Diabetes Care and Outcomes: Disparities Across Rural America

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Abstract We examined differences in receipt of diabetes care and selected outcomes between rural and urban persons living with diabetes, using nationally representative data from the 2006 Behavioral Risk Factor Surveillance System (BRFSS). “Rural” was defined as living in a non-metropolitan county. Diabetes care variables were physician visit, HbA1c testing, foot examination, and dilated eye examination. Outcome variables were presence of foot sores and diabetic retinopathy. Analysis was limited to persons 18 and older self-reporting a diagnosis of diabetes (n = 29,501). A lower proportion of rural than urban persons with diabetes reported a dilated eye examination (69.1 vs. 72.4%; P = 0.005) or a foot examination in the past year (70.6 vs. 73.7%; P = 0.016). Conversely, a greater proportion of rural than urban persons reported diabetic retinopathy (25.8 vs. 22.0%; P = 0.007) and having a foot sore taking more than four weeks to heal (13.2 vs. 11.2%; P = 0.036). Rural residence was not associated with receipt of services after individual characteristics were taken into account in adjusted analysis, but remained associated with an increased risk for retinopathy (OR = 1.20, 95% CI = 1.02–1.42). Participation in Diabetes Self-Management Education (DSME) was positively associated with all measures of diabetes care included in the study. Availability of specialty services and travel considerations could explain some of these differences.

Keywords Rural · Diabetes care · Diabetes outcomes · Diabetes self management education

Introduction

As the number of persons living with diabetes continues to increase [1], providing care necessary to reduce associated morbidity and mortality will become increasingly important. Diabetes care requires screenings, preventive services, self-management education and counseling be integrated with primary care services for treating routine conditions [2]. Recommendations outlining care all persons living with diabetes should receive have been developed by the American Diabetes Association (ADA) and include routine physician visits, Hemoglobin A1c (HbA1c) testing, foot examinations by a health professional and dilated eye examinations [3]. These services are important for prevention and early detection of complications associated with diabetes, including retinopathy and ulcerated foot sores.

Studies using nationally representative survey data have tracked changes in diabetes care over time and disparities in care among certain sub-populations [4–8]. However, few have examined differences in diabetes care differed based on residence in rural areas. Meeting ADA recommendations for diabetes care can be challenging under optimal conditions, even more so for rural areas lacking the infrastructure to sustain processes needed to improve care and outcomes among persons living with diabetes [2]. Rural populations often lack adequate access to primary care and specialty care services [9], which are critical for providing
quality diabetes care. Studies conducted among rural or underserved populations noted difficulties in meeting the recommendations for diabetes care; however, results are localized and do not produce nationally representative estimates on differences in diabetes care among rural populations [10–14].

The ADA recommends that all individuals diagnosed with diabetes participate in Diabetes Self-Management Education (DSME). The effectiveness of DSME in improving diabetes care has been demonstrated [7, 15–17]; however, studies of participation in DSME among rural populations have noted significant challenges related to the availability and sustainability of DSME [18–20]. The extent to which these relationships impact diabetes care has not been fully explored.

The purpose of the present study is to explore differences in diabetes care and selected outcomes associated with rural residence. Given the challenges rural populations face with access to adequate health care resources and utilizing DSME, it is believed that persons living with diabetes in rural areas will be less likely to receive recommended diabetes care than those residing in urban areas, resulting in worse outcomes.

Methods

Design, Data Source and Sample

We conducted a cross-sectional analysis of data from the 2006 Behavioral Risk Factor Surveillance System (BRFSS). The BRFSS is a state based survey system, coordinated and centrally compiled by the Centers for Disease Control and Prevention, which gathers data on preventive health practices, risk behaviors, and health care access. The BRFSS uses a multistage cluster design based on random-digit dialing to collect data on non-institutionalized civilian residents of the United States aged 18 years or older. Data from each state are pooled and weighted to produce nationally representative estimates. An optional module related to diabetes was completed by 47 states and included in the 2006 BRFSS dataset. Diabetes status was determined by response to the question of “Have you ever been told by a doctor you have diabetes?” Those responding “Yes” were considered to be persons living with diabetes and constitute the study sample of \( n = 29,501 \). Once identified as having diabetes, individuals were asked additional questions on services, outcomes and disease management.

