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# Are there disparities in diabetes care? A comparison of care received by US rural and non-rural adults with diabetes

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**Aim:** Are there differences in diabetes care between rural and non-rural US adults with diabetes? **Background:** Rural Healthy People 2010 includes diabetes as a major health priority, suggesting a possible disparity between diabetes care in rural settings as compared to non-rural locales. **Methods:** This cross-sectional study using population-based survey data sought to determine if there was a difference in the *quality* of diabetes care between rural and non-rural US adults (⩾18 years). A diabetes care index was computed from five separate dichotomous care-related variables (HbA1c checked, lipids checked, dilated eye exam, feet checked by health care provider, and diabetes education), with adequate care defined as receiving at least four of these interventions. Multivariate methods were used to detect differences in diabetes care received by individuals living in rural compared to non-rural settings. **Results:** Multivariate regression analysis revealed that US adults with diabetes living in rural communities were more likely to receive inadequate care than non-rural residents (OR = 1.205; 95% CI 1.201, 1.209). Rural residents were more likely to receive inadequate diabetes care if they were: <40 years of age, male, Caucasian, not a high school graduate, not partnered, without health insurance, inactive or without an identified health care provider. Those deferring medical care because of cost, or who did not have an annual routine physical or had fewer than two diabetes related office visits annually were also at greater risk for suboptimal care. Routine physical checkups and deferring medical care because of cost had a greater impact on diabetes care for rural adults compared to non-rural adults. **Conclusion:** The results of this study indicated that rural residents were less likely to receive adequate diabetes care compared to their non-rural counterparts. The findings suggest that efforts to identify and to address this disparity would likely improve the outcomes for diabetic individuals living in rural communities.

**Key words:** adequacy of diabetes care; BRFSS; comparison of rural and urban adults with diabetes; diabetes care index; health disparities

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## Introduction

Diabetes currently ranks among the top five most prevalent chronic diseases in the United States of America (Thorpe *et al*., 2007) and its incidence

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continues to rise. Adult cases of newly diagnosed diabetes in the USA have almost tripled from 493 000 in 1985 to 1.4 million in 2005 (Centre for Disease Control, 2005), with an annual cost of more than $130 billion for diabetes care – $92 billion in direct medical costs and $40 billion in indirect costs due to missed work days and lost productivity (Hogan *et al*., 2003). Given its substantial impact, it is not surprising that US Healthy People 2010 (HP 2010) (US Department of Health and Human Services, 2000) considers reducing the burden from diabetic disease as a top priority. A companion piece to HP2010, Rural Healthy People 2010 (RHP 2010) (Gamm *et al*., 2002), also lists diabetes as a major health priority. Specifically, the rural-focused document highlights a disparity between diabetes care in rural settings compared to non-rural locales and emphasizes the importance of incorporating rural residency as a factor in diabetes care.

A health disparity population is defined as a population where there is a significant *avoidable* difference in the overall rate of disease incidence, prevalence, morbidity, mortality, or survival rates when compared to the general population (National Institute of Health, 2002; P.L. 106-525, 2000). Although it is widely recognized that rural/urban areas differ in many ways, such as in their environment and demography, only recently have public health scholars recognized that rural residency may be associated with health disparities (Hartley, 2004). Using survey data collected from a broad spectrum of stockholders, Gamm *et al*. (2002) identified diabetes as the third ranked health care priority for rural communities. Despite the perceived importance of diabetes to rural communities, few studies have been conducted that compare diabetes care among rural residents with the care provided to urban populations. Although the studies that have been published have detected rural/urban differences, several of the studies are international (Tang and Chen, 2000; Levin *et al*., 2001; Satman *et al*., 2002; McLean *et al*., 2007; O'Brien and Denham, 2008) and as such may not have findings that are generalizable to the US population of adults with diabetes. While US studies comparing rural/urban diabetes prevalence and management also demonstrate rural/urban differences, their findings are somewhat limited because these studies either examined regional variations (Grandinetti *et al*., 1998; Coon and Zulkowski, 2002; Andrus *et al*., 2004; Deshpande *et al*., 2005; Moore *et al*., 2006; Shaw *et al*., 2006) or focused on a select and very specific population such as Medicare beneficiaries (Weingarten *et al*., 2006), rural Hispanics (Koopman *et al*., 2006) or rural African Americans (Mainous *et al*., 2004). No national study of US adults with diabetes exists that examines differences in diabetes care for rural residents compared to non-rural residents among a broad spectrum of adults.

