PREVALENCE OF DIABETES AND PRE-DIABETES IN KANSAS

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Objective: The study objective was to determine the prevalence of diabetes and pre-diabetes among rural and urban populations in Kansas.

Research Design and Methods: This study utilized 2009 BRFSS data and included 18,912 respondents. Participants were identified through a stratified random sample of adult Kansans, living in a non- institutionalized setting, and with access to a land-based telephone line. Analyses were conducted using SAS to provide descriptive statistics for groups based on diabetes status. A logistic regression was conducted to explore significant variables associated with the likelihood of diabetes.

Results: Diabetes prevalence was lower among urban (11.8%) populations than rural (12.7%) areas of Kansas, but the inverse was true for pre-diabetes (3.7% urban, 3.1% in rural). Lower income and lower levels of educational attainment were associated with increased rates of diabetes and pre-diabetes, with the highest prevalence levels overall found among rural Latinos (19.3%) and urban African Americans (22.9%). Multivariate regression suggests that age, income, ethnicity, education, sex, rural vs urban status, and race all served as significant predicators of diabetes, net of other factors.

Conclusions: Rural residents were more likely than urban residents to report having diabetes, whereas urban residents were more likely than rural residents to report having pre-diabetes. Although rural vs urban status played a significant role in the model's predicative ability for diabetes and pre-diabetes diagnosis, increased age was by far the most significant factor in diabetes and pre-diabetes diagnosis. (*Ethn Dis.* 2013;23[4]:415–420)

Key Words: Diabetes, Pre-diabetes, Rural, Urban

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INTRODUCTION

The prevalence of diabetes mellitus (type 2 diabetes [T2D]), a largely preventable condition, has more than tripled since 1985. In the United States, 26 million adults are estimated to have diagnosed or undiagnosed T2D.[1] A diagnosis of T2D imparts an increased risk of stroke, coronary heart disease, renal failure, and cardiovascular disease (CVD).[2–4] In fact, those with T2D are 2 to 4 times more likely than those without it to have CVD, the leading cause of death in the United States.[1,5] The mortality rate for T2D is 22.5 deaths per 100,000 population.[6]

Approximately 79 million American adults (aged ≥20 years) have pre-diabetes, defined as having elevated fasting glucose or glycosylated hemoglobin (HbA1c) levels.[1] Those with pre-diabetes have an elevated risk for developing T2D and CVD, and among those with pre-diabetes who never develop frank diabetes, just having pre-diabetes alone has been linked to an increased risk of insulin resistance, CVD, stroke, and mortality.[7,8]

There appears to be a significant disparity in the prevalence of T2D between urban and rural communities with residents of rural communities disproportionately affected. However, most urban-rural diabetes disparity studies have been conducted outside of the United States.[9–14] It is unclear if this disparity exists in the United States, and if there is a similar urban-rural disparity for pre-diabetes. The purpose of our study was to determine the prevalence of T2D and pre-diabetes in Kansas, stratified by urban and rural residence. Moreover, as there are substantial disparities in the prevalence of T2D by ethnicity, race, income, and education in the United States, we sought to explore the association of these variables with diabetes and pre-diabetes in urban and rural communities.

The purpose of our study was to determine the prevalence of T2D and pre-diabetes in Kansas, stratified by urban and rural residence.

METHODS

For this study, we used the 2009 Kansas Behavioral Risk Factor Surveillance System (BRFSS) survey. The BRFSS inclusion criteria included individuals who: a) were ≥18 years, b) resided in Kansas, c) did not reside in an institution, and d) owned a landline telephone.