Environmental data, such as rural versus urban residence, were drawn from Area Resource File (ARF). The ARF is sponsored by the Health Resources and Services Administration, USDHHS and compiles county level data pertaining to health facilities, health professionals, health outcomes and basic demographics. The ARF data were linked to the BRFSS based on respondents’ reported county of residence.

Independent Variable: Rural Residence

Definitions of rural were based on the 2003 Urban Influence Codes (UICs) from the United States Department of Agriculture Economic Research Service [21]. UICs divide the 3,141 counties, county equivalents, and independent cities into 12 groups based on population and commuting data from the 2000 Census [22]. For the purposes of this study, UICs of 1 and 2 were classified as “Urban,” while UICs 3–12 were considered “Rural.” Rural counties vary in size, and may contain modest urbanized areas of less than 50,000 population.

Dependent Variables

Selected services and outcomes associated with diabetes care were used to examine differences in care based on residence. Having one or more physician visits in the past 12 months was the first dependent variable of interest and was coded dichotomously (yes/no). Values for HbA1c testing were derived from the question “How many times in the past 12 months has a doctor, nurse, or other health professional checked for hemoglobin ‘A one C’.” Individuals reporting two or more HbA1c tests in the past 12 months were considered to meet ADA recommendations [3]. The foot exam variable was derived from the question “About how many times in the past 12 months has a health professional checked your feet for any sores or irritations?” Persons reporting their feet were checked at least once in the past 12 months were considered to meet recommendations [3]. Values for eye exams were derived from the question “When was the last time you had eye exam in which the pupils were dilated? This would have made you temporarily sensitive to bright light?” Individuals reporting at least one dilated eye exam in the past 12 months were considered to meet recommendations [3].

Two self-reported diabetic sequellae were also studied. Persons with diabetes were asked “Has a doctor ever told you that diabetes has affected your eyes or that you had retinopathy?” Persons responding “yes” were considered to have diabetic retinopathy. The foot sore variable was derived from responses to the question “Have you ever had any sores or irritation on your feet that took more than four weeks to heal?” and was also coded dichotomously (yes/no).

Covariates

Anderson’s Behavioral Model for Health Services Use served as the conceptual framework for defining covariates...
that might affect the receipt of diabetes care and diabetes outcomes [23]. The Anderson model conceptualizes health utilization as a function of the individual’s predisposing characteristics such as age, enabling factors such as insurance coverage, and need for services, together with environmental factors such as the availability of services.

Predisposing characteristics held constant in the analysis include sex, race/ethnicity, and age. Race/ethnicity was a four level variable, non-Hispanic White, non-Hispanic Black, non-Hispanic Other and Hispanic. Age was grouped into ages of 18–34, 35–54, 55–64 and 65 and older.

Enabling factors available in the 2006 BRFSS included education, marital status, income, participation in DSME, insurance status, and not seeing a provider due to cost. Education was coded as high school diploma or less, some college or technical school and college graduate or above. Marital status was coded as married, divorced or separated, and other. Values for income were <$25,000, $25,000–$50,000, and $>50,000. Values for participation in DSME were derived from the question “Have you ever taken a course or class in how to manage your diabetes yourself?” Health insurance status was derived from the question “Do you have any kind of health care coverage, including health insurance, prepaid plans such as HMOs, or government plans such as Medicare?” and was coded dichotomously as (yes/no). Not seeing a provider due to cost was taken from the question “Was there a time in the past 12 months when you needed to see a doctor but could not because of cost?” and was also coded dichotomously.

Factors of individual need recorded by the BRFSS include insulin dependence, overweight or obesity status, smoking status, and self-reported health status. The overweight/obese variable was derived from the respondent’s Body Mass Index (BMI) and defined as greater than 25, or above the 85th percentile. Values for self-reported health were coded dichotomously: Excellent/Very Good/Good Health versus Fair/Poor Health.

Because rural counties are not homogenous, environmental characteristics obtained from the ARF were also included as covariates. Health Professional Shortage Area (HPSA) designation serves as an important measure of primary care physician availability in a given county. Counties can be designated as a whole or partial HPSAs based on primary care physician to population ratio and primary care service need. Counties or partial counties with a physician to population ratio of at least 3,500 to 1 are considered HPSAs. In addition, those with a physician to population ratios greater than 3,000 to 1, but with high needs for primary care services or insufficient capacity of existing primary care providers are considered a HPSA [24]. Values for HPSA designation were considered a 3 level categorical variable; not a HPSA, partial county HPSA and whole county HPSA.