The purpose of this study was to fill this identified gap in the current literature by examining the impact place of residence on the quality of health care received by US adults with diabetes. Specifically, by using a nationally representative database, this study sought to determine if there were differences in diabetes care between rural and non-rural adult populations in the USA.

## Methodology

Using data from the 2005 Behavioral Risk Factor Surveillance Survey (BRFSS), we examined disparities in care between rural and non-rural adults with diabetes in the USA. The study used 2005 BRFSS data because this was the most recent year of data collection where several variables relevant to our analyses were included.

BRFSS is a cross-sectional, random digit telephone survey that is a collaborative project of the Centers for Disease Control and Prevention (CDC) and all US states and territories. The survey measures several behavioural risk factors in the adult population aged 18 through 99 years. Its objective is to collect uniform, state-specific data on preventive health practices and risk behaviours linked to chronic diseases, injuries and preventable infectious diseases in the non-institutionalized adult US population. Data are collected from a random sample of adults (one per household). A more detailed description of the sampling methodology of BRFSS is available elsewhere (Mokdad *et al*., 2003). All BRFSS data are self-reported responses to mostly forced-choice questions. No additional data are generated to corroborate or substantiate the self-reported responses. As recommended by the Center for Disease Control, all analyses were performed on weighted data. The weighting provides a stratified representation of the US adult non-institutionalized population.

The Metropolitan Statistical Area (MSA) variable included in BRFSS was used to define place of



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residence as either rural or urban. Rural residents were defined as people living either within an MSA that had no city centre or outside an MSA. Non-rural residents included all respondents living in a city centre of an MSA, outside the city centre of an MSA but inside the county containing the city centre, or inside a suburban county of the MSA.

For analyses, a number of independent variables were collapsed into the following bifurcated categories:

- Age (⩾40 years/ <40 years),
- Race (Caucasian/Non-Caucasian),
- Education (did not graduate from high school/ graduated from high school),
- Household income (<$35 000/⩾35 000),
- Marital status (partnered/not partnered),
- Self-reported health status (fair or poor health/ good or excellent health),
- Have own health care provider (yes/no),
- Diabetes related office visits (at least two times in the past 12 months/fewer than two times in the past 12 months).

Gender and health insurance status were also independent variables with bifurcated categories used in the analyses but these categories were not the result of a collapsing effort. Level of physical activity, another independent variable used, was computed by combining two other variables assessing physical activity level: 1) whether or not a person was getting recommended levels of moderate physical activity, and 2) whether or not a person was getting recommended levels of vigorous physical activity. People who reported getting recommended levels of either moderate or vigorous physical activity were coded as getting at least recommended levels of moderate physical activity. Recommended levels of moderate physical activity were defined as: moderate-intensity activities such as brisk walking for at least 30 min per day, at least five days a week.

Receipt of *inadequate diabetes care* from a physician or nurse practitioner or other health care provider constituted the dependant variable for this study. This was a computed variable derived from responses given to multiple questions. The answers given by respondents to each of these questions were collapsed into bifurcated categories, in a manner similar to the one just discussed. The questions and the resulting bifurcated variables are displayed in the chart below.

