenza vaccination (AOR = 0.86, 95% CI: 0.78–0.94), pneumococcal vaccination (AOR = 0.79, 95% CI: 0.72–0.87), or diabetes self-care education (AOR = 0.75, 95% CI: 0.68–0.83).

Second, in terms of enabling factors, people with diabetes living in counties with a high physician density were more likely to have an A1c test (AOR = 1.15, 95% CI: 1.04–1.27), foot examination (AOR = 1.12, 95% CI: 1.03–1.21) or an eye examination (AOR = 1.13, 95% CI: 1.05–1.21). Those living in counties with a high uninsurance rate were less likely to receive an influenza vaccination (AOR = 0.86, 95% CI: 0.78–0.96), visit a doctor for diabetes care (AOR = 0.80, 95% CI: 0.68–0.94), or have an A1c test (AOR = 0.74, 95% CI: 0.64–0.84) or a foot examination (AOR = 0.88, 95% CI: 0.80–0.98). Interestingly, people with diabetes living in counties with a high household median income were less likely to receive an influenza vaccination (AOR = 0.77, 95% CI: 0.70–0.85) or have an A1c test (AOR = 0.84, 95% CI: 0.74–0.96). Third, in terms of the need factor, people with diabetes living in counties with a high diabetes prevalence were less likely to receive an influenza vaccination (AOR = 0.83, 95% CI: 0.76–0.90) or diabetes self-care education (AOR = 0.88, 95% CI: 0.81–0.95) (Table 3).

Discussion

Few studies in the past have assessed the effects of community characteristics on use of diabetes care services.[26–28] Kelly and colleagues analyzed data of 1528 diabetes patients visiting a hospital in the United Kingdom and found that diabetes patients from socioeconomically disadvantaged neighborhoods (eg, high unemployment, larger proportion of households of lower socioeconomic classes) were less likely to take insulin than those living in more affluent neighborhoods.[27]

Our results indicate that 7 of the 8 county-level factors examined in this analysis were significantly associated with use of preventive diabetes care services. First, our study results show that uninsurance rate was significantly associated with the use of 4 preventive diabetes care services. Specifically, people with diabetes living in a county with a high uninsurance rate were less likely to have an influenza vaccination, visit a doctor for diabetes care, have an A1c test or a foot examination. Research on access to care among the general population had similar findings. For instance, a study analyzing the Community Tracking Study Household Survey data found that uninsured persons living in communities with the highest percentage of uninsured persons were 2 times more likely to report difficulties in obtaining care.[29] While personal health insurance is an important enabling factor for access to care, our results indicate that, at the contextual level, the overall health insurance coverage rate in a community was an important enabling factor for preventive diabetes care services. This finding may reflect the need for health care delivery organizations to encourage and coordinate use of preventive diabetes care services. A patient-centered medical home may also improve diabetes care. A low community-level insurance rate could also be the proxy for socioeconomic disadvantage of the community. Economic arrangements and social policies are critical to people's living and working conditions and hence to accessing health care and addressing health equity.[30] Thus, continuous efforts and the necessary resources for diabetes care should target those disadvantaged areas.

Second, our results indicate that county-level physician density was significantly associated with receipt of screening for diabetes-specific complications—an A1c test, foot examination, and eye examination, that is, people with diabetes living in a county with more physicians per capita were more likely to have an A1c test, foot examination, or eye examination. These findings suggest that increased availability of physicians is associated with increased levels of screening for complications in the US population with diabetes. These findings are similar to what was observed of screening for other diseases. For instance, a study of 2231 women in Ohio aged 50 to 69 years indicated that those living in counties with more primary care physicians were more likely to have breast cancer screening.[31] Another study reported that women who resided in areas with few primary care physicians were less likely to have had a Pap test.[32] Moreover, existing literature on preventive diabetes care indicated that availability of health care providers at the health care system level, particularly specialists, improved use of diabetes preventive care.[33]

Third, black population rate was negatively associated with having A1c test and self-care education; and less than a high-school education rate was also negatively associated with having 3 types of preventive diabetes care—influenza vaccination, pneumococcal vaccination, and self-care education. Similar findings have been reported in a prior study, which found that the odds of reporting no usual source of care were negatively associated with higher education level in a county.[23]