Instrument

The BRFSS is the largest continuing telephone health survey system, managed by the Centers for Disease Control and Prevention (CDC) and administered by state health departments.[15] Participants are interviewed and prompted to answer questions regarding health risk behaviors, preventive health behaviors, and demographics. Data are collected monthly in all 50 states, the District of Columbia, Puerto Rico, the US Virgin Islands, and Guam. The BRFSS is composed of three modules: the core module, optional modules, and state-added modules. For this study, we utilized the Kansas 2009 BRFSS database, including the CDC core module of demographics, the optional modules regarding pre-diabetes and diabetes, and a stated-added module on diabetes. While there is a distinction between type 1 and type 2 diabetes, this distinction is not present in the BRFSS instrument, with the general term diabetes used, making it impossible to distinguish between type 1 and type 2 diabetes with the data available. Therefore, we will use the term 'diabetes' to encompass both types.

Variables and Definitions

We delineated rural and urban using the definition from the US Census Bureau.[16] Based on these definitions, urban areas were defined as those that included ≥50,000 residents. All 105 Kansas counties were classified accordingly into a dichotomous variable- rural or urban.

Similarly, low socioeconomic status (SES) counties were defined as low education and low income.[17] Low education was defined as below the national average for percent graduating from high school,[18] and low income was defined as above the national average for percent living below the poverty line.[19,20] Regarding the BRFSS data, participants' income levels were collapsed into three categories: <$25,000, ≥$25,000 and <$50,000, and ≥$50,000.

Participants were classified into three diabetes-health categories: no diabetes, diabetes, or pre-diabetes based on two questions, "Have you ever been told by a doctor that you have diabetes?" and "Have you ever been told by a doctor or other health professional that you have pre-diabetes or borderline diabetes." There were six possible responses to the former question: 1) yes, 2) yes, during pregnancy, 3) no, 4) no, pre-diabetes or borderline diabetes, 5) don't know/not sure, and 6) refused. There were four possible responses to the latter question: 1) yes, 2) yes, during pregnancy, (3) no, and (4) do not know/not sure. A cross-reference of responses to both questions was utilized to classify each participant into one of three exclusive categories: diabetes, pre-diabetes, or no diabetes. Those respondents who reported being unsure, did not know, or had missing responses to the diabetes and pre-diabetes questions were excluded from the analysis.

Statistical Analysis

All analyses were conducted using SAS software for Windows version 9.3 (Cary, North Carolina). Descriptive statistics were presented as means and standard deviations for continuous variables (eg, age), and frequencies and proportions were presented for categorical variables (eg, sex). Chi-square analysis was conducted to explore differences in demographic variables between rural and urban counties. Logistic regression analysis was conducted to explore significant variables associated with the likelihood of self-reported diabetes status. Survey weight and stratum were taken into consideration to adjust for sampling bias. All tests were two-sided with $P<.05$ considered statistically significant.

RESULTS

A total of 18,912 respondents were included in the 2009 BRFSS Kansas database, representing 2,095,851 individuals in Kansas. Fifty-one percent (51.0%, n=11,665) were female, 86.1% (n=16,667) were non-Latino, and 89.3% (n=17,129) were Caucasian (Table 1). More than one-third (34.8%, n=6,560) reportedly graduated from college or technical school.

Bivariate analyses were conducted on variables of interest between rural and urban residents (Table 2). A smaller proportion of respondents reported having diabetes in urban (11.8%) rather than rural (12.7%) areas. The inverse is true for pre-diabetes (3.7% in urban and 3.1% in rural). Income and education had negative linear relationships with diabetes (as education increased, prevalence of diabetes decreased). Income also had a negative linear relationship with pre-diabetes. Prevalence of diabetes was greater among Latinos (19.3% in rural communities) and African Americans/ Blacks (22.9% in urban communities).

A multiple logistic regression model was conducted to identify significant predictors for diabetes health status (no diabetes, diabetes, or pre-diabetes). The predictors were: income (<$25,000, ≥$25,000 and <$50,000, ≥$50,000), education (did not graduate from high school, graduated from high school, attended college or technical school, graduated from college or technical school), race (African American/Black, Caucasian/White, other, as the sample size of additional racial groups was relatively small), ethnicity (Latino, non-Latino), population density (rural, urban), and age (18 to 24 years, 25 to 34 years, 35 to 44 years, 45 to 54 years, 55 to 64 years, and ≥65 years).