| Survey question | Variable name | Original response choices | Recoded bifurcated category |
|---|---|---|---|
| 1) A test for 'A one C' measures the average level of blood sugar over the past three months. About how many times in the past 12 months has a doctor, nurse or other health professional checked you for haemoglobin 'A one C'? | HbA1c | 1–76 (continuous variable) | At least once in the past 12 months/not within the past 12 months |
| 2) About how long has it been since you last had your blood cholesterol checked? | Cholesterol checked | Within the past year/within the past two years/within the past five years/five or more years ago | Within past year/not within past year |
| 3) About how many times in the past 12 months has a health professional checked your feet for any sores or irritations? | Feet checked by health care provider | 1–76 (continuous variable) | At least once in the past 12 months/not within the past 12 months |
| 4) When was the last time you had an eye exam in which the pupils were dilated? This would have made you temporarily sensitive to bright light. | Dilated eye exam | Within the past month /within the past year/within the past two years/two or more years ago | At least once in the past year/not within the past year |
| 5) Have you ever taken a course or class in how to manage your diabetes yourself? | Had diabetes education | Yes/no/don't know/not sure/ refused | Yes/no |



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For our analyses, we created a diabetes care index from the five bifurcated variables. These variables were chosen because they reflected the American Diabetes Association's (ADA) *clinical practice recommendations* at the time that these data were collected. The variables chosen for the diabetes care index remained current as of 2009.

According to our index, the quality of care for adults with diabetes was classified as either adequate or inadequate care. Adequate diabetes care was defined as adults with diabetes getting at least four of the following: 1) HbA1c checked in past 12 months, 2) lipids checked in past year, 3) dilated eye exam in past year, 4) feet checked by health care provider at least once in past 12 months, and 5) formal diabetes education at least once in a lifetime. Inadequate care was defined as getting fewer than four of these five interventions.

Bivariate analysis using contingency tables with unadjusted odds ratios (ORs) was conducted to determine whether or not there were differences in diabetes care between rural and non-rural adults. Our bivariate analysis stratified adequacy of care by place of residence by the independent predictor variables. Multivariate logistic regression was performed to characterize US adults with diabetes receiving inadequate care. Inadequate diabetes care was the dependant variable for three separate logistic regression models – one that included all US adults with diabetes, one including only rural adults with diabetes, and one including only non-rural adults with diabetes. Alpha was set at $<0.05$ for all tests of statistical significance. All analyses were conducted using SPSS 17.0 (Chicago, IL) complex samples. This study was approved by the University of Illinois-Chicago College of Medicine at Rockford's Institutional Review Board (IRB).

## Results

The unweighted sample size for US adults with diabetes in 2005 was 37 173. For analyses, these data were weighted to represent 18 864 121 adults with diabetes. Our analyses of 2005 BRFSS data yielded a diabetes prevalence estimate of 9% for the overall (rural and non-rural) US adult population $\geqslant$18 years of age. This prevalence rate is similar to that reported for adults $\geqslant$20 years of age by the National Diabetes Information Clearinghouse (9.6% prevalence estimate) (NIDDKD, 2005). We also found that US rural adults were more likely to have diabetes (OR = 1.157; 95% class interval (CI) 1.156, 1.158).

A description of US adults with diabetes by place of residence is presented in Table 1. This description allows for both a within group and between groups descriptive comparison. Of note, the majority of adults with diabetes, regardless of place of residence, lived in households with incomes lower than $35 000. Also, approximately one in five US adults with diabetes did not graduate from high school. The proportion for both these independent predictors was higher for the rural diabetic population.

For both non-rural and rural adults, more than one in ten with diabetes reported that they did not have health insurance. This disparity was more marked for rural adults with diabetes. At least 26% of US adults with diabetes reported seeing their health care provider fewer than two times in the past 12 months for diabetes care. More than half of both rural and non-rural adults with diabetes indicated they had not had their feet checked by a health care provider in the past 12 months.

Greater than 15% of US adults with diabetes reported deferring their medical care because of cost with a higher proportion of rural adults doing so. Additionally, more than one in five US adults with diabetes did not have their HbA1c checked in the past 12 months. One in ten did not have their cholesterol checked within the last year, and one in three did not have a dilated eye exam in the past year. Finally, more than 45% of US adults with diabetes reported that they had never received formal diabetes education. For three of these indicators – diabetes education, cholesterol check and dilated eye exam – rural adults were less likely to receive recommended care.

