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Rural and Remote Food Environments and Obesity

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Abstract Within most developed countries, rural residents are more likely to be obese and overweight compared to their urban counterparts. Studies of specific rural communities have found that the limited availability of healthy foods in the community and home as well as individual characteristics and preferences contribute to poor diet and overweight. The rural food environment is varied and may be affected by climate, regional and cultural preferences, transportation access, and remoteness among other factors. Given this diversity and the vulnerabilities of rural residents, who are more likely to have low-income, substandard housing or low educational attainment compared to their urban counterparts, policy and programmatic interventions should target specific needs and communities. This review will describe the rural community, home, and individual food environments and what is known about their roles in healthy eating.

Keywords Rural · Obesity · Overweight · Food environment · Diet quality

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Introduction and Context

At the national level and among specific states within the USA, rural children and adults have higher prevalence and greater risk of obesity compared to their urban counterparts, even when controlling for demographic characteristics, nutrition, and physical activity [1, 2, 3•, 4]. Based on self-reported weight and height, 20 % of rural adults are obese compared to 18 % of urban adults [4]. When clinical data are examined, 40 % of rural adults are obese compared to 33 % of urban adults [3•]. Compared to urban counties, obesity prevalence is higher in rural counties adjacent to urban ones and in small, remote rural counties [5], while the rural South and Midwest have higher obesity prevalence than the rural Northeast and West [4]. The reasons for greater obesity prevalence in rural communities and by region may relate to aspects of the food environment. Some rural studies have found that the limited availability of healthy foods in the community and home [6, 7] as well as individual characteristics and preferences contribute to poor diet and overweight [1, 2]. For rural USA residents nationally and at the state level, higher daily energy intake and higher percent of calories from fat were associated with higher obesity prevalence [3•, 8, 9].

Rural and urban residents share similarities in their food environments. Both tend to travel outside of their home communities for groceries except for those that lack easy access to personal transportation [10–12]. However, rural residents may be more likely than urban residents to obtain food from community and household farms, hunt, fish, forage, and use large freezers for storing bulk foods. A recent survey of households in Maine, one of the most rural states in the country, indicates that more than thirty percent of all households depend on some form of self-provisioning to meet their food needs [13]. Additionally, a comprehensive review found that rural residents often lived in neighborhoods with poor access to supermarkets and healthy food [14]. Few studies compare the rural and urban food environment; however, the literature

does reveal that specific rural communities have unique characteristics, pointing to the need to avoid generalizations in defining the rural food environment.

In general rural residents are more likely to have demographic characteristics that place them at greater risk for obesity and other poor health outcomes. Compared to urban residents, rural residents face disparities in health status and outcomes [15–17] and receive fewer medical services [18, 19]. Rural residents are also more likely to have low-income and low-educational attainment than urban residents [20]. In agreement across studies, low-income and low educational attainment are associated with high obesity prevalence among rural children and adults [1, 2, 21]. Low educational attainment, such as having a high school degree or less, was also associated with increased obesity risk [21], greater likelihood of eating at food outlets associated with obesity (e.g., buffets) [22], and having limited access to fruits and vegetables [23]. Additionally, having a health condition other than obesity, being in fair or poor health, or having a limitation in daily activities were also associated with obesity for rural children and adults [1, 4].

The purpose of this review is to provide an update on the literature and key issues and current debates relating to the rural food environment and its contribution to obesity rates in rural communities. Our approach included PubMed and Google Scholar searches focusing on recently published US research and reviews (2005–2014), with earlier sentinel publications included that introduce the connection between food environment and obesity and that provide content where gaps exist in the more current literature. Due to limitations on the length of this review, we concentrate on the rural community, home, and individual food environments, based on a previously published conceptual model [10]. We do not focus on the rural school food environment, food policy environment or retail food store policy and decision making. PubMed search terms included rural food environment; rural food desert; rural food access; rural food insecurity; and rural obesity and overweight. We used a "snowball" approach when searching to capture the most relevant peer reviewed articles on the rural food environment and its impact on obesity. We also highlight controversies in the field that we have observed through our own research. For ease of use, we refer to rural and urban location, terms that are commonly defined by federal agencies on the basis of population centers, commuting patterns, and geographic boundaries [24]. Urban and rural areas within the USA are often identified based on the federal Office Management and Budget's metropolitan and non-metropolitan county designations. The metropolitan designation is based on a population center and includes adjacent communities that commute to the core, while the non-metropolitan designation is given to all counties that do not meet the metropolitan designation. The term "remote" is primarily used where a rural county is adjacent only to another rural county [24].