Fourth, our results indicate that people with diabetes living in a county with a higher prevalence of diabetes were less likely to have influenza vaccination or self-management education. Also, our bivariate results indicate that people with diabetes living in a county with a higher prevalence of diabetes were more likely to visit a doctor. Of note, the positive effects of diabetes self-management education on self-care behaviors and glycemic control

among individuals are well documented.[34,35] Our study results provide useful information for future resource allocation in preventive diabetes care. To be effective, efforts to improve the quality of care may need to take into account the possibility that factors external to individuals and clinical settings influence quality of care and adherence to evidence-based guidelines.[36–38]

Last, our results indicate that county median household income was negatively associated with having an influenza vaccination and an A1c test, which seems to be counterintuitive. We are not sure why these findings were not consistent with prior work on access to care among the general population. For example, a study of Kansas Medicare beneficiaries found that women in counties with high median incomes and percentages of residents with high-school diplomas had high utilization rates of mammography.[39] Another study in Ohio reported that people were more likely to report no usual source of care as the proportion of individuals with incomes less than the federal poverty level and the proportion of households headed by women increased in the county.[23] Additional analyses suggest that a significant negative association remained for the second and third quintiles of income (vs first quintile) with having an influenza vaccination, but the association was not significant for the fourth and fifth quintiles. We suspect that persons who lived in the poorest counties (the first quintile income) may receive more assistance from public facilities and nontraditional sources. Future research is needed to explicate the association between community income level and use of preventive diabetes care services.

Limitations

There are several limitations in this study. First, our study is a cross-sectional analysis, so no causal relationships can be inferred. Second, all data were self-reported and are subject to recall and other biases, including overreporting the use of preventive diabetes care services. And this especially could be a problem among those with less education because they may not understand the A1c test. Third, BRFSS samples excluded people without landline telephones and those with substantial disabilities that prevent them from getting to the phone. Fourth, due to data unavailability, we did not include other factors in the multivariate models such as community transportation (a contextual enabling factor) and diabetes status (an individual need factor). Fifth, we did not test interactions between county and individual characteristics due to model complexities. Sixth, given that this study assessed associations of county level and individual characteristics to 7 outcomes, the significant findings ($P < .05$) should be interpreted with caution. Seventh, the available data we used might not reflect current environmental factors and current health system changes. Future studies need to confirm these findings using more recent data. Finally, while seemingly providing meaningful characteristics of the environment where people live and work, county-level data does have the potential for “ecological fallacy” because conclusions drawn from such group-level data may be different from those obtained from individual-level data. Also, access to health systems is not always determined by county boundaries.

Conclusions

To our knowledge, this study was the first to assess the association of contextual factors (measured as county-level characteristics) with use of preventive diabetes care services in the United States. Our multilevel analyses suggest that individual-level predisposing and enabling characteristics may be necessary but not sufficient to assure effective access to diabetes preventive care. Overall, our results indicate that Americans with diabetes who lived in counties with the least desirable socioeconomic circumstances were associated with a higher risk of underutilizing recommended preventive diabetes care services. These findings highlight the need to tackle disparities in access to preventive diabetes care services as a consequence of county socioeconomic characteristics. A recent social experiment study indicated that moving people from a neighborhood with a high level of poverty to one with a low level of poverty was associated with modest reductions in the prevalence of extreme obesity and diabetes.[40]

Furthermore, understanding and eliminating disparities in health care is an important national agenda. Three of the overarching objectives in the Healthy People 2020 campaign are to create social and physical environments that promote good health for all and achieving health equity, to eliminate disparities, and to improve the health of all groups.[12] The World Health Organization defines social determinants as the conditions where people are born, grow, live, work, and age, including the health system. Social determinants of health are often responsible for inequities in health care.[41] To achieve the new targets of diabetes care practices specified in Healthy People 2020,[12] county policy makers may consider using the strategic directions and priorities detailed in the National Stakeholder Strategy for Achieving Health Equity and the complementary 2011 HHS Action Plan to Reduce Racial and Ethnic Disparities to enhance development of local initiatives to address these disparities in use of preventive diabetes care services.[42] Policy initiatives are needed to address care disparity in socioeconomically disadvantaged communities, especially in communities with low levels of education, low health insurance rates, and fewer physicians. Increased research efforts are needed to identify interventions that are effective at the contextual level.