Using the diabetes care index created from the diabetes care variables (HbA1c checked, lipids checked, dilated eye exam, feet checked by health care provider, and diabetes education), we estimated the prevalence rate for adequacy of care by place of residence (rural/non-rural). This analysis revealed that rural adults with diabetes had increased risk for receiving inadequate care (OR = 1.212; 95% CI 1.210, 1.215). Given this finding, we chose to perform a bivariate analysis that stratified adequacy of care by place of residence



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**Table 1** Description of US adults with diabetes by place of residency rural/urban Behavioral Risk Factor Surveillance Survey 2005 data (weighted $n = 18\,864\,121$)

| Variables | Factors | Rural (%) weighted $n = 4\,257\,099$ | Urban (%) weighted $n = 14\,607\,022$ |
|---|---|---|---|
| Age | <40 years | 10.2 | 11.6 |
| | ⩾40 years | 89.8 | 88.4 |
| Sex | Male | 48.4 | 49.4 |
| | Female | 51.6 | 50.6 |
| Race and ethnicity | Caucasian | 77.2 | 61.4 |
| | Non-Caucasian | 22.8 | 38.6 |
| Education | Graduated HS | 78.9 | 80.8 |
| | Not a HS Graduate | 21.1 | 19.2 |
| Household income | <$35 000 | 64.3 | 55.9 |
| | ⩾35 000 | 35.7 | 44.1 |
| Marital status | Partnered | 63.4 | 61.2 |
| | Not partnered | 36.6 | 38.8 |
| Self reported health status | Good or better health | 48.9 | 53.5 |
| | Fair or poor health | 51.1 | 46.5 |
| Have health insurance | Yes | 86.9 | 89.0 |
| | No | 13.1 | 11.0 |
| Have health care provider | Yes | 92.7 | 91.7 |
| | No | 7.3 | 8.3 |
| Deferred medical care due to cost | Yes | 17.9 | 15.7 |
| | No | 82.1 | 84.3 |
| Gets at least recommended levels of moderate physical activity | Yes | 34.1 | 35.6 |
| | No | 65.9 | 64.4 |
| Routine physical checkup within last year | Yes | 82.8 | 85.0 |
| | No | 17.2 | 15.0 |
| Diabetes related office visits | Fewer than two times in the past 12 months | 26.0 | 26.7 |
| | At least two times in the past 12 months | 74.0 | 73.3 |
| Had diabetes education | Yes | 47.9 | 54.2 |
| | No | 52.1 | 45.8 |
| HbA1c checked | At least once in the past 12 months | 77.6 | 76.9 |
| | Not within the past 12 months | 22.4 | 23.1 |
| Cholesterol checked | Within last year | 89.3 | 90.6 |
| | Not within last year | 10.7 | 9.4 |
| Feet checked by health care provider | Not within in the past 12 months | 55.4 | 50.7 |
| | At least once in the past 12 months | 44.6 | 49.3 |
| Dilated eye exam | At least once in the past 12 months | 64.2 | 69.1 |
| | Not within the past 12 months | 35.8 | 30.9 |

HS = high school.

by the independent predictor variables (age, sex, race, education, household income, marital status, self-reported health status, health insurance status, have health care provider, deferred medical care because of cost, physical activity, routine physical checkup, and diabetes related office visits). Of note, in both populations, adults with diabetes who did not complete high school,



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deferred medical care due to cost, did not have a routine physical in the past year, had fewer than two diabetes related office visits in the past 12 months and did not get recommended levels of moderate physical activity were more likely to receive inadequate diabetes care (see Table 2).

Multivariate regression analyses were performed using the computed *diabetes care index* with inadequacy of care as the dependant variable (see Table 3). Three models were tested with analyses focused on identifying the characteristics of either all US adults, rural US adults or urban US adults with diabetes receiving inadequate care. The analyses yielded that US adults with diabetes receiving inadequate care were more likely: rural residents, <40 years of age, male, Caucasian, not a high school graduate, living in households with incomes <$35 000, not partnered, without health insurance, without a health care provider, deferring medical care because of cost, not getting moderate physical activity, not getting an annual routine physical, and getting fewer than two diabetes related office visits in the last 12 months. The results for non-rural and rural adults alike with diabetes were similar to the first logistic regression model for all US adults, with the exception of household income. Income did not impact rural adults with diabetes receiving inadequate care as much as it did their non-rural counterparts.