Community Food Environment

In general, the community food environment is based on food stores' availability, type, and location with products described by availability, quality, and price [25]. Since the small population base of many rural communities cannot support a supermarket or grocery store, non-traditional food outlets may take on a larger role in ensuring food availability in rural over urban environments.

Availability, Type, and Location of Food Outlets

At the community level, the rural food environment is composed of both traditional and non-traditional food outlets [26, 27]. Traditional food sources include supermarkets, grocery stores, and fast-food and full-service restaurants. Non-traditional sources include convenience stores, pharmacies and drug stores, heavily-discounted retail stores (i.e., dollar stores), farmers' markets and produce stands, mass marketers, and "channel-blurred" retail (e.g., gas stations with a food outlet). Supermarkets typically provide the best availability and lowest price of healthy foods over grocery stores and convenience stores [28]; however, research suggests that rural communities have limited access to food stores where wide selections of high quality, healthy foods and low prices are available [29–31]. Whether or not a household has access to a motor vehicle and willingness to travel may also impact the community food environment. Limited motor vehicle access reduced consumption of fast food among rural communities of New Hampshire and Vermont [22], while it improved access to fruits and vegetables in a six-county rural area of Texas [32]. Residents of isolated rural communities through the South and Western US regions traveled long distances to purchase food in bulk to take advantage of lower prices [33]. Rural Maine parents who drove longer distances (20 miles or more) to grocery shop were more likely to buy from stores that scored well on product availability, quality, and price [10]. Compared to urban Minnesota residents, rural focus group participants mentioned they were willing to travel to obtain food, but they planned the trip in advance to take advantage of visiting multiple stores in one trip [34].

Rural food store and restaurant accessibility is limited to convenience stores, fast-food restaurants, and dollar stores for rural populations generally and for rural low-income and minority populations specifically [14, 26, 29, 31, 35]. For example, convenience stores were the most common food outlet over grocery stores and supermarkets for American Indians living on reservations in Washington State; however, these convenience stores provided limited access to foods that were part of the national standard for a minimally nutritious diet at low cost [35].

Non-traditional food outlets that may be more common in rural compared to urban food environments include

purchasing from farmers directly as well as making purchases at flea and farmers' markets. Farmers' markets and orchards were common food sources among residents of rural Maine [10], Oregon [30], and Hawaii [36], while flea markets and mobile and home-based food vendors were part of the community food environment in rural areas along the south Texas border with Mexico [37, 38]. Food pantries and other civic safety-net options such as community kitchens and meals on wheels are also among alternative food sources for low-income rural residents [39], especially at the month's end when resources have dwindled [11].

To understand the complex rural food environment and design appropriate interventions, it is critical to consider the availability and variety of food in all types of stores and restaurants accessible to families, including dollar and convenience stores, flea and farmers' markets, and fast food restaurants [40, 41]. In the general food environment literature, evidence suggests that proximity to supermarkets is associated with increased consumption of fruits and vegetables, while proximity to fast-food outlets increases consumption of higher-energy food and lower-quality diet [42]. However, an emphasis on supermarkets, groceries and restaurants alone will not adequately capture rural food retail sources [37]. It appears that urban and suburban communities have good access to supermarkets and grocery stores; however, few studies compare the rural and urban community food environment. In one study of rural and urban communities in upstate New York, an urban minority community experienced more barriers to retail fruit and vegetable availability than did a rural community [43].

How Well Does the Community Food Environment Explain Obesity?

Findings are mixed on the influence of the community food environment on weight status for rural residents. In a national, longitudinal study, density of small grocery stores was not related to weight status for rural residents. However, persons who encountered an increase in density of supermarkets because they moved from a rural to urban area experienced a decline in body mass index (BMI) over two years, while greater density of full-service restaurants resulted in an increase in BMI [44]. Limited availability of fresh fruits and vegetables in food outlets in rural Southern communities was not associated with obesity [45]. Small area interventions in rural communities improved healthy eating among child-caregiver dyads [46] and reduced or attenuated body fat among students [47].

Studies that did not focus on rural residency also reported contradictory findings of the influence of food store accessibility on BMI. Though close proximity to supermarkets and grocery stores indicated improved access to healthy food [28] and improved diet [48], access to supermarkets, fast food restaurants, or convenience stores did not impact BMI among California youth [49•] or elementary school children nationally [50•]. In contrast, proximity to supermarkets [45, 51] and farmers' markets in North Carolina [52] was associated with lower BMI, while proximity and frequent use of convenience stores [14], small grocery stores [21], and fast food outlets [23] were associated with higher BMI. It may be that selected age groups and limited sample sizes within and community variations across these studies result in inconsistencies. However, there is no clear path toward a large area analysis given the difficulty in aligning data sources with indicators of overweight and obesity and an accurate description of the community food environment.

