

Rural Health

AND Rural Landscapes:

An Ecological Approach to the Study of Obesity

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The increasing prevalence of obesity is now considered to be a global pandemic, and has been linked to a wide range of chronic diseases including Type 2 Diabetes, hypertension, breast cancer, gall-bladder disease, asthma, and depression. The causes of obesity are multifaceted, and are related to individual-level factors such as age, gender, and education as well as area-level factors that determine the environments in which people live. In particular, the development of obesogenic environments is hypothesized to increase the risk of obesity by discouraging physical activity, increasing consumption of energy-dense foods, and limiting the availability of healthy foods (Egger & Swinburn, 1997). Obesogenic environments can be further dissected based on the environment type (physical, economic, political, and sociocultural) and spatial scale (micro- and macro-environments) (Swinburn et al., 1999).

Although comparisons of rural and urban populations have frequently found higher rates of overweight and obesity in rural areas, our current knowledge of the environmental determinants of obesity is

still largely based on research conducted in urban and suburban environments. In contrast, our understanding of the spatial patterns and determinants of obesity within rural areas is based on far fewer studies. In the 2000 Census, rural areas encompassed more than 97 percent of the total U.S. land area and were home to 59 million people (21 percent of the U.S. population). Given the uniqueness and diversity of rural environments, it is not possible to generalize findings from studies focused on cities and suburbs. Instead, novel perspectives and approaches are needed to elucidate the environmental determinants of obesity in rural areas, and to develop appropriate strategies for reducing the health burden of obesity in these environments.

In this article, we address several topics relevant to the problem of understanding obesity in rural environments. First, we outline a conceptual ecological model for understanding the influences of physical, economic, and sociocultural environments on obesity in rural areas. Next, we examine existing frameworks for classifying rural areas and discuss their limitations and the

implications for studying obesity in rural landscapes. Finally, we present an overview of a recent study that mapped and analyzed geographic patterns of obesity and associated risk factors within the conterminous U.S. We discuss how this type of ecologically focused, spatially explicit research can lead to novel insights about the characteristics of rural obesogenic environments, and we address the implications for future research efforts and public health applications.

Conceptual Model

Most research on obesogenic environments has examined populations living in and around cities, and has focused primarily on aspects of the built environment. For example, suburban sprawl may reduce physical activity by necessitating automobile use and discouraging walking and bicycling as means of transportation and recreation (Leal & Chaix, 2010). Thus, newer suburban neighborhoods that lack sidewalks and segregate residential and commercial areas should have higher rates of obesity compared to more traditional urban mixed-use neighborhoods.

In addition to the physical structure of communities, socioeconomic characteristics also contribute to the development of obesogenic environments (Leal & Chaix, 2010). Residents of neighborhoods with high levels of material deprivation, as measured by factors such as high unemployment and low income, frequently have higher levels of overweight and obesity than less deprived neighborhoods. Several proximal environmental factors may drive these relationships. If residents have concerns about their safety or negative perceptions of neighborhood aesthetics, then outdoor physical activity may be reduced. Furthermore, residents of low-income and

minority neighborhoods often have relatively low access to supermarkets and other stores with a wide selection of healthy foods, particularly fresh fruits and vegetables. Instead, deprived neighborhoods frequently have high concentrations of convenience stores and fast food outlets.

Whereas cities and suburbs are dominated by the built environment, the character of rural communities is molded by aspects of the natural environment including climate, vegetation, terrain, and soils. The idea of the cultural landscape has long been recognized as a framework for understanding the relationships between humans and

their environment (Sauer, 1925). The development of the field of landscape ecology, coupled with the emergence of computerized geographic information systems (GIS) technology, has provided a suite of concepts and techniques for measuring, classifying, and modeling landscapes (Forman & Godron, 1986). These approaches are being increasingly applied in the health sciences, mainly in the ecological study of vector-borne and zoonotic diseases. However, similar approaches can also be applied in the context of human ecology for studying the environmental determinants of obesity and other chronic diseases.