## Discussion

Using a national database, this study found that rural residents were about 20% more likely to experience inadequate care for diabetes than their non-rural counterparts. The analyses also revealed that diabetes prevalence rates were higher for rural adults (9.7%), a finding consistent with previous studies (Benson and Marano, 1998; Pleis and Lethbridge-Çejku, 2007). However, our study revealed a higher prevalence of diabetes than previously reported for both rural *and* non-rural residents, a result consistent with the increasing incidence of diabetes that is often described as being epidemic. Our finding that rural adults were 16% more likely to have diabetes is not surprising, as obesity, a key risk factor for type 2 diabetes, is more prevalent in rural adults (Jackson *et al*., 2005).

While smaller regional studies (Coon and Zulkowski, 2002; Satman *et al*., 2002; Andrus *et al*., 2004; Deshpande *et al*., 2005; Moore *et al*., 2006; Shaw *et al*., 2006) also found that rural adults were at greater risk for suboptimal diabetes care, this study is the first to use national data and adds to the growing body of literature indicating that there is a disparity in diabetes care for individuals living in rural communities. For instance, a previous study (Andrus *et al*., 2004) found lower adherence to ADA standards for rural patients in Alabama. Specifically, rural patients were less likely to achieve recommended LDL (low-density lipoproteins), blood pressure or HbA1c targets, and also less likely to receive preventive services such as lipid profiles, eye exams, or to be tested for microalbinuria. Similarly, another regional study (Coon and Zulkowski, 2002) found that health care providers in Montana did not adequately follow the ADA clinical practice standards for managing rural patients with diabetes.

In contrast, those studies using a national database that examined selected populations with diabetes (Mainous *et al*., 2004; Koopman *et al*., 2006; Weingarten *et al*., 2006) did not identify the disparity found in our study and other earlier regional studies. For example, researchers examining Medicare beneficiaries only (Weingarten *et al*., 2006), concluded that Medicare beneficiaries living in rural areas received comparable care for their diabetes compared to non-rural residents. Our findings suggest that there is indeed a gap in receiving recommended care between rural/non-rural patients with diabetes. However, because not all groups appear equally disadvantaged, further research examining subgroups may be valuable for developing strategies targeted at improving diabetes care in rural communities. As several landmark clinical studies indicate that diabetes complications can either be prevented or delayed by adhering to recommended guidelines (Zgibor and Songer, 2001), improved adherence to recommended standards seems likely to reduce diabetes related complications for residents in rural communities.

A second important finding from our study was that one in three US adults with diabetes reported not having a dilated eye exam in the past 12 months, and rural US adults with diabetes were 19% more likely not to have had a dilated eye exam in the past 12 months. Other studies have

**Table 2** Bivariate analysis of diabetes care index by independent variables and place of residency (rural/ urban) for US adults Behavioral Risk Factor Surveillance Survey data 2005 (weighted $n = 18\,864\,121$)