Home Food Environment

The home food environment is complex and varying, affected by food availability at various outlets, shopping frequency, and the influence of the person who shops and prepares meals [53]. Eating foods prepared at home is often associated with healthy eating while eating foods prepared away from home is associated with poorer diet quality [54]. More frequent family meals are associated with higher consumption of healthy foods in children, adolescents, and adults and increased family meal frequency may decrease risk of overweight or obesity in children and adolescents. However, if family meals consist of fast food, television viewing or a chaotic environment, the benefits of family meals may dissipate [55]. It is unclear whether rural families are more likely to eat meals in the home together than urban or suburban families and whether family meals are more or less likely to include healthy food choices.

Healthy Behaviors in the Home and Barriers to Healthy Eating

Very few studies have examined the rural home food environment. Among those that have, unhealthy foods in the home lead to poor nutrition, while certain behaviors, such as eating as a family, promote healthy eating. For example, in North Carolina and in rural Georgia the presence of unhealthy foods in the home was associated with intake of unhealthy foods [8, 56], while a healthy home food environment promoted normal weight status among rural American Indian children [57]. Home food behaviors — such as eating as a family, children eating breakfast, serving vegetables, and use of a farmer's market — and parent food consumption were associated with children's healthy eating behaviors among low-income rural Maine families [10]. Even when taste preferences for fruits and vegetables were low among urban and suburban Minnesota adolescents, home availability continued to positively influence consumption [58]. Examining the influence of fruit and vegetable availability despite preference among rural

families may help determine whether differences exist in the rural versus urban home food environment.

The home food environment may be particularly challenging for some of the most vulnerable rural populations. Rural American Indian children [59] and youth [60] encountered barriers to eating healthy food such as lack of home availability, high cost, lack of time to prepare healthy meals, personal eating patterns and lack of knowledge of healthy eating choices, and limited availability of grocery stores on reservations. In rural Appalachia, those who prepared meals for their families saw more social and practical costs than rewards to serving vegetables, and family norms prevented learning about and exposure to unfamiliar vegetables [61]. Rural persons with disabilities may experience more difficulties in accessing large food retailers as a result of travel and time issues [62]. In a qualitative examination of food access in New York low-income rural, village and inner-city families, nearly one-half of primary grocery shoppers reported health conditions or disabilities that limited food access [63]. Among rural adults in the Lower Mississippi Delta Household food insecurity was associated with poor health status [64].

Influence of Parents on Children's Eating Behavior

Parent BMI has been shown to influence weight status for children [49•, 57]. Limited research points to the possibility that parents' eating habits also predict eating behaviors and weight status of rural children. Among parents of young children in rural southeastern Missouri, parents who frequently ate homegrown fruits and vegetables had children who were more likely to also eat homegrown fruits and vegetables [65]. Among low-income rural Maine families, parent consumption of healthy foods was negatively associated with childhood obesity [10].

Influence of Work and Social Events on Food Availability

Workplaces and social environments may serve as an extension of the home environment. The demands of work schedules as well as the work environment itself influenced the home food environment in several rural communities. For rural women in North Carolina, the commute between an urban workplace and rural home was often used to pick up premade dinners or shop for dinner ingredients outside of their home communities [66], while rural Oregon residents purchased take-out food on the way home from work, as a way to ease time demands [30]. The rural workplace in New York and Georgia included unhealthy food served at work events and as rewards [67, 68]. We found no evidence that the work environment among rural residents was notably different from that of urban residents; however, given that rural residents generally travel longer distances to work, this may impact time for healthy in-home cooking. Among rural focus group participants, food was regarded as a sign of hospitality at social events and attendees felt an obligation to accept [33, 67].

Food Insecurity

The absence of food security — defined as inconsistent access to adequate food for active healthy lives [69] — is associated with high obesity rates [70, 71]. Compared to urban, rural children rely more frequently on food stamps and free or reduced price lunch [72]. Rural focus groups and survey respondents reported continued and growing reliance on federal food assistance programs, such as food stamps, WIC, and commodity foods. Respondents also reported the use of food pantries, food banks, or other programs in emergency situations [33, 73]. While these studies do not conclusively identify a link between rural food insecurity and obesity, it appears that rural residents that depend on food assistance may face higher risk for overweight and obesity than their urban counterparts.