In rural areas, elements of the natural environment including climate, physiography, and vegetation, exert a strong influence on the type of land use that is practiced (Figure 1). Land uses can vary widely in rural areas, ranging from agriculture and natural resource extraction to emerging economies linked to recreation and outdoor amenities. These land uses determine the range of human activities that occur in rural landscapes, and also shape the socioeconomic status and demographic structure of the populations that inhabit these landscapes. Regional variability in natural environments and economies also affects the culture of rural populations and influences social norms related to food consumption and physical activity (Hartley, 2004). Rural areas exhibit considerable variability in their spatial patterns of human settlement, ranging from exurban developments at the fringes of

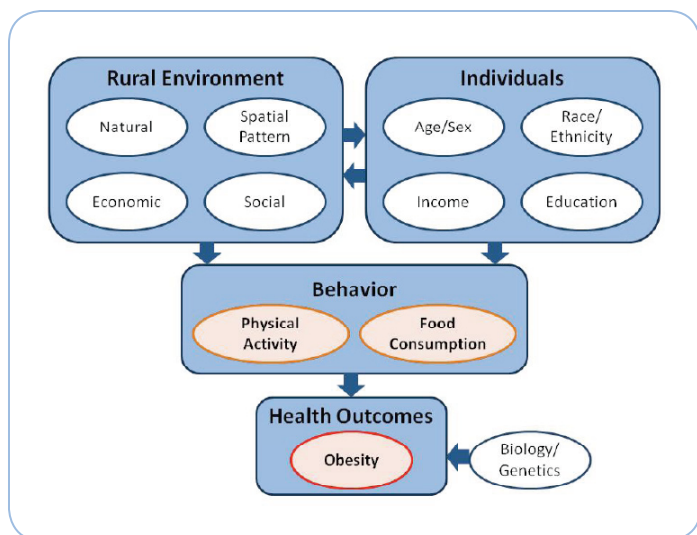


Figure 1: Conceptual ecological model of rural obesogenic environments.



metropolitan areas to isolated communities located hundreds of miles from a city. This geographic isolation may increase automobile dependence and limit access to health care facilities, sources of healthy foods, and recreational opportunities.

Definitions—What is Rural?

The word rural evokes a variety of images, including sparsely populated landscapes, mosaics of farms and forests, and small towns. However, the classification and study of specific areas as rural or non-rural requires a more clear-cut definition. The U.S. Census Bureau classifies urban and rural areas at the spatial resolution of the census block group—an area containing a population of 600-3000 people. Urban areas, including large urbanized areas and smaller urban clusters, are identified using a complex algorithm that takes into account population thresholds, population density, and the spatial arrangement of the population. In contrast, rural areas are the remaining block groups that do not meet the urban criteria.

Another commonly-used definition of rural areas is based on the metropolitan/nonmetropolitan county classification developed by the U.S. Office of Management and Budget. Metropolitan areas are centered

on core counties with dense, urbanized populations, but also incorporate adjacent counties that have a high degree of social and economic integration as measured by commuting ties. All counties that do not fit this definition are considered nonmetropolitan. Although metropolitan and nonmetropolitan classifications are often interpreted as proxies for “urban” versus “rural” counties, both types of counties typically contain a mixture of urban and rural populations (Figure 2a, see next page).

A key point of this comparison is that the definition of rural is both subjective and scale dependent. Furthermore, neither the rural nor the nonmetropolitan classification arises from a specific conceptual model of rurality. Instead, they both encompass areas that are left over following the classification of more urbanized environments. Furthermore, the very act of classification belies the considerable physical and social heterogeneity of rural landscapes. For all these reasons, simple comparisons of obesity in urban versus rural areas are likely to be of limited utility. Instead, obesity research should focus on identifying specific environmental characteristics that are associated with obesity in rural areas. This knowledge can then be applied to develop

new approaches for modeling and mapping relevant environmental variability.

Geographic Patterns of Obesity

One way to avoid the subjective nature of the urban-rural dichotomy is through exploratory spatial data analysis. Instead of making comparisons based on an a priori classification, spatial smoothing and clustering techniques can be applied to highlight geographic areas with high and low obesity prevalence. We recently completed a study of the spatial patterns of obesity, physical activity, and fruit and vegetable consumption across the conterminous United States (Michimi & Wimberly, 2010). The analysis was based on seven years of national data from the Behavioral Risk Factors Surveillance System (BRFSS), an annual survey conducted by the Centers for Disease Control and Prevention in collaboration with state health departments. Because of the small sample sizes in most nonmetropolitan counties, a spatial smoothing method (weighted head-banging) was used to reduce local variability and elucidate broader geographic trends in obesity and associated risk factors (Mungiole et al., 1999).