Statistical Methods

Bivariate analysis was conducted to compare outcomes among categorical variables using Chi-squared tests for independence. In addition, unadjusted odds ratios were obtained for rural and urban differences in recommended services and selected outcomes. Multivariate logistic regression was performed with each of the recommended services and selected outcomes serving dependent variable. Rural residence was the primary independent variable of interest while the described individual and environmental characteristics were included as covariates in each model.

To account for the multistage, complex sampling design of the BRFSS, all analysis was conducted using SAS-callable SUDAAN (RTI International, Research Triangle Park, NC).

Results

Characteristics of Population

The demographic characteristics of adults with diabetes reached by the 2006 BRFSS are shown in Table 1, stratified by residence. A higher proportion of rural than urban persons reported diabetes among all racial/ethnic classifications (9.0 vs. 7.7%; P ≤ 0.001). Rural non-Hispanic Blacks had the highest proportion of diabetes among all racial/ethnic categories (13.4%). Characteristics of persons with diabetes are shown in Table 2. The population of persons with diabetes in rural areas has a slightly higher proportion of women (50.6 vs. 47.6%; P = 0.01).

Rural residents with diabetes were disadvantaged compared to urban residents in several important enabling areas, including lower levels of educational attainment and a greater likelihood of being in the lowest income category (Table 2). Thus, 58% of rural residents, versus
49% of urban, had only a high school education. Also, rural persons with diabetes were more likely to lack health insurance and to report not seeing a physician due to cost, and less likely to report participation in DSME than urban persons. From a family support perspective, rural residents were more likely to be married than their urban peers.

While rural and urban residents did not differ regarding insulin dependence, a higher proportion of rural persons with diabetes were overweight/obese (85.5%) compared to urban persons.
their urban counterparts (83.4%; \( P = 0.02 \)). Fewer rural persons with diabetes reported good to excellent health compared to urban persons (49.5 vs. 53.5%; \( P \leq 0.001 \)). Among environmental factors influencing diabetes care, persons living with diabetes residing in rural areas were more likely to be in a whole county HPSA than urban persons (9.4 vs. 1.2%; \( P \leq 0.001 \)).

Diabetes Services

Receipt of selected health services and outcomes are shown in Table 3, stratified by residence. No significant differences were observed between rural and urban persons with diabetes regarding a physician visit in the past 12 months (88.8 vs. 89.5%; \( P = 0.513 \)) or reporting at least two HbA1c tests in the past year (66.6 vs. 67.3%; \( P = 0.588 \)). The proportion of rural residents reporting an annual dilated eye examination (69.1%), however, was significantly lower than among urban persons with diabetes (72.4%; \( P = 0.006 \)). Rural persons with diabetes were also less likely to report having an annual foot examination by a health professional in the past year than their urban counterparts (70.6 vs. 73.7%; \( P = 0.016 \)).

Adjusted Analysis of Receipt of Diabetes Services

Physician Visit

As shown in Table 4, after adjusting for enabling factors, predisposing characteristics and individual measures of need, there were no significant differences in the odds of reporting a physician visit based on rural residence (OR = 0.90, 95% CI = 0.75–1.09). Individuals residing in a partial county HPSA, however, were less likely to have a physician visit than those not residing in a HPSA (OR = 0.76, 95% CI = 0.62–0.93). Those participating in DSME were more likely to have a physician visit in the past year (OR = 1.65, 95% CI = 1.35–2.03). Individuals disadvantaged by lack of health insurance or previously deferring care due to cost were less likely to report a physician visit. Income, however, showed a curvilinear distribution, with persons in the middle-income category (between $25,000 and $50,000) but not those in the lowest category being less likely to report a visit (OR = 0.77, 95% CI = 0.60–0.99).

With enabling factors held equal in analysis, non-Hispanic Blacks (OR = 1.46, 95% CI = 1.04–2.06) and non-Hispanic Others (OR = 1.82, 95% CI = 1.12–2.94) were more likely than whites to report a physician visit in the past year. Need was markedly associated with reported physician visit, with persons reporting insulin dependence (OR = 3.66, 95% CI = 2.76–4.87) and those who were overweight/obese (OR = 1.39, 95% CI = 1.02–1.89) being more likely to report a physician visit than their counterparts.

