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Estimated County-Level Prevalence of Diabetes and Obesity --- United States, 2007

Comprehensive disease surveillance systems are important for developing preventive health policies and tracking their impact in populations at high risk. Although existing chronic disease surveillance systems function well at the national or state level, few provide data at the local level, where many policies and interventions ultimately are implemented. To overcome this limitation, Bayesian multilevel models have been applied to reliably estimate disease prevalence at the local level (*1*). CDC adapted this methodology to estimate diabetes and obesity prevalence in all 3,141 U.S. counties in 2007 (*2*--*4*). This report provides an overview of the methodology used and a descriptive analysis of the resulting estimates. The results indicated distinct geographic patterns in diabetes and obesity prevalence in the United States, including high prevalence rates for diabetes (≥10.6%) and obesity (≥30.9%) in West Virginia, the Appalachian counties of Tennessee and Kentucky, much of the Mississippi Delta, and a southern belt extending across Louisiana, Mississippi, middle Alabama, south Georgia, and the coastal regions of the Carolinas. Isolated counties, including tribal lands in the western United States, also had high prevalence of diabetes and obesity. This report demonstrates how model-based estimates can identify areas with populations at high risk, providing local public health officials with important data to assist them in developing targeted programs to reduce diabetes and obesity.

Existing Surveillance for Chronic Disease

Type 2 diabetes and obesity are major public health priorities because of their high prevalence and incidence nationwide and their long-term health implications for the U.S. population (*5*--*6*). Diabetes and obesity are thought to coexist in specific geographic patterns because of a convergence of prevailing social norms, community and environmental factors, socioeconomic status, and genetic risk factors among ethnically similar groups (*7*). Current surveillance systems (e.g. the National Health Interview Survey and the Behavioral Risk Factor Surveillance System [BRFSS]) have characterized these conditions at the national and state level (*5*,*6*) but cannot provide data at local levels, where many policies and interventions ultimately are designed and implemented. Researchers seek better understanding of the distribution of diabetes and obesity in smaller areas for various reasons. First, each condition might emanate from behavioral, environmental, and socioeconomic conditions that are rooted in cultural and geographic patterns (*7*). A better understanding of the modifiable correlates of these conditions at the local level might enable more efficient prevention policies. Second, evidence-based interventions, particularly for diabetes prevention and control, often depend on efficient referral to local community programs* and

support groups (*8*). Finally, recent natural disasters (e.g., Hurricane Katrina) have highlighted the vulnerability of persons with diabetes and their sometimes urgent need for essential medications.

BRFSS is an ongoing, state-based, random-digit--dialed telephone survey designed to represent the noninstitutionalized population of adults in each of the 50 states, the District of Columbia, and three U.S. territories (*5*,*9*). Although BRFSS now samples from virtually all counties (*5*,*9*) and permits direct estimates from selected metropolitan/micropolitan statistical areas, small sample sizes prevent direct calculation of reliable county-specific estimates from more than 90% of U.S. counties (*9*). However, advances in statistical methodology, including Bayesian multilevel modeling, have enabled use of state-level BRFSS data to produce valid county-level estimates (*2*--*4*). The Bayesian multilevel model treats available BRFSS data as observed data collected from a larger set of complete U.S. Census data (*3*). A probability model is then built for the unobserved data. This model borrows information across years and counties and estimates prevalence for all 3,141 counties, including those for which direct estimates ordinarily are not reliable. The model-based estimates are validated against direct estimates obtained from 298 large counties. To do this, 95% confidence intervals for the differences between the two estimates are calculated for each county; if the interval does not contain zero, the estimates are considered to be in disagreement.

Use of BRFSS Data for Model-Based Estimates

To illustrate the use of model-based estimates, CDC characterized diabetes and obesity prevalence in all 3,141 U.S. counties in 2007. Data from BRFSS for 2006, 2007, and 2008 and from the U.S. Census were used to estimate the number and prevalence of cases of diabetes and obesity among adults aged ≥20 years for all 3,141 counties in the United States. Validation studies revealed disagreement in 6% of diabetes estimates and 4% of obesity estimates for the 298 large counties (*2*--*4*). The total number of BRFSS respondents during 2006--2008 was approximately 1.2 million. The median response rate among all states and territories, based on Council of American Survey and Research Organizations (CASRO) guidelines, was 51% to 53% during 2006--2008 and ranged from 27% to 85% among states. BRFSS determined diabetes status by asking, "Has a doctor ever told you that you have diabetes?" Women with gestational diabetes were excluded. To calculate body mass index (BMI), a measure of overweight and obesity, participants were asked to report their height and weight. Obesity was defined as a BMI ≥30 kg / m^2. Data from the 2000 U.S. Census were used to age-adjust the results by population.