The obesity map generated using these techniques clearly illustrates regional clusters



of higher and lower obesity prevalence (Figure 2b). Although obesity statistics are frequently summarized and mapped at the state level, these smoothed county-level patterns do not necessarily correspond with state boundaries. For example, multi-state regions such as the Mississippi Delta, the Southern Appalachians, and the Piedmont and Coastal Plains of the southeastern United States emerge as higher-obesity regions. In contrast, much of the interior West along with portions of the upper Midwest and New England have lower obesity prevalence. These geographic patterns of obesity are negatively correlated with physical activity, and also have weaker negative correlations with fruit and vegetable consumption (Michimi & Wimberly, 2010).

New Insights into Obesogenic Environments

In addition to highlighting regions with high and low obesity prevalence, this type of exploratory analysis can provide insights into the underlying obesogenic environments. For example, inspection of the obesity prevalence map suggests correlations with metrics of the social environment. Higher-obesity counties appear to be spatially associated with higher-poverty counties across much of the eastern United States, but not in the West (Figure 2c). Many lower-

obesity counties in the West and in New England have a higher proportion of adults with a college degree (Figure 2d). A key insight from this visual assessment is that the associations between obesity and the environment can be spatially heterogeneous. A particular environmental variable may be strongly associated with obesity in some geographic regions (e.g., poverty in the Southeast), but not in others.

Previous research has focused on identifying environmental determinants of obesity at the scale of neighborhoods, or “micro-environments” where people purchase food, exercise, and carry out daily activities (Swinburn et al., 1999). In contrast, the term “macro-environment” has been used to characterize much broader structural influences of industries, governments, and other sectors operating at regional, national, and international levels. Our national-level study suggests that there is an intermediate level of “meso-environmental” influences that reflects regional and sub-regional variability in the natural environment, land use, human settlement patterns, and culture (Michimi & Wimberly, 2010). These factors help to determine characteristics of the micro-environments nested within the broader meso-environments, and can also have

direct influences on physical activity, diet, and other risk factors for obesity.

Connecting these ideas with the ecological conceptual model outlined previously (Figure 1) offers the potential for new perspectives and insights into the complex web of factors that affect obesity and other rural health problems. For example, over the past several decades the “recreation county” has emerged as a unique type of non-metropolitan area (Johnson & Beale, 2002). These are defined as counties that have high concentrations of outdoor recreational amenities such as mountains, water, and forest. As a result of these amenities, they also have large proportions of employment or income that are derived from recreation-related industries, including hotels and restaurants, outdoor recreation, real estate, and other service industries.

Natural amenities are known to be a major force of migration that attracts workers and retirees to move from elsewhere. Thus, high-rates of population growth in recreation counties are driven by this combination of desirable outdoor recreational amenities and economic opportunities. The natural environment determines whether counties will develop a recreation base, and the existence