Table 3 presents the odds ratios with their 95% confidence intervals for having diabetes and pre-diabetes. There was a negative linear trend for income and a positive linear trend for age with diabetes and pre-diabetes. However, for sex, population density, education, ethnicity, and race, there were less exact relationships with diabetes and pre-diabetes. The variables with the greatest influence in predicting diabetes were, in order: age, income, ethnicity, education, sex, population density, and then race (Table 3). The variables with the greatest influence in determining pre-diabetes were age, in order: education, income, race, sex, population density, and ethnicity.

DISCUSSION

Our study suggests there is a disparity in diabetes between urban and rural communities; the prevalence of diabetes was higher among rural than urban residents (12.7% vs. 11.8% for the raw percentage, 9.5% vs. 8.1% for the weighted percentage, respectively). The finding of higher prevalence of

Table 1. Respondents self-reported demographics

	Frequency	%[d]	Weighted %[e]
Sex			
Male	7,247	38.3	49.0
Female	11,665	61.7	51.0
Education[a]			
Did not graduate high school	1,181	6.3	6.5
Graduated high school	5,626	29.8	28.8
Attended college or technical school	5,518	29.2	29.8
Graduated from college or technical school	6,560	34.7	34.8
Ethnicity[b]			
Non-Hispanic	16,667	88.5	86.1
Hispanic	2,170	11.5	13.9
Race[c]			
Caucasian/White	17,129	91.1	89.3
African-American/Black	776	4.1	4.0
Other race	899	4.8	6.7
Population density			
Rural	7,136	37.7	37.4
Urban	11,776	62.3	62.7

[a] 27 respondents did not answer the education question.
[b] 75 respondents did not answer the ethnicity question.
[c] 108 respondents did not answer the race question.
[d] Percentage is calculated based on the numbers presented in Table 1.
[e] Weighted percentage represents the percentage of observations taking into consideration of the survey weight and stratum provided by BRFSS to correct for the sampling bias.

diabetes in rural areas is consistent with other studies, although most have been conducted outside of the United States.[9–14] Age is clearly a strong factor influencing prevalence. The rural/urban prevalence differences might reflect that rural Kansas is home to a larger proportion of citizens ≥65 than in urban Kansas. Additionally, as diabetes is strongly associated with SES, it is possible these differences in prevalence between rural and urban communities reflects differences in SES between rural and urban communities.[24]

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Low-SES groups have a disproportionately higher risk of diabetes due to a litany of issues tied to low SES (eg, health illiteracy, poor access to quality health care, poor nutrition, and physical in activity), more so than race or ethnicity.[21–24] These issues often reflect underlying health disparities between different racial and ethnic groups, such that SES becomes a more prominent predictor of diabetes prevalence than race or ethnicity alone.[21–24] Our study is consistent with the literature; there was a relatively strong linear trend in the relationship between income and diabetes, with this trend being much more pronounced with income and diabetes than with diabetes and race or diabetes and ethnicity.

Moreover, our study is consistent with the literature in suggesting that there can be a higher prevalence of diabetes when risk factors are combined.[24] For instance, in the bivariate analysis, Latinos residing in rural areas reported greater prevalence of diabetes than Latinos in urban areas. One study suggests that Latinos living in rural populations experience double the prevalence of diabetes of urban Latinos or urban Whites.[25] In addition to greater prevalence, rural residents, low-SES groups, and Latinos experience greater morbidity related to diabetes than urban residents, high-SES groups, and non-Latinos.[1,26–29] These health disparities, evident in the literature and in our study, suggest the presence of a compounded disadvantage for racial and ethnic minorities, low-SES groups, and rural populations.