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TABLE 1

Individual-Level Characteristics[a] by Use of Preventive Diabetes Care

	Influenza Vaccination		Pneumococcal Vaccination		Doctor's Visit		A1C Test		Foot Examination		Eye Examination		Self-care Education	
Individual Characteristics	**Yes**	**No**	**Yes**	**No**	**Yes**	**No**	**Yes**	**No**	**Yes**	**No**	**Yes**	**No**	**Yes**	**No**
Predisposing factors, %														
Age (mean)	63.4[b]	54.7	64.4[b]	54.8	59.2	58.3	58.6	59.5	59.4[c]	58.4	61.2[b]	55.2	58.3[b]	60.5
Female	49.6	50.3	51.6	50.1	49.7	46.6	48.5[d]	51.9	48.8[c]	51.1	50.3	49.5	50.6	49.2
Married	61.3[d]	58.6	59.7	60.2	61.0[d]	55.8	63.4	52.4	61.8[b]	57.8	61.3[b]	57.3	62.6	56.9
Race														
White	69.3[b]	57.1	72.2[b]	55.9	63.8[b]	63.9	66.7[b]	55.2	64.7[b]	61.3	64.7[b]	60.6	64.7[b]	61.8
Black	12.1	17.6	12.1	17.1	15.0	9.9	14.0	15.4	16.3	10.8	14.9	14.4	15.8	13.8
Hispanic	12.6	19.1	10.1	20.6	15.1	19.6	12.9	23.2	12.9	21.7	14.2	18.7	13.5	18.0
Other	6.1	6.2	5.6	6.4	6.1	6.7	6.3	6.1	6.1	6.2	6.2	6.3	6.0	6.4
Education level														
<High school	19.5[b]	22.6	19.1[b]	22.9	19.8[c]	23.3	16.1[b]	31.2	18.5[b]	24.6	19.5[b]	23.7	15.9[b]	26.9
High school	32.2	32.1	33.3	31.8	32.5	29.6	32.0	32.4	32.5	31.3	31.6	33.6	32.0	32.5
>High school	48.3	45.3	47.7	45.3	47.7	47.1	52.0	36.4	49.1	44.1	48.9	42.7	52.1	40.7
Enabling factors, %														
Household annual income														
<$15 000	20.2[d]	23.4	20.9[b]	22.7	20.7[d]	25.9	17.5[b]	31.7	19.5[b]	25.5	19.5[b]	25.6	18.2[b]	25.8
$15 000–$24 999	23.6	22.8	25.0	21.5	23.0	23.3	21.8	27.0	23.2	22.7	22.5	24.6	22.2	24.5
$25 000–$34 999	15.1	13.9	15.4	13.8	14.6	12.8	14.7	13.1	14.9	13.4	14.3	14.8	14.4	14.5
$35 000–$49 999	15.0	13.9	14.7	14.3	14.7	14.8	15.8	10.9	15.0	13.7	14.9	13.8	15.6	13.2
≥$50 000	26.2	26.1	24.0	27.7	27.0	23.2	30.2	17.3	27.4	24.7	28.9	21.1	29.6	22.0
Employment status														
Employed	29.2[b]	45.0	25.1[b]	47.2	37.0	40.0	39.6[b]	32.4	36.4[d]	38.5	33.7[b]	43.3	38.7[b]	34.1
Retired	25.2	31.4	26.2	29.6	27.6	28.3	26.1	32.8	27.5	28.9	26.4	31.8	27.6	29.0
Unemployed	45.5	23.6	48.8	23.2	35.4	31.7	34.3	34.8	36.1	32.7	39.9	24.9	33.8	36.9
Having health insurance	93.1[b]	83.9	93.4[b]	84.4	90.1[b]	78.3	91.1[b]	80.4	91.2[b]	83.6	92.7[b]	80.8	90.7[b]	86.8
Having personal doctor	95.2[b]	89.1	95.1[b]	89.8	93.7[b]	80.8	94.9[b]	83.1	94.5[b]	87.4	95.0[b]	86.7	93.9[b]	90.7

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Individual Characteristics	Influenza Vaccination		Pneumococcal Vaccination		Doctor's Visit		A1C Test		Foot Examination		Eye Examination		Self-care Education	
	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
Need factor, %														
Health status														
Excellent/very good	16.7	17.9	16.0[d]	18.9	17.3[d]	19.7	17.9[b]	16.4	17.2	17.7	18.1[d]	15.8	18.6[b]	15.9
Good	32.8	33.5	31.6	34.6	33.1	36.6	35.2	30.4	33.7	32.8	33.4	32.1	34.2	31.7
Fair	50.4	48.6	52.3	46.5	49.5	43.7	46.9	53.3	49.1	49.5	48.4	52.0	47.2	52.4

[a]Weighted percentage and mean.