HbA1c Testing

Rural residence was not significantly associated with the likelihood of reporting HbA1c testing in adjusted analysis (OR = 1.06, 95% CI = 0.93–1.20), nor was HPSA status of the county. Persons with diabetes participating in DSME were more likely to have at least two HbA1c tests in the past year (OR = 1.72, 95% CI = 1.48–1.99). Paralleling results for physician visits, the odds of receiving at least two HbA1c tests in the past year was reduced among persons lacking health insurance (OR = 0.60, 95% CI = 0.45–0.79), not seeing a provider in the previous year due to cost (OR = 0.55, 95% CI = 0.44–0.69), and having an income between $25,000 and $50,000 (OR = 0.77, 95% CI = 0.60–0.99). Among individual measures of need, being insulin dependent (OR = 1.78, 95% CI = 1.49–2.12) was

Table 3 Diabetes care and selected outcomes among adults living with diabetes by residence, 2006 BRFSS

<table>
<thead>
<tr>
<th>Service receipt</th>
<th>% Urban (referent)</th>
<th>% Rural</th>
<th>Odds that a rural resident will receive services (OR (LBL–UBL))</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Provider visit in past 12 months</td>
<td>89.5</td>
<td>88.9</td>
<td>0.95 (0.80–1.14)</td>
<td>0.513</td>
</tr>
<tr>
<td>At least 2 HbA1c test in past year</td>
<td>67.3</td>
<td>66.6</td>
<td>0.97 (0.87–1.09)</td>
<td>0.588</td>
</tr>
<tr>
<td>At least 1 foot exam in past year</td>
<td>73.7</td>
<td>70.9</td>
<td>0.89 (0.79–1.00)</td>
<td>0.016</td>
</tr>
<tr>
<td>Dilated eye exam in past year</td>
<td>72.4</td>
<td>69.1</td>
<td>0.86 (0.77–0.97)</td>
<td>0.006</td>
</tr>
<tr>
<td>Outcomes</td>
<td></td>
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</tr>
<tr>
<td>Reported retinopathy</td>
<td>22.0</td>
<td>25.8</td>
<td>1.21 (1.04–1.40)</td>
<td>0.007</td>
</tr>
<tr>
<td>Foot sore (&gt;4 weeks to heal)</td>
<td>11.2</td>
<td>13.2</td>
<td>1.21 (1.02–1.43)</td>
<td>0.036</td>
</tr>
</tbody>
</table>

All results are reported in weighted percentages, \( P \) value indicates rural/urban difference

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Table 4 Odds that a person with diabetes will report receipt of selected services and selected outcomes, 2006 BRFSS