Counties were divided into quintiles, based on age-adjusted estimated prevalence of diabetes and obesity. The top (i.e., highest prevalence) quintiles included those counties with prevalences of ≥10.6% for diabetes and ≥30.9% for obesity; counties in the top two quintiles and bottom two quintiles for both diabetes (≥9.1% versus ≤7.1%) and obesity (≥29.2% versus ≤26.3%) also were identified. A regression model was used to estimate the correlation between diabetes and obesity prevalence estimates. Appropriate statistical software was used for descriptive analyses, data management, and the Bayesian regression model (*10*).

County Diabetes and Obesity Prevalence Estimates

Specific totals, prevalence estimates, and 95% confidence intervals for all 3,141 counties are available online (*4*). Age-adjusted estimates of diabetes prevalence in the U.S. counties

ranged from 3.7% to 15.3%, with a median of 8.4%. Counties in the top quintile (i.e., with diabetes prevalence ≥10.6%) were located primarily in a belt extending from the Mississippi River to the coastal Carolinas and the Appalachians (Figure). Among counties in Alabama, Georgia, Louisiana, Mississippi, and South Carolina, 73% were in the top quintile for diabetes prevalence. Similarly, 62% of counties in West Virginia and Tennessee combined were in the top quintile. Isolated top-quintile counties also were evident in tribal lands in Montana, the Dakotas, the Southwest, and eastern Oklahoma.

Age-adjusted estimates of obesity prevalence ranged from 12.4% to 43.7%, with a median of 28.4%. Counties with the highest obesity prevalence largely were in the South, western Appalachians, and coastal Carolinas (Figure). In Alabama, Kentucky, Louisiana, Mississippi, South Carolina, and West Virginia, 70% of counties had obesity prevalence in the top quintile (≥30.9%)

County-level obesity prevalence was highly correlated with diabetes prevalence (r = 0.72). A county with obesity prevalence five percentage points higher than another county had diabetes prevalence that was, on average, 1.4 percentage points higher (95% confidence interval = 1.3--1.5). Counties in the top two quintiles in both obesity and diabetes prevalence were concentrated in the South and Appalachian region, and counties with low diabetes and obesity prevalence largely were in the West, Northern Plains, and New England (Figure). Among counties in Alabama, Georgia, Louisiana, Mississippi, and South Carolina, 77% were in the top two quintiles for both diabetes and obesity prevalence; among counties in Kentucky, Tennessee, and West Virginia, 81% were in the top two quintiles for both conditions.

Uses of County-Level Prevalence Estimates

The county prevalence estimates in this study generally were consistent with state and metropolitan area estimates from other methods (5,*9*). Both methods highlight geographic patterns of high prevalence of diabetes or obesity in specific areas of the South, Appalachia, Mississippi Delta, and western tribal lands.

Better local estimates of diabetes and obesity prevalence might influence public health efforts in various ways. First, awareness of the size and scope of the problems is important for local policy makers to identify the necessary community and clinical services to prevent and control the conditions. For example, lifestyle programs for diabetes prevention and community support groups for diabetes self-management have been shown effective when they are linked to a referring clinical center (*8*). Second, population-targeted interventions (e.g., changes in health-care access, preventive care, food taxation, or food labeling) might affect specific areas, populations segments, or high-risk populations in ways that are not detectable via broad, population-based surveys. More sensitive local area surveillance can provide a better means of tracking such effects.

The findings in this report are subject to at least five limitations. First, data regarding diabetes and obesity are obtained by self-report; diabetes prevalence excludes persons with undiagnosed diabetes, and obesity prevalence often is underestimated because respondents tend to underestimate body weight and overestimate height. The accuracy of self-reporting might vary by region, and thus affect these estimates. Second, BRFSS only samples households with landline telephones; wireless-only households tend to have younger occupants and lower incomes, and tend to be members of minority populations. Third, because of statistical interdependence, any inferences regarding statistical differences among

counties should be based only on the data and 95% confidence intervals provided online (*4*). Fourth, low BRFSS response rates for some states might indicate response bias, although BRFSS weighting procedures partially correct for nonresponse. Finally, although estimates in this report are age adjusted, they are not adjusted for factors such as race/ethnicity and income, which also might be related to geographic area. These data can be merged with county-level datasets, including U.S. Census data, for broader analyses (*4*).

The growing obesity and diabetes burden in the United States has generated interest in population-targeted prevention measures, ranging from health-system support for preventive lifestyle interventions to increased legislation of the food environment, to enhanced social marketing to reduce risk factors for obesity and diabetes (*7*,*8*). Improved surveillance systems will be crucial to target interventions toward areas with populations at high risk and track the impact of those interventions at the local level.

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* Additional information available at http://www.thecommunityguide.org/diabetes/index.html.