[b]$P < .001$.

[c]$P < .05$.

[d]$P < .01$.

TABLE 2

County-Level Characteristics[a] by Use of Preventive Diabetes Care

	Influenza Vaccination		Pneumococcal Vaccination		Doctor's Visit		A1C Test		Foot Examination		Eye Examination		Self-care Education	
County Characteristics	**Yes**	**No**	**Yes**	**No**	**Yes**	**No**	**Yes**	**No**	**Yes**	**No**	**Yes**	**No**	**Yes**	**No**
Predisposing factors, mean (SD)														
Median age	35.65 (3.74)[b]	35.51 (3.41)	35.83 (3.81)[c]	35.37 (3.37)	35.61 (3.59)[b]	35.31(3.46)	35.65 (3.59)[c]	35.32 (3.45)	35.66 (3.60)[d]	35.41 (3.52)	35.68 (3.64)[c]	35.38 (3.45)	35.46 (3.55)[c]	35.72 (3.62)
Black pop percentage	12.02 (13.79)[c]	13.34 (13.34)	12.12 (14.04)[c]	13.05 (13.06)	12.79 (13.76)[c]	11.24 (11.54)	12.46 (13.70)[b]	13.14 (13.16)	13.06 (14.23)[c]	11.77 (12.14)	12.90 (13.91)[b]	12.39 (13.08)	12.65 (13.89)	12.95 (13.49)
>High-school education rate	8.18 (5.30)[c]	8.94 (5.50)	7.97 (5.13)[c]	9.06 (5.51)	8.51 (5.44)	8.76 (5.26)	8.20 (5.09)[c]	9.37 (5.83)	8.12 (5.10)[c]	9.42 (5.84)	8.28 (5.28)[c]	9.11 (5.65)	8.10 (5.02)[c]	9.09 (5.86)
Enabling factors, mean (SD)														
Household median income (in 1000)	43.89 (12.50)	42.78 (12.51)	43.85 (12.46)	42.80(12.31)	43.39 (12.80)	44.12 (11.43)	44.10 (12.32)[c]	42.14 (12.79)	43.94 (12.41)[c]	42.40 (12.88)	44.01 (12.68)[c]	42.11 (12.41)	44.15 (12.19)[c]	42.45(13.06)
Unemployment rate	5.52 (2.18)[c]	5.70 (2.19)	5.46 (2.09)[c]	5.75 (2.23)	5.62 (2.23)	5.57 (1.98)	5.52 (2.08)[c]	5.82 (2.27)	5.51 (2.10)[c]	5.83 (2.33)	5.54 (2.20)[c]	5.75 (2.18)	5.53 (2.11)[c]	5.71 (2.29)
Uninsurance rate	14.37 (5.15)[b]	14.64 (5.07)	14.21 (5.02)[c]	14.79 (5.10)	14.42 (5.15)[c]	15.11(4.90)	14.38 (4.97)[c]	14.95 (5.34)	14.35 (5.00)[c]	14.84 (5.32)	14.40 (5.08)[d]	14.72 (5.23)	14.44 (4.93)	14.58 (5.36)
Physician density rate (per 1000 pop)	2.41 (1.91)	2.39 (1.66)	2.39 (1.85)	2.38 (1.70)	2.41 (1.81)	2.38 (1.63)	2.42 (1.83)	2.36 (1.58)	2.46 (1.88)[c]	2.29 (1.57)	2.46 (1.86)[c]	2.29 (1.66)	2.44 (1.79)[b]	2.37 (1.82)
Need factor, mean (SD)														
County diabetes prevalence	7.94 (1.65)[c]	8.10 (1.50)	8.00 (1.67)	8.04 (1.49)	8.03 (1.60)[c]	7.83 (1.43)	8.00 (1.60)	8.01 (1.48)	8.03 (1.61)	7.97 (1.51)	8.01 (1.60)	8.05 (1.54)	7.95 (1.58)[c]	8.12 (1.59)

[a]Weighted percentage and mean.

[b]$P < .05$.

[c]$P < .001$.

[d]$P < .01$.