Fresh Versus Processed Fruits and Vegetables

It is generally understood that fresh fruits and vegetables are part of a healthy, well-balanced diet. However, a focus on fresh produce may be a disservice to rural persons who might have improved access to healthy foods if they were to consume canned or frozen options that are easier and cheaper to supply in more remote communities compared to fresh produce. In a rural community where the nearest large grocery outlet is 40 miles away, but where smaller grocery stores, convenience stores, and gas stations with limited fresh produce are easily accessed, should we continue to promote fresh over canned and frozen foods in these settings? In a pre-post assessment of a policy change to add fruits and vegetables to the WIC food package, small vendors and pharmacies met WIC requirements by stocking canned or frozen vegetables [74].

A review comparing the nutritional content of fresh, frozen, and canned fruits and vegetables revealed that loss of nutrients during storage may in fact be greater in fresh produce than in stored frozen and canned foods [75]. In six rural Texas counties, rural residents had better travel distance to a variety of fresh and processed fruits and vegetables among non-traditional food stores and convenience stores than to the nearest supermarket [41]. Because many rural families may not have access to gardens and farmers' markets [12] and may rely on dollar or convenience stores that do not stock fresh produce, a full understanding of the rural food environment must include the understanding of a variety of healthful food options, including canned and frozen foods, in all types of stores that are accessible to rural families [40].

Individual Food Environment

The individual food environment, composed of the individual's demographic characteristics and their eating behavior, may influence weight status. Rural residents' eating behavior may be influenced by regional and cultural preferences as well as by personal taste and attitudes.

Influence of Personal Taste and Attitudes on Food Choices

Among rural and urban North Carolina women, mothers were motivated to create a healthier food environment; however, family members' preferences for unhealthy fast food or convenient snack foods negatively influenced women's food choices [66]. In a study of urban and suburban Minnesota adolescents, home availability and taste preferences were found to be the primary influence on whether an adolescent consumed fruits and vegetables [58]. Focus groups with American Indian 5th graders in a rural frontier setting revealed that dislike for foods on the federal Dietary Guidelines for Americans was the number one barrier to consumption of foods such as grains, fruits and vegetables, meat, beans, and milk [59]. Regional food patterns and preferences also impact food choices, with Southern communities in particular known for their high-fat food choices [68, 76].

Applying the Food Desert Concept to Rural Communities

The term 'food deserts' refers to areas where residents have limited access to a variety of healthy and affordable foods. Residents of these areas who lack access to vehicles or public transportation are particularly vulnerable, and may rely more on smaller neighborhood stores that lack healthy foods or offer them at higher prices [77, 78]. Food deserts have been associated with poor-quality diets [48], but contradictory findings and study limitations have led some to call for more rigorous, longitudinal research to determine the strength of the relationship between food deserts and diet [49•]. The term 'food swamp' has been introduced as a twist on the metaphor 'food desert,' to depict areas where families may have access to healthy foods and have strategies to travel to stores with healthful options, but where less healthy, convenient, easy, and cheap foods options may 'swamp' out the healthy ones [79].

Most studies of food deserts have focused on neighborhoods in urban settings. Some researchers have suggested that applying the concept of food deserts to rural areas may be less meaningful, given the complex and varied sources of food (e.g., from farmers, hunting, gardening, bartering, freezing) that rural residents have reported and the distance that they are accustomed to driving for work and services, including food shopping [10, 11, 34]. In a published exchange on this issue, Lucan and colleagues [12] argued that weakening the term food desert for rural areas may shift needed attention from the reality of rural food-access problems. They voiced concerns over Hartley and colleagues' assertion that rural residents have access to alternate means of food procurement, including hunting and gardening. They also noted that rural residents living in mobile homes, substandard housing conditions, and shanty towns may not have room or electricity to support large freezers for storing bulk food items, which Hartley et al. found to alleviate rural food access concerns in rural Maine. Lucan and colleagues [12] suggest that many rural residents have limited or no access to vehicles, restricting travel to stores for purchasing food, while Hartley and colleagues [80] theorized that the boundaries of food deserts in rural areas could potentially be expanded because of residents' reports of accepting distant travel for services as a part of rural life. As noted elsewhere, rural residents were more likely than urban to shop for food outside their home community [81]. Both sets of authors agreed that rural communities are heterogeneous, and because of this, careful study is required for understand the complexities of the rural food environment in different communities.