Those respondents aged ≥65 years were 16.17 times more likely to report having been diagnosed with diabetes than persons aged 18 to 24 years. Additionally, respondents aged ≥65 years were 2.93 times more likely to report having been diagnosed with pre-diabetes than those aged 18 to 24 years. There was a positive linear trend for diabetes and age, and nearly a positive linear trend for pre-diabetes and age. This age disparity is consistent with the literature.[30,31]

Our study suggests there are ethnic disparities in the risk for diabetes. Nearly one-fifth (19.3%) of Latinos residing in rural areas and 18.5% of Latinos residing in urban areas reported having diabetes, compared to 16.6% of non-Latinos in rural areas and 13.3% of non-Latinos in urban areas (data not shown). This finding is consistent with the literature. Latinos have more risk factors for diabetes than non-Latinos.[26,27,32,33] Nationally, the age-adjusted prevalence of diabetes is 11.8% for Latinos, as compared to 7.1 percent for non-Latino Whites.[34,35] Mexican-Americans are among the most impacted; 13.3% have been diagnosed with diabetes (compared to 7.6% of Cuban Americans and Central and South Americans).[1]

Table 2. Bivariate analysis of rural vs urban on demographic variables[a]

	Rural	Urban	*P*
Sex			<.001
Male	2,663 (37.3)	4,584 (38.9)	
Female	4,473 (62.7)	7,192 (61.1)	
Education			<.001
Did not graduate high school	584 (8.2)	597 (5.1)	
Graduated high school	2,370 (33.3)	3,256 (27.7)	
Attended college or technical school	2,257 (31.7)	3,261 (27.7)	
Graduated from college or technical school	1,911 (26.8)	4,649 (39.5)	
Ethnicity			<.001
Non-Hispanic	6,474 (91)	10,193 (86.9)	
Hispanic	637 (9)	1,533 (13.1)	
Race			<.001
Caucasian/White	6,663 (94)	10,466 (89.4)	
African American/Black	99 (1.4)	677 (5.8)	
Other race	329 (4.6)	570 (4.9)	
Income			<.001
<$25,000	1,834 (29.5)	2,193 (21)	
$25,000 to <$50,000	2,180 (35)	2,957 (28.4)	
≥$50,000	2,209 (35.5)	5,274 (50.6)	
Health status			<.001
Diabetes	896 (12.7)	1,371 (11.8)	
No diabetes	5,931 (84.2)	9,830 (84.5)	
Pre-diabetes	216 (3.1)	431 (3.7)	

[a] Raw, not weighted, frequencies and (percentages) are presented.

The high prevalence of diabetes among Latinos deserves further research. Latinos represent the fastest-growing segment of the US population; it is estimated that by 2050, 25% of Americans will be Latinos.[36] As this population has become more acculturated to a new environment, their dietary lifestyle has changed drastically. Immigration to the US is associated with worse dietary habits and increasing obesity.[37,38] Acculturation is associated with many of the maladaptive behaviors associated with diabetes, including consumption of sugar-sweetened beverages,[39,40] fast food,[41] and skipping breakfast.[42] The longer Latinos live in the United States, the higher their blood sugars become, and the greater their risk for diabetes.[43] Moreover, Latinos face additional challenges including language, poverty, pending immigration status, lack of insurance, and lack of trust in the health care system. These challenges serve as barriers to accessing preventive care and adequate health care treatment.

Our study suggests there is also a substantial racial disparity in the prevalence of diabetes. African Americans/Blacks reported significantly higher prevalence of diabetes (22.6%) than Caucasians/Whites (14.7%) (data not shown). In fact, 22.9% of African Americans/Blacks residing in urban areas reported having diabetes; in the bivariate analysis, this racial group had the highest risk for diabetes than any group in the study (racial or otherwise).