| Independent variables and factors | Diabetes care index by place of residence | | | |
|---|---|---|---|---|
| | Rural (weighted $n = 4\,257\,099$) | | Urban (weighted $n = 14\,607\,022$) | |
| | Unadjusted odds ratio (95% CI) | Explanation | Unadjusted odds ratio (95% CI) | Explanation |
| Age (⩾40 Years/ <40 Years) | 1.123 (1.119, 1.128) | Rural adults with diabetes who were aged ⩾40 years were more likely to get adequate care. | 1.080 (1.078, 1.082) | Urban adults with diabetes who were aged ⩾40 years were more likely to get adequate care. |
| Sex (male/female) | 1.019 (1.017, 1.021) | Rural adults with diabetes who were male were more likely to get adequate care. | 1.027 (1.026, 1.028) | Urban adults with diabetes who were male were more likely to get inadequate care. |
| Race (Caucasian/Non-Caucasian) | 1.016 (1.014, 1.019) | Rural adults with diabetes who were Caucasian were more likely to get inadequate care. | 1.111 (1.110, 1.112) | Urban adults with diabetes who were Caucasian were more likely to get adequate care. |
| Education (not a HS graduate/graduate from HS) | 1.417 (1.413, 1.422) | Rural adults with diabetes who were not a HS graduate were more likely to get inadequate care. | 1.577 (1.575, 1.580) | Urban adults with diabetes who were not a HS graduate were more likely to get inadequate care. |
| Household income (<$35 000/⩾35 000) | 1.136 (1.132, 1.140) | Rural adults with diabetes who lived in households with incomes <$35 000 were more likely to get inadequate care. | 1.391 (1.388, 1.393) | Urban adults with diabetes who lived in households with incomes <$35 000 were more likely to get inadequate care. |
| Marital status (partnered/not partnered) | 1.088 (1.086, 1.091) | Rural adults with diabetes who were partnered were more likely to get adequate care. | 1.139 (1.137, 1.140) | Urban adults with diabetes who were partnered were more likely to get adequate care. |
| Self reported health status recoded (fair or poor health/good or better health) | 1.101 (1.098, 1.104) | Rural adults with diabetes who self report fair or poor health status were more likely to get inadequate care. | 1.195 (1.193, 1.197) | Urban adults with diabetes who self report fair or poor health status were more likely to get inadequate care. |
| Have health insurance (yes/no) | 1.397 (1.390, 1.403) | Rural adults with diabetes who had health insurance were more likely to get adequate care. | 1.686 (1.681, 1.691) | Urban adults with diabetes who had health insurance were more likely to get adequate care. |
| Have own health care provider (yes/no) | 1.332 (1.323, 1.340) | Rural adults with diabetes who had their own health care provider were more likely to get adequate care. | 1.685 (1.680, 1.690) | Urban adults with diabetes who had their own health care provider were more likely to get adequate care. |
| Deferred medical care due to cost (yes/no) | 1.363 (1.358, 1.367) | Rural adults with diabetes who deferred medical care because of cost were more likely to get inadequate care. | 1.456 (1.453, 1.459) | Urban adults with diabetes who deferred medical care because of cost were more likely to get inadequate care. |

**Table 2** *Continued*

| | | | | |
|---|---|---|---|---|
| Gets at least recommended levels of moderate physical activity (no/yes) | 1.193 (1.189, 1.196) | Rural adults with diabetes who did not get at least recommended levels of moderate PA were more likely to get inadequate care. | 1.186 (1.184, 1.188) | Urban adults with diabetes who did not get at least recommended levels of moderate PA were more likely to get inadequate care. |
| Routine physical checkup (not within last year/ within last year) | 1.774 (1.769, 1.779) | Rural adults with diabetes who did not have a physical checkup within the past year were more likely to get inadequate care. | 1.827 (1.824, 1.830) | Urban adults with diabetes who did not have a physical checkup within the past year were more likely to get inadequate care. |
| Diabetes related office visits (fewer than two times in past 12 months/ at least two times in past 12 months) | 1.847 (1.842, 1.852) | Rural adults with diabetes who had diabetes related office visits fewer than two times in the last 12 months were more likely to get inadequate care. | 2.173 (2.169, 2.176) | Urban adults with diabetes who had diabetes related office visits fewer than two times in the last 12 months were more likely to get inadequate care. |
| BMI (overweight or obese/ healthy weight) | 1.152 (1.148, 1.156) | Rural adults with diabetes who were overweight or obese were more likely to get adequate care. | 1.089 (1.088, 1.091) | Urban adults with diabetes who were overweight or obese were more likely to get adequate care. |

HS = high school, PA = physical activity.