What is already known on this topic?

Current surveillance methods are not able to provide reliable local estimates of chronic disease prevalence because of sample size limitations.

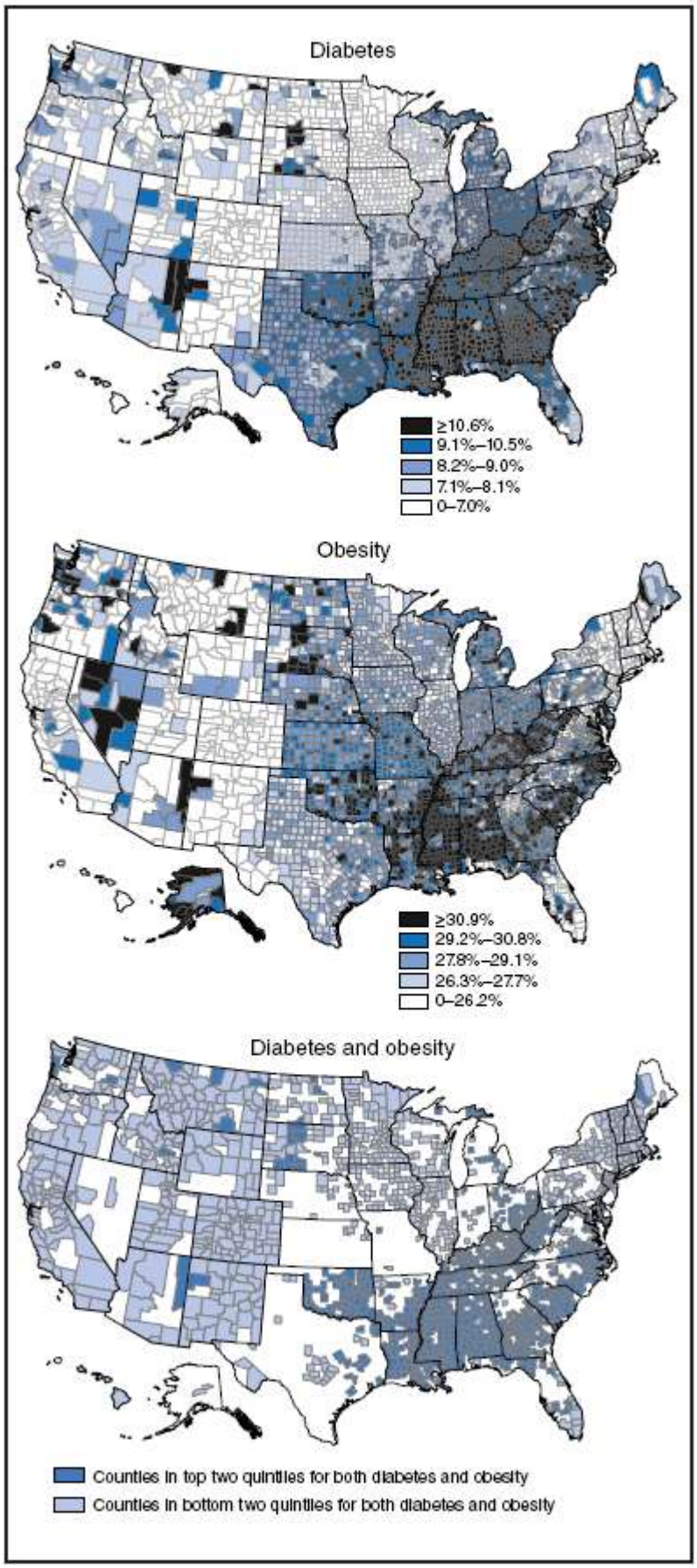
What is added by this report?

Using Bayesian modeling, estimates of diabetes and obesity prevalence identified regional belts in the southern United States and isolated areas (e.g., tribal lands) in western states with high prevalence of diabetes and obesity.

What are the implications for public health practice?

These findings of wide county-level variation in diabetes and obesity prevalence provide important data for consideration by local public health officials when developing programs to reduce the prevalence and complications of diabetes and obesity.

FIGURE. Age-adjusted percentages of persons aged ≥20 years with diabetes and obesity, by county --- United States, 2007



Alternate Text: The figure above shows age-adjusted percentages of persons aged ≥20

years with diabetes, obesity, and both diabetes and obesity in the United States in 2007. Estimates of diabetes prevalence in U.S. counties ranged from 3.7% to 15.3%, with a median of 8.4%; estimates of obesity prevalence ranged from 12.4% to 43.7%, with a median of 28.4%. Counties in the top two quintiles in both obesity and diabetes prevalence were concentrated in the South and Appalachian region, and counties with low diabetes and obesity prevalence largely were in the West, Northern Plains, and New England.

http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5845a2.htm