<table>
<thead>
<tr>
<th>Service receipt</th>
<th>Provider visit OR (LBL–UBL)</th>
<th>At least 2 Hba1c Test OR (LBL–UBL)</th>
<th>Diabetic retinopathy OR (LBL–UBL)</th>
<th>Foot sore OR (LBL–UBL)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<tr>
<td><strong>Predisposing</strong></td>
<td></td>
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<tr>
<td>Residence (ref: urban)</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Rural</td>
<td>0.90 (0.75–1.09)</td>
<td>1.06 (0.93–1.20)</td>
<td>0.95 (0.83–1.09)</td>
<td>0.96 (0.84–1.09)</td>
</tr>
<tr>
<td>Race/ethnicity (ref: white)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Black</td>
<td>1.46 (1.04–2.06)</td>
<td>0.86 (0.69–1.08)</td>
<td>1.73 (1.38–2.16)</td>
<td>1.16 (0.94–1.44)</td>
</tr>
<tr>
<td>Other</td>
<td>1.82 (1.12–2.94)</td>
<td>0.90 (0.66–1.23)</td>
<td>1.04 (0.77–1.39)</td>
<td>1.27 (0.95–1.70)</td>
</tr>
<tr>
<td>Hispanic</td>
<td>1.08 (0.71–1.65)</td>
<td>0.85 (0.64–1.14)</td>
<td>1.38 (1.02–1.87)</td>
<td>1.00 (0.73–1.37)</td>
</tr>
<tr>
<td>Gender (ref: female)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>0.85 (0.69–1.05)</td>
<td>0.85 (0.74–0.99)</td>
<td>1.16 (1.00–1.34)</td>
<td>0.89 (0.77–1.04)</td>
</tr>
<tr>
<td>Age (ref: 35–54)</td>
<td></td>
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</tr>
<tr>
<td>18–34</td>
<td>0.75 (0.44–1.28)</td>
<td>0.61 (0.43–0.86)</td>
<td>0.84 (0.58–1.22)</td>
<td>0.77 (0.54–1.11)</td>
</tr>
<tr>
<td>55–64</td>
<td>1.23 (0.95–1.60)</td>
<td>1.16 (0.95–1.42)</td>
<td>1.24 (1.03–1.50)</td>
<td>1.39 (1.15–1.70)</td>
</tr>
<tr>
<td>65+</td>
<td>0.90 (0.66–1.21)</td>
<td>0.96 (0.78–1.17)</td>
<td>1.41 (1.15–1.72)</td>
<td>2.32 (1.89–2.84)</td>
</tr>
<tr>
<td><strong>Enabling</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Education (ref: college grad)</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>&lt;High school</td>
<td>1.25 (0.97–1.60)</td>
<td>0.82 (0.67–0.99)</td>
<td>0.90 (0.74–1.08)</td>
<td>0.80 (0.65–0.98)</td>
</tr>
<tr>
<td>High school some college</td>
<td>1.03 (0.79–1.33)</td>
<td>0.88 (0.73–1.07)</td>
<td>0.94 (0.77–1.15)</td>
<td>0.81 (0.66–1.01)</td>
</tr>
<tr>
<td>Income (ref: $50,000)</td>
<td>0.88 (0.65–1.20)</td>
<td>0.86 (0.68–1.08)</td>
<td>1.08 (0.86–1.37)</td>
<td>0.79 (0.61–1.02)</td>
</tr>
<tr>
<td>$25,000–$50,000</td>
<td>0.77 (0.60–0.99)</td>
<td>0.75 (0.61–0.92)</td>
<td>0.91 (0.74–1.11)</td>
<td>0.84 (0.68–1.04)</td>
</tr>
<tr>
<td>Participation in DSME (ref: none)</td>
<td>1.65 (1.35–2.03)</td>
<td>1.72 (1.48–1.99)</td>
<td>2.10 (1.83–2.42)</td>
<td>1.93 (1.66–2.25)</td>
</tr>
<tr>
<td>No health insurance (ref: insured)</td>
<td>0.46 (0.33–0.63)</td>
<td>0.60 (0.45–0.79)</td>
<td>0.72 (0.56–0.94)</td>
<td>0.70 (0.53–0.93)</td>
</tr>
<tr>
<td>Not seeing provider due to cost in past year (ref: saw provider)</td>
<td>0.65 (0.50–0.85)</td>
<td>0.55 (0.44–0.69)</td>
<td>0.61 (0.49–0.75)</td>
<td>0.57 (0.46–0.71)</td>
</tr>
<tr>
<td><strong>Individual need</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Insulin dependent (ref: not insulin dependent)</td>
<td>3.66 (2.76–4.87)</td>
<td>1.78 (1.49–2.12)</td>
<td>2.19 (1.82–2.63)</td>
<td>1.60 (1.34–1.90)</td>
</tr>
<tr>
<td>Overweight or obese (ref: normal weight)</td>
<td>1.39 (1.02–1.98)</td>
<td>1.12 (0.92–1.36)</td>
<td>1.14 (0.94–1.37)</td>
<td>1.15 (0.95–1.40)</td>
</tr>
<tr>
<td>Current smoker (ref: non–smoker)</td>
<td>1.02 (0.79–1.31)</td>
<td>0.91 (0.75–1.11)</td>
<td>1.01 (0.83–1.22)</td>
<td>0.77 (0.63–0.94)</td>
</tr>
<tr>
<td>Self reported health status (ref: good to excellent)</td>
<td>Fair to poor</td>
<td>1.12 (0.90–1.38)</td>
<td>1.09 (0.94–1.28)</td>
<td>1.16 (1.00–1.35)</td>
</tr>
<tr>
<td>Environment</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HPSA (ref: no HPSA)</td>
<td>0.76 (0.62–0.93)</td>
<td>1.05 (0.90–1.24)</td>
<td>1.00 (0.86–1.17)</td>
<td>1.01 (0.86–1.19)</td>
</tr>
<tr>
<td>Partial county</td>
<td>0.87 (0.56–1.35)</td>
<td>0.81 (0.60–1.11)</td>
<td>0.99 (0.71–1.38)</td>
<td>0.81 (0.57–1.13)</td>
</tr>
</tbody>
</table>

Included in the analyses but not shown because not significant for any outcome: marital status
associated with having at least two HbA\textsubscript{1c} tests in the past year.