There were two variables that consistently showed a significant relationship with pre-diabetes - income and age. Regarding income, as income increased, the prevalence of pre-diabetes decreased in a linear trend – in urban and rural areas. As age increased, so did the risk of pre-diabetes. The remaining variables (sex, population density, education, ethnicity, and race) had less exact relationships with pre-diabetes. Females, urban residents, and other races appeared to have the highest risk for pre-diabetes. This is likely reflective of many factors, including access to care. We speculate that those populations with a higher prevalence of diabetes and lower prevalence of pre-diabetes progress to diabetes prior to detection of pre-diabetes. This would suggest either limited glucose screening exams and/or direct progression from normoglycemia to frank diabetes.

Limitations

The BRFSS has a cross-sectional study design. As such, we are unable to identify causal relationships in our study, however, we have identified relationships and associations between diabetes, pre-diabetes, and a number of demographic variables that warrant further exploration. Also due to the design of the BRFSS, we must rely on respondents' self-reported responses as opposed to clinical diagnoses. This is particularly problematic with the self-reported pre-diabetes diagnosis question, as it is likely that many respondents are pre-diabetic and have not have been diagnosed as such. This is potentially confounded by the lack of endocrinologists and larger numbers of uninsured/underinsured people in rural communities, decreasing access to adequate care where a pre-diabetes diagnosis could be made. The BRFSS also asks about diabetes in a very general manner, making it impossible to parse out differences between type 1 and type 2 diabetes. However, as a limited number of studies focusing on diabetes and pre-diabetes prevalence specifically in the rural United States have been conducted, the benefits of this population-based study outweigh the limitations.

Additionally, participation in the 2009 BRFSS required owning a landline telephone. This is a potentially important limiting factor, as there are important demographic differences, such as age, family structure, and home ownership

Table 3. Odds ratio (OR) estimates for diabetes and pre-diabetes

	OR for Diabetes	95% CI		Pre-diabetes	95% CI	
Sex						
Male	1.26	1.25	1.27	.87	.85	.89
Female	1			1		
Population density						
Rural	1.04	1.03	1.05	.88	.86	.9
Urban	1			1		
Income						
<$25,000	1.83	1.81	1.86	1.45	1.41	1.49
$25,000 to <$50,000	1.2	1.19	1.22	1.07	1.05	1.1
≥$50,000	1			1		
Education						
Did not graduate high school	1.59	1.55	1.63	.98	.93	1.02
Graduated high school	1.18	1.17	1.2	1.19	1.16	1.22
Attended college or technical school	1.36	1.34	1.38	1.57	1.53	1.61
Graduated from college or technical school	1			1		
Ethnicity						
Latino	1.6	1.55	1.65	.94	.89	1
Non-Latino	1			1		
Race						
African American/Black	1.06	1.02	1.1	.99	.92	1.06
Other race	1.08	1.04	1.12	1.54	1.44	1.64
Caucasian/White	1			1		
Age						
18 to 24 years	1			1		
25 to 34 years	1.35	1.3	1.41	.97	.93	1.02
35 to 44 years	3.09	2.97	3.21	1.61	1.54	1.67
45 to 54 years	6.14	5.92	6.36	1.97	1.89	2.05
55 to 64 years	12.64	12.2	13.1	3.42	3.29	3.55
≥65 years	16.17	15.62	16.75	2.93	2.82	3.05

between those who are cell-phone only and those with a landline telephone.[44] As such, there is the potential that those who are younger or do not own their own home may not be adequately represented by the respondents included in this sample. However, the BRFSS utilizes a stratified sampling approach, which includes oversampling low-income and minority participants to ensure a final sample that represents the United States. Oversampling accounted for any concentration of low income or younger participants that may have been excluded from the study due to lack of a phone.

CONCLUSIONS

Rural residents were more likely than urban residents to report having diabetes, whereas urban residents were more likely than rural residents to report having pre-diabetes. Population density played a significant role in diabetes and pre-diabetes diagnosis. Age is by far the most significant factor in diabetes and pre-diabetes diagnosis, although income and education also appear to be significant factors.

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