TABLE 3

Multilevel Model Results of Associations Between County and Individual Characteristics and Use of Preventive Diabetes Care

Variables	Influenza Vaccination (n = 37 431)[a] AOR (95% CI)	Pneumococcal Vaccination (n = 36 048)[a] AOR (95% CI)	Doctor's Visit (n = 35 415)[a] AOR (95% CI)	A1C Test (n = 33 322)[a] AOR (95% CI)	Foot Examination (n = 35 319)[a] AOR (95% CI)	Eye Examination (n = 35 878)[a] AOR (95% CI)	Self-care Education (n = 36 219)[a] AOR (95% CI)
County characteristics[b]							
Predisposing factors							
Median age	0.91[c] (0.85–0.99)	0.99 (0.92–1.07)	0.98 (0.88–1.08)	0.96 (0.87–1.07)	1.00 (0.93–1.08)	1.04 (0.96–1.12)	0.92[c] (0.86–0.99)
Black pop percentage	0.92 (0.84–1.01)	0.94 (0.87–1.03)	1.05 (0.92–1.19)	0.80[d] (0.71–0.89)	1.01 (0.92–1.10)	0.94 (0.87–1.03)	0.89[e] (0.82–0.97)
<High-school education rate	0.86[e] (0.78–0.94)	0.79[d] (0.72–0.87)	1.13 (0.97–1.31)	1.06 (0.92–1.22)	0.91 (0.82–1.01)	1.02 (0.93–1.13)	0.75[d] (0.68–0.83)
Enabling factors							
Household median income	0.77[d] (0.70–0.85)	0.91 (0.82–1.00)	0.89 (0.77–1.04)	0.84[c] (0.74–0.96)	0.97 (0.87–1.08)	1.09 (0.99–1.20)	0.93 (0.84–1.03)
Unemployment rate	1.05 (0.97–1.13)	0.96 (0.90–1.03)	1.02 (0.91–1.14)	1.08 (0.97–1.20)	1.07 (0.99–1.16)	0.99 (0.91–1.06)	1.04 (0.96–1.12)
Physician density rate	1.02 (0.95–1.09)	1.02 (0.95–1.09)	1.01 (0.91–1.13)	1.15[e] (1.04–1.27)	1.12[e] (1.03–1.21)	1.13[e] (1.05–1.21)	1.05 (0.97–1.13)
Uninsurance rate	0.86[e] (0.78–0.96)	0.99 (0.90–1.10)	0.80[e] (0.68–0.94)	0.74[d] (0.64–0.84)	0.88[e] (0.80–0.98)	0.96 (0.87–1.07)	0.97 (0.87–1.08)
Need factor							
County diabetes prevalence	0.83[d] (0.76–0.90)	0.94 (0.86–1.03)	1.07 (0.94–1.22)	1.10 (0.97–1.24)	0.93 (0.85–1.02)	1.06 (0.97–1.17)	0.88[e] (0.81–0.95)
Individual characteristics							
Predisposing factors							
Age	3.07[d] (2.83–3.32)	3.70[d] (3.39–4.05)	1.02 (0.90–1.15)	0.78[d] (0.70–0.86)	1.04 (0.96–1.13)	1.86[d] (1.72–2.01)	0.65[d] (0.60–0.70)
Female	0.96 (0.91–1.01)	1.04 (0.99–1.11)	1.11[c] (1.02–1.21)	1.08 (0.99–1.16)	0.87[d] (0.82–0.92)	1.08[c] (1.02–1.14)	1.26[d] (1.19–1.33)
Married	1.07[c] (1.01–1.14)	0.97 (0.91–1.03)	1.04 (0.94–1.14)	1.11[c] (1.02–1.21)	1.08[c] (1.01–1.15)	1.01 (0.95–1.07)	1.12[d] (1.06–1.19)
Race (vs other)							
White	0.92 (0.81–1.06)	1.11 (0.97–1.27)	0.76[c] (0.62–0.94)	1.06 (0.89–1.25)	0.71[d] (0.61–0.82)	0.76[d] (0.66–0.87)	0.97 (0.85–1.09)
Black	0.72[d] (0.60–0.85)	0.75[d] (0.64–0.88)	1.27 (0.98–1.65)	1.04 (0.85–1.28)	1.15 (0.96–1.37)	1.09 (0.93–1.28)	1.21[c] (1.04–1.41)
Hispanic	0.94 (0.79–1.11)	0.75[e] (0.63–0.90)	0.84 (0.63–1.11)	0.80 (0.64–1.01)	0.68[d] (0.56–0.82)	0.94 (0.79–1.12)	0.94 (0.80–1.11)
Education level (vs >high school)							
<High school	0.72[d] (0.66–0.78)	0.67 (0.62–0.73)	1.02 (0.89–1.16)	0.57[d] (0.51–0.63)	0.82[d] (0.75–0.90)	0.75[d] (0.69–0.82)	0.53[d] (0.49–0.57)
High school	0.85[d] (0.80–0.90)	0.79 (0.74–0.84)	1.03 (0.93–1.15)	0.79[d] (0.72–0.86)	0.88[d] (0.83–0.94)	0.81[d] (0.76–0.87)	0.76[d] (0.71–0.80)