**Annual Dilated Eye Exam**

In adjusted analysis, rural and urban residents did not differ in the probability of reporting an annual dilated eye exam in the past year (OR = 0.96, 95% CI = 0.84–1.09). Residing in a partial (OR = 1.01, 95% CI = 0.86–1.19) or whole (OR = 0.81, 95% CI = 0.57–1.13) county HPSA was also not significantly associated with having an annual dilated eye exam (OR = 0.94, 95% CI = 0.80–1.11). Individuals who participated in DSME were more likely to report an annual dilated eye exam than their counterparts (OR = 1.93, 95% CI = 1.66–2.25). Enabling factors reducing the likelihood of having an annual dilated eye exam included less than a high school education (OR = 0.80, 95% CI = 0.65–0.98), lack of health insurance (OR = 0.70, 95% CI = 0.53–0.93) and not seeing a doctor in the past 12 months due to cost (OR = 0.57, 95% CI = 0.46–0.71).

Among predisposing characteristics, adults between the ages of 55–64 (OR = 1.39, 95% CI = 1.15–1.70) and those 65 or over (OR = 2.32, 95% CI = 1.89–2.84) were more likely to report having an annual dilated eye exam than those in the 35–54 age group. Need was also associated with having an annual dilated eye exam, those reporting insulin dependence (OR = 1.60, 95% CI = 1.34–1.90) were more likely to have an annual dilated eye exam. Being a smoker reduced the likelihood of having an annual dilated eye exam. (OR = 0.77, 95% CI = 0.63–0.94).

**Annual Foot Exam by Health Professional**

Adjusted analysis yielded no significant differences between rural and urban persons living with diabetes in the odds of reporting an annual foot exam (OR = 0.95, 95% CI = 0.83–1.09). Likewise, residing in a whole (OR = 1.00, 95% CI = 0.86–1.17) or partial (OR = 0.99, 95% CI = 0.71–1.38) county HPSA was not associated with having an annual foot exam. However, participation in DSME was associated with an increased likelihood of receiving an annual foot exam (OR = 2.10, 95% CI = 1.83–2.42). Other enabling factors reducing the likelihood of having a foot exam include having no health insurance (OR = 0.72, 95% CI = 0.56–0.94) and not seeing a provider due to cost (OR = 0.61, 95% CI = 0.49–0.75).

Among predisposing characteristics associated with diabetes care, non-Hispanic Blacks (OR = 1.73, 95% CI = 1.38–2.16) and those of Hispanic ethnicity (OR = 1.38, 95% CI = 1.02–1.87) were more likely to report a foot exam than non-Hispanic Whites. In addition, individuals between the age of 55 to 64 (OR = 1.24, 95% CI = 1.03–1.50) and those 65 and over (CI = 1.41, 95% CI = 1.15–1.72) were more likely to report having a foot exam in the past year. Need was also associated with having a foot exam with those insulin dependent (OR = 2.19, 95% CI = 1.82–2.63) being more likely to have a foot exam than their counterparts.

**Diabetes Outcomes, Prevalence and Adjusted Analysis**

**Diabetic Retinopathy**

As shown in Table 3, rural persons living with diabetes were more likely to indicate having retinopathy (25.8%) than were 22.0% of urban residents (OR 1.21; P = 0.007). This relationship was retained in adjusted analysis, as rural residents with diabetes were more likely to indicate having retinopathy than were their urban peers (OR = 1.20, 95% CI = 1.02–1.42). Neither residing in a whole or partial county HPSA, nor participating in DSME was associated with having diabetic retinopathy. While uninsured persons and those deferring care were at lower odds for receipt of services in the past year, these financial access characteristics did not affect the odds for retinopathy, although low-income persons did have increased risk (Income under $25,000 versus over $50,000, OR = 1.252, 95% CI = 1.11–2.07).