**Table 3** Logistic regression for All US, Rural and Urban adults with diabetes dependent variable: inadequate diabetes care Behavioral Risk Factor Surveillance Survey 2005 data

| Independent variable | Factors | Adjusted odds ratio (95% CI) | | |
|---|---|---|---|---|
| | | All US adults | Rural US adults | Urban US adults |
| Age | <40 years | 1.076 (1.070, 1.081) | 1.259 (1.245, 1.272) | 1.039 (1.034, 1.045) |
| | ⩾40 years | –* | –* | –* |
| Sex | Male | 1.070 (1.067, 1.073) | 1.040 (1.034, 1.047) | 1.081 (1.077, 1.085) |
| | Female | –* | –* | –* |
| Race and ethnicity | Caucasian | 1.052 (1.049, 1.055) | 1.225 (1.216, 1.234) | 1.021 (1.017, 1.024) |
| | Non-Caucasian | –* | –* | –* |
| Education | Not a HS graduate | 1.918 (1.910, 1.926) | 2.001 (1.985, 2.017) | 1.894 (1.885, 1.903) |
| | Graduate from HS | –* | –* | –* |
| Household income | <$35 000 | 1.215 (1.211, 1.219) | 0.987 (0.980, 0.994) | 1.283 (1.278, 1.287) |
| | ⩾$35 000 | –* | –* | –* |
| Marital status | Not partnered | 1.175 (1.171, 1.179) | 1.133 (1.125, 1.141) | 1.187 (1.183, 1.192) |
| | Partnered | –* | –* | –* |
| Health insurance status | No | 1.455 (1.448, 1.463) | 1.367 (1.354, 1.381) | 1.481 (1.472, 1.490) |
| | Yes | –* | –* | –* |
| Have health care provider | No | 1.501 (1.491, 1.510) | 1.200 (1.182, 1.218) | 1.581 (1.570, 1.593) |
| | Yes | –* | –* | –* |
| Medical care deferred because | Yes | 1.151 (1.146, 1.156) | 1.426 (1.414, 1.439) | 1.075 (1.069, 1.080) |
| of cost | No | –* | –* | –* |
| Gets at least recommended levels | No | 1.295 (1.291, 1.299) | 1.250 (1.242, 1.258) | 1.308 (1.303, 1.312) |
| of moderate physical activity | Yes | –* | –* | –* |
| Routine physical checkup | No | 2.555 (2.544, 2.565) | 2.947 (2.921, 2.972) | 2.457 (2.445, 2.468) |
| within last year | Yes | –* | –* | –* |
| Diabetes office visits | Fewer than two times in the past 12 months | 4.080 (4.066, 4.093) | 3.640 (3.614, 3.667) | 4.210 (4.194, 4.226) |
| | At least two times in the past 12 months | –* | –* | –* |
| Self reported health status | Good or better health | 0.967 (0.964, 0.970) | 0.934 (0.928, 0.940) | 0.977 (0.974, 0.981) |
| | Fair or poor health | –* | –* | –* |
| Place of residence | Rural | 1.205 (1.201, 1.209) | | |
| | Urban | –* | | |

–* = reference category; HS = high school.

similarly found that rural adults with diabetes were less likely to get dilated eye exams (Coon and Zulkowski, 2002; Andrus *et al*., 2004; Weingarten *et al*., 2006). Given the potential benefit of early recognition of proliferative retinopathy, this should be an area of concern for health care providers and their patients with diabetes. While our findings do not provide the reason for this difference in care, significant differences in services still exist between rural and urban settings in the US and fewer eye exams may be a result of limited access to specialized eye care in rural areas (Dansky and Dirani, 1998). Another finding suggesting an association of access to quality was that all US adults with diabetes receiving inadequate care were less likely to have had an annual physical checkup. The adjusted OR for this independent predictor was higher for rural adults in comparison to urban ones. It is not surprising that adherence to ADA standards was related to an annual check up, because many ADA examination standards are incorporated into an annual examination. In addition, an annual exam may also trigger physicians to order recommended tests or, if not done by an examiner, prompts a referral for a dilated eye exam.