Variables	Influenza Vaccination (n = 37 431)[a] AOR (95% CI)	Pneumococcal Vaccination (n = 36 048)[a] AOR (95% CI)	Doctor's Visit (n = 35 415)[a] AOR (95% CI)	A1C Test (n = 33 322)[a] AOR (95% CI)	Foot Examination (n = 35 319)[a] AOR (95% CI)	Eye Examination (n = 35 878)[a] AOR (95% CI)	Self-care Education (n = 36 219)[a] AOR (95% CI)
Enabling factors							
Income (vs $50 000+)							
<$15 000	0.97 (0.88–1.08)	1.10 (0.99–1.23)	0.80[c] (0.68–0.95)	0.51[d] (0.44–0.59)	0.95 (0.85–1.07)	0.71[d] (0.63–0.79)	0.83[d] (0.75–0.92)
$15 000–$24 999	0.96 (0.88–1.05)	1.10[c] (1.01–1.21)	0.85[c] (0.73–0.98)	0.58[d] (0.51–0.67)	0.96 (0.87–1.05)	0.73[d] (0.66–0.81)	0.87[e] (0.80–0.96)
$25 000–$34 999	1.03 (0.94–1.13)	1.07 (0.98–1.18)	0.85[c] (0.73–0.99)	0.67[d] (0.58–0.78)	0.93 (0.83–1.03)	0.80[d] (0.72–0.88)	0.91[c] (0.83–0.99)
$35 000–$49 999	1.06 (0.98–1.15)	1.00 (0.91–1.10)	0.82[e] (0.71–0.94)	0.76[d] (0.66–0.87)	0.89[c] (0.81–0.98)	0.84[d] (0.77–0.93)	0.97 (0.89–1.05)
Employment status (vs unemployed)							
Employed	0.68[d] (0.63–0.74)	0.59[d] (0.54–0.64)	0.99 (0.88–1.13)	0.97 (0.87–1.07)	0.92 (0.85–1.00)	0.76[d] (0.70–0.82)	0.88[e] (0.82–0.95)
Retired	0.86[d] (0.80–0.94)	0.95 (0.87–1.03)	1.12 (0.99–1.28)	1.07 (0.96–1.18)	1.06 (0.97–1.15)	0.85[d] (0.78–0.92)	0.95 (0.88–1.02)
Having health insurance	1.49[d] (1.36–1.64)	1.36[d] (1.24–1.51)	2.16[d] (1.90–2.46)	1.79[d] (1.59–2.00)	1.41[d] (1.28–1.55)	1.74[d] (1.59–1.90)	1.20[d] (1.09–1.31)
Having personal doctor	1.66[d] (1.47–1.87)	1.35[d] (1.18–1.54)	3.12[d] (2.71–3.59)	2.68[d] (2.32–3.09)	2.08[d] (1.85–2.35)	1.55[d] (1.38–1.75)	1.27[d] (1.12–1.43)
Need factor							
Health status (vs fair/poor)							
Excellent/very good	0.84[d] (0.77–0.91)	0.68[d] (0.62–0.73)	0.65[d] (0.57–0.74)	0.81[d] (0.73–0.90)	0.77[d] (0.71–0.83)	1.08 (0.99–1.17)	0.96 (0.90–1.04)
Good	0.89[d] (0.84–0.95)	0.78[d] (0.74–0.83)	0.77[d] (0.69–0.85)	0.99 (0.91–1.07)	0.94 (0.88–1.00)	1.04 (0.98–1.11)	0.97 (0.91–1.03)

Abbreviations: AOR, adjusted odds ratio; CI, confidence interval.

[a]Usable observations in the model.

[b]The county level variables are rescaled by 2 times the standard deviation.

[c]$P < .05$.

[d]$P < .001$.

[e]$P < .01$.