Minorities, specifically non-Hispanic Blacks (OR = 1.80, 95% CI = 1.36–2.38) and Hispanic adults (OR = 1.89, 95% CI = 1.32–2.71) had higher odds for retinopathy compared to non-Hispanic Whites (Table 4). Males and older adults were also more likely to report retinopathy. Need factors associated with an increased likelihood of having retinopathy include being insulin dependent (OR = 3.40, 95% CI = 2.89–4.10) and having self reported health of fair to poor (OR = 1.88, 95% CI = 1.55–2.28).

**Foot Sore with More than Four Weeks to Heal**

The proportion of rural persons indicating having a foot sore taking more than four weeks to heal was significantly greater than of urban persons (13.2 vs. 11.2%, OR 1.21, P = 0.036). In adjusted analysis, however, the relationship between residence and foot sores was attenuated (OR = 1.06, 95% CI = 0.87–1.28). Neither residing in a partial or whole county HPSA, nor participating in DSME was associated with having a foot sore taking more than four weeks to heal. Among enabling factors, reporting an income less than $25,000 was associated with an increased likelihood of having a foot sore taking more than four weeks to heal (OR = 2.07, 95% CI = 1.43–3.01).

Among predisposing characteristics, non-Hispanic Blacks (OR = 0.60, 95% CI = 0.45–0.82), those with less
than a high school education (OR = 0.66, 95% CI = 0.51–
0.84), between the ages of 55–64 (OR = 0.73, 95% 
CI = 0.55–0.97) and those 65 or older (OR = 0.54, 95% 
CI = 0.40–0.73) were less likely to have a foot sore taking
more than four weeks to heal. Need factors associated with 
an increased probability of having a foot sores include 
insulin dependence (OR = 2.00, 95% CI = 1.62–2.48) and a 
self reported health status of fair to poor (OR = 2.21,
95% CI = 1.71–2.86).

Discussion

Our analysis confirmed that rural residents with diabetes 
differ from their urban counterparts. The prevalence of self-reported diabetes in adults is 17% higher in rural 
counties than in metropolitan areas (9.0 vs. 7.7%), across 
all race/ethnicity groups except Hispanics. The presence of 
rural disparities in diabetes prevalence echoes prior work 
using the 1988–1994 National Health and Nutrition 
Examination Survey [25]. Because rural residents suffer a 
higher burden from diabetes, they constitute an important 
public health target group.

Rural adults with diabetes differed from their urban 
counterparts in ways that affect planning for rural inter-
ventions. Rural adults were less well educated, more likely 
to report low incomes, more likely to lack health insurance, and correspondingly, more likely to report deferring care 
due to cost than urban adults. In addition, other research has 
shown that rural residents travel further for care [26]. 
Despite these disadvantages, rural persons with diabetes 
were no less likely to report receiving two HgA1c tests in the 
past year than urban residents, although only about two 
thirds of persons in either geographic area met this guideline. 
However, a smaller proportion of rural than urban adults 
with diabetes reported receipt of a foot exam or a dilated eye 
examination. Thus, it is not surprising that slightly more 
rural than urban respondents noted foot sores of more than 
one month’s duration and a diagnosis of retinopathy.

The proportion of rural persons reporting a dilated eye 
exam in the present study (68.1%), is slightly higher than 
previous population estimates produced using 2002 and 
2003 BRFSS data [6, 8], while similar to that in research 
among Medicare beneficiaries for the 1999–2001 period 
[27]. Nonetheless, performance on this measure remains 
below the Health People 2010 goal of 75% [28]. On all 
service receipt variables, lack of health insurance and 
reported deferring of care due to cost were strongly asso-
ciated with reduced odds for service receipt in adjusted 
analysis, while rural residence alone ceased to have an 
association with services. This suggests that programs 
focusing on reducing cost barriers may improve service 
quality on this measure.

Retinopathy is a common result of diabetes, but receipt 
of recommended care can lower the risk of vision loss [29] 
and slow the resulting decline in health related quality of 
life [30]. The reduced rate at which rural residents receive 
dilated eye examinations compared to urban adults appears 
attributable to lower education and income levels in the 
rural population, both of which reduced the likelihood of 
receiving an examination. However, the higher prevalence 
of diabetic retinopathy among rural adults was virtually 
unchanged in adjusted analysis (OR 1.21; AOR 1.20). With 
the exception of income, access variables (insurance, 
defered care) were not significantly associated with dia-
betic retinopathy, while risk factors were markedly linked, 
including insulin dependence, perceived fair/poor health, 
and age of 55 or higher. It is possible that rural practitio-
ners, who typically see more patients and provide fewer 
preventive screening services than urban physicians [31] 
are not sufficiently aggressive in educating and monitoring 
patients with diabetes. A recent study found that counties 
with rural health clinics, which are required to incorporate 
a midlevel practitioner in addition to one or more physi-
cians, have better population based rates for eye screening 
than other rural counties [32]. Increasing use of non-phy-
sician workforce, therefore, may be one approach for 
improving eye outcomes among rural patients.