Both rural and non-rural individuals report cost as a barrier to care. However, our findings indicated that the disparity was much greater for rural adults receiving inadequate diabetes care compared to their urban counterparts (7.5% for non-rural adults versus 43% for rural adults), which was not unexpected because a disproportionate share of rural adults with diabetes did not have health insurance. Our results suggest that health planners should focus on more equitably distributing available medical resources and on research to identify and test strategies such as group visits, telemedicine, or a *visiting specialist day* that might reduce cost and lessen financial barriers to care. Other strategies, such as enhancing self-management and patient education efforts might also increase adherence to guidelines. While enhancing the patient role in management for chronic disease is an affective and often cost effective strategy, this might prove even more challenging in the rural setting since our results indicated they, currently, are less likely to receive diabetes education. While it is unlikely that 100% adherence to guidelines will ever be achieved, further studies investigating innovative strategies uniquely tailored to rural communities should be implemented and tested.

In addition to providing insight for diabetes care strategies, the findings from this research project should be of use in planning public health policy focused on national health objectives and initiatives regarding diabetes. Both HP2010 and RHP2010 express concerns about diabetes care and outcomes in their respective planning documents. HP2010 included 17 specific diabetes-related objectives among their objectives for improving health and RHP2010 listed diabetes as a major health priority for rural residents, health care providers and policy makers in the US.

Research findings such as the ones reported here provide information on diabetes prevalence and evidence of disparities in diabetes care for rural residents. The failure to reference rural diabetes health disparities (in HP2010) and adequate diabetes care (in HP2010 and RHP2010) is surprising given that type 2 diabetes is arguably the most rapidly growing chronic disease in the USA. Ultimately, the findings reported here suggest that policy statements regarding rural diabetes should be incorporated into the next iterations of HP2010 and RHP2010. However, this would require some modifications in the way surveillance survey data are collected. Presently, 10 of the 17 diabetes objectives in HP2010 call for the use of BRFSS data for surveillance. While diabetes prevalence can be calculated from the current surveillance survey questions which are asked of all respondents to BRFSS, adequacy of care can be assessed only in those states that elect to use the diabetes module as part of their health surveillance strategies. Hence, to monitor adequacy of diabetes care nationally, the diabetes surveillance module would need to become part of the set of core surveillance survey questions asked of all BRFSS respondents annually.

Several potential limitations to this study should be noted. First, the survey is based on telephone-derived data and may be skewed because those who could not be reached by phone could not participate in the survey. For example, persons of lower socioeconomic status may have been excluded because of poorer phone access. However, the fact that the vast majority of US residents live in households with telephones minimizes this bias.

A second limitation is that the survey used close-ended questions, which limit a responder's



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options to fully explain response choices. However, while a different question format may have yielded different results, the survey questions were worded so that the answer choices covered a wide range of response possibilities. A third and related limitation is that the answers are self-reported, which introduces the possibility of recall bias on the part of the survey participants.

A fourth potential bias is that the majority of the rural adults with diabetes in this study were Caucasian. Consequently, the findings may not be generalizable to persons of other races or ethnicities. Rural communities, however, are predominately Caucasian and as such the survey respondents reflected the racial composition of rural communities.

A fifth bias resulted from the languages of the survey – English and Spanish. Individuals who did not speak English or Spanish were excluded from this survey. Not all US residents speak the two languages of this survey and those who do not may in fact be among the population of US adults with diabetes receiving inadequate care or who experience difficulties with access to medical care. For instance, lack of acculturation of Arab immigrants to the USA has been identified as a risk factor for developing diabetes (Jaber *et al*., 2003). Since these groups of immigrants do not speak English, they would not be able to participate in a survey such as BRFSS, potentially limiting the generalizability of the findings.

## Conclusions

The study results indicated that rural residents were less likely to receive adequate diabetic care compared to their non-rural counterparts. Our findings suggest that addressing this disparity would likely improve the outcomes for diabetic individuals living in rural communities. Models developed for diabetes management could also potentially serve as models to improve management and outcomes for individuals with other chronic diseases, living in a rural setting.

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