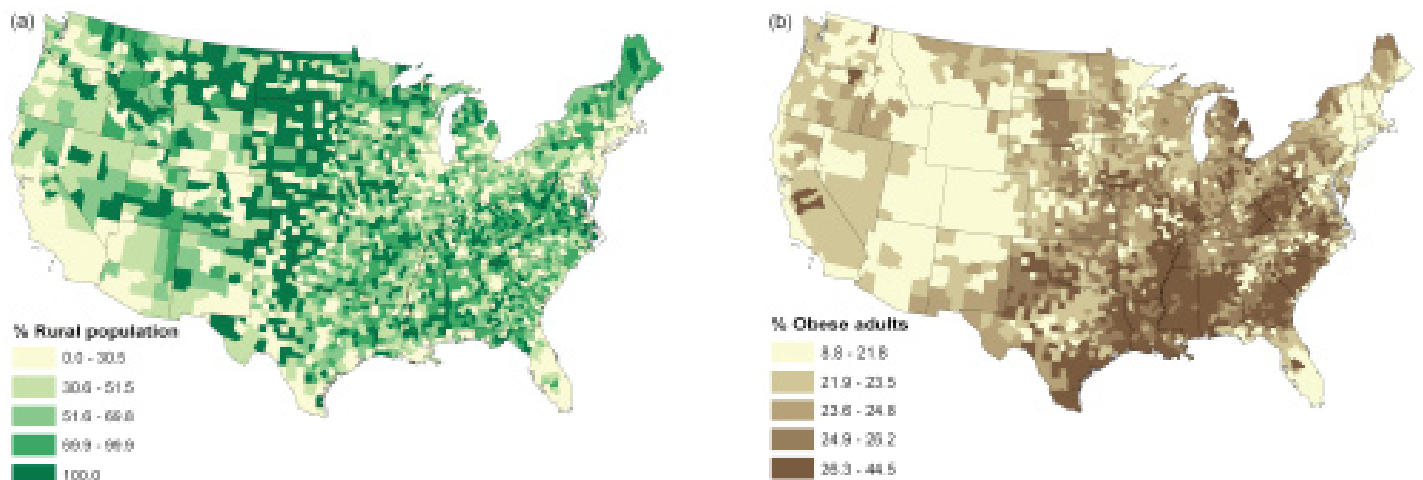


Figure 2. Spatial patterns of obesity and socioeconomic characteristics in the conterminous United States. (a) percent of population living in rural areas; (b) smoothed prevalence of obese adults (aged +18 years) with body mass index of over 30kg/m²; (c) percent of population with income below the poverty

of desirable amenities and recreational opportunities influences the demographic makeup and socioeconomic status of the population. This combination of natural environments that encourages outdoor activity, local culture focused on outdoor recreation, higher socioeconomic status, and selection by residents who are predisposed to engage in physical activity may help to explain the relatively low prevalence of obesity across many non-metropolitan counties in the West (Figure 2b).

Conclusions

An ecological approach to the study of obesity addresses questions about spatial patterns of obesity and their relationships with obesogenic environments and other risk factors. The spatially explicit nature of this type of research makes it particularly relevant to the development and implementation of public health efforts to reduce the burden of obesity. For example, mapping the geographic distribution of obesity and its environmental correlates can help ensure that community health efforts are directed toward the areas where they are most needed. Furthermore, research that improves our understanding of obesogenic environments can aid in the design of appropriate health interventions and inform the development

of public policies that encourage healthier communities. Our future research will aid in these efforts by testing a set of hypotheses about the influences of supermarket accessibility, outdoor recreational amenities, and other environmental variables on the prevalence of obesity in rural areas. We are also working to develop more refined classification schemes for rural landscapes that emphasize the environmental factors most relevant to obesity, integrate elements of the natural and built environments, and effectively capture the broad variability in rural landscapes.■

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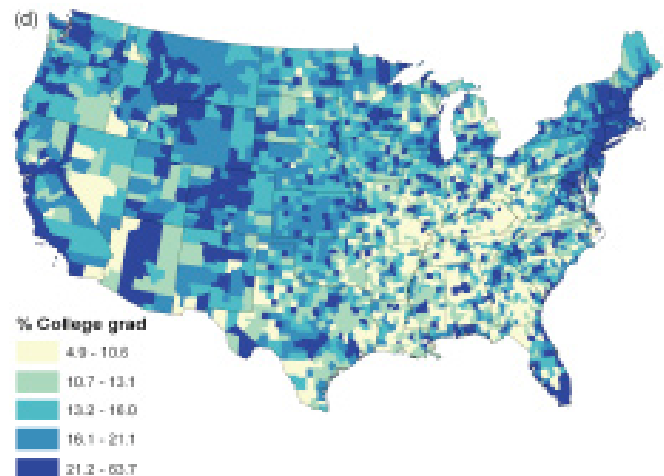
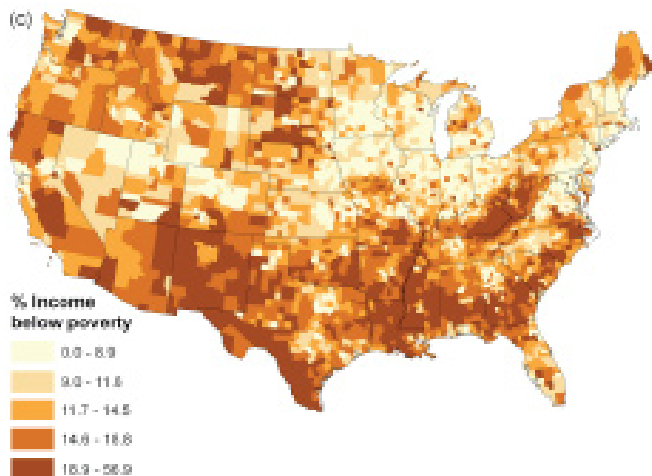
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level; (d) percent of population (aged +25 years) with a college degree. Sources: 2000 U.S. Census Population Data for (a), (c), and (d) and 2000-2006 Behavioral Risk Factor Surveillance System for (b).