The proportion of rural persons receiving a foot exam by a 
health professional in the past year was 70.9%, slightly less 
than among urban persons with diabetes (73.7%) and short 
of the Healthy People 2010 goal of 75% [28]. Since our 
study found no differences in the proportion of persons 
reporting a physician visit within the past year, and a foot 
examination does not require special equipment or access to 
specialty care, the shortfall is difficult to explain. With no 
differences in reported physician visits, it should be expec-
ted foot care and outcomes would not differ by residence. 
However, this is not the case.

Efforts to implement quality improvement initiatives to 
improve diabetes care among rural and underserved pop-
lulations are critical for increasing the number of persons 
receiving preventive services and improving outcomes. 
 Certain quality initiatives among rural and underserved 
populations have show improvements in diabetes care and 
warrant consideration. A group of 19 Midwestern com-
munity health centers implemented Plan-Do-Study-Act 
cycles to improve diabetes care provided to patients. Sig-
nificant improvements in HbA1c testing, referrals for eye 
examinations and foot examinations were noted after one 
year [33]. Other examples of collaborative efforts between 
multiple partners to improve diabetes care have also been 
noted. The Montana diabetes prevention and control pro-
grams worked with the University of North Dakota to 
support 37 rural primary care practices to improve diabetes 
care. This collaborative effort also demonstrated
improvements in HbA_1c testing, eye and foot examinations among patients [2].

Participation in DSME was positively associated with quality of care measures, including a reported physician visit in the past year, two or more HbA_1c tests in the past year, an annual dilated eye exam and an annual foot exam by a health professional. This finding is consistent with previous studies examining participation in DSME among the general population [7, 17]. However, rural residents were less likely to have participated in DSME, with 52.0% of rural persons living with diabetes participated in DSME compared to 55.9% of urban persons (P = 0.003), a finding that parallels previous research [13, 18, 20]. Given the strong positive relationship between participation in DSME and diabetes care, efforts should continue to ensure rural populations have adequate access and utilize DSME services. Various strategies to increase access to DSME among rural populations have shown promise. One state established a mentoring program to increase the number of Certified Diabetes Educators (CDE) in rural and frontier areas and increase the number of certified education programs available in rural areas [19]. Others have implemented elements of a chronic care model by placing a CDE in a physician practice to support providers in diabetes management and provide patient education [34]. More recently, the expansion of telemedicine has created the opportunity to deliver DSME in rural areas. A Pilot project using telemedicine to deliver DSME demonstrated improved knowledge, self-efficacy and more frequent self care among participants [35]. The present study has several limitations. First, a cross-sectional study can only present associations among variables, not causal relationships. Next, all information is self-reported. Third, a broad definition of rural was used, potentially masking notable differences in diabetes care that may be present in very small or remote rural counties. Fourth, the study only considers the receipt of specific health services and does not account for the content or quality of care being provided, nor how well diabetes is being controlled through follow up activities. Next, participation in DSME demonstrated a strong positive relationship with diabetes care. However, individuals voluntarily participating in DSME might also be more inclined to take an active role in disease management, introducing selection bias. Finally, the BRFSS is a telephone survey of non-institutionalized adults; therefore, individuals such as those in nursing homes, or without a telephone could be excluded [17].

Rural residents as a whole are more likely to report having diagnosis, less likely to receive recommended services, and more likely to suffer from diabetic retinopathy. The characteristics of rural populations such as lower reported levels of income, educational attainment and health insurance, rather than location alone, place them at increased risk. The combination of these factors underscores the importance of ensuring quality diabetes care extends to vulnerable populations, including those residing in rural areas. Promising practices in improving diabetes care have been noted; however, sustainability of quality initiatives can be elusive in the absence of organizational and technical support [14]. As national discussions regarding health care reform and quality of care continues, efforts to improve diabetes care among rural and underserved populations warrant consideration and should be supported.

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References