Regardless of the meaning and measure of 'food deserts,' large food retailers with lower prices such as grocery chains and supercenters may not find it feasible to operate in rural areas that lack sufficient infrastructure and customer base [79]. Developing creative programs and incentives for increasing access to healthy and affordable foods in rural areas is necessary. Researchers agree that rural communities are not homogeneous and require tailored, creative solutions increasing residents' access to healthful and affordable foods. Although personal factors impact eating behaviors of rural residents, it has been found that it is often the physical and social environments that place constraints on food access. Solutions to decrease barriers to healthful eating should include creating alternatives, such as community gardens and informal transportation networks in rural communities [82].

Conclusions

Despite limits on access to supermarkets and other sources of healthy food, the food environment in some rural communities seems to be characterized by the use of freezers, hunting, foraging, and mobile vendors. Other rural communities have a narrower food environment restricted by deep poverty or a lack of transportation. Given diversity among rural communities [83] as well as variation in the type and density of food outlets within rural communities, it will be important for policy makers and community planners interested in addressing

gaps and limits in the rural food environment to fully know the community they seek to help. Strategies for rural environmental and policy change should include developing broad-based partnerships and building on existing infrastructure [84•]. What works for low-income rural white persons in Maine will differ from what works for low-income rural Hispanic persons in south Texas. Additionally, direct observation or "ground-truthing" is important in describing the rural food environment, because of disagreement between the actual food environment and secondary or commercial data sources [22, 26, 85]. At the research level, it will be important to supplement rural-specific studies with ones that compare rural and urban communities, perhaps within the same state or featuring similar demographic features to determine if the characteristics of the rural food environment are indeed different from those of the urban environment. In particular, little is known about vegetable preferences and consumption patterns among rural, low-income US families, which may be helpful in developing family-centered, home food environment interventions [61]. Food pantries, community kitchens, and meals on wheels are valuable alternative food sources to be explored when designing interventions to improve the rural food environment, especially for low-income residents.

Several documents describe interventions to the rural food environment that improved access to nutritious diets and decreased overweight and obesity [73, 86, 87]. Additionally, other interventions have successfully improved the home environment through home visits [6], community gardening [88], health information and goal setting support [89], healthy foods in schools [90, 91], and a peer intervention [92]. Most barriers to implementing healthy eating and active living policies result from the limitations inherent in small communities: lack of interest from funders in supporting their efforts; limited influence in state policies; and lack of adequate staff [84•]. However, given the creative and thoughtful approaches rural individuals have applied to their food environment [10, 11, 34] as well as the interventions documented above, rural communities and residents have illustrated that they have the determination and self-sufficiency to address their food environment challenges. Rural communities and residents as well as policymakers and community planners have many opportunities to address disproportionate obesity prevalence.

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Compliance with Ethics Guidelines

Conflict of Interest Jennifer D. Lenardson, Anush Y. Hansen, and David Hartley declare they have no conflict of interest.

Human and Animal Rights and Informed Consent This article does not contain any studies with human or animal subjects performed by any of the authors.

References

Papers of particular interest, published recently, have been highlighted as:
- • Of importance

1. Lutfiyya MN, Lipsky MS, Wisdom-Behounek J, et al. Is Rural Residency a Risk Factor for Overweight and Obesity for U.S. Children? Obesity. 2007;15(9):2348–56.
2. McMurray RG, Harrell JS, Bangdiwala SI, et al. Cardiovascular disease risk factors and obesity of rural and urban elementary school children. J Rural Health. 1999;15(4):365–74.
3.• Befort CA, Nazir N, Perri MG. Prevalence of obesity among adults from rural and urban areas of the United States: findings from NHANES (2005–2008). J Rural Health. 2012;28(4):392–7. *This study uses nationally representative data to examine rural and urban obesity prevalence based on clinical markers*.
4. Patterson PD, Moore CG, Probst JC, et al. Obesity and physical inactivity in rural America. J Rural Health. 2004;20(2):151–9.
5. Jackson JE, Doescher MP, Jerant AF, et al. A national study of obesity prevalence and trends by type of rural county. J Rural Health. 2005;21(2):140–8.
6. Kegler MC, Alcantara I, Veluswamy JK, et al. Results from an intervention to improve rural home food and physical activity environments. Prog Community Health Partnersh. 2012;6(3):265–77.
7. Hosler AS. Retail food availability, obesity, and cigarette smoking in rural communities. J Rural Health. 2009;25(2):203–10.
8. Satia JA, Galanko JA. Comparison of Three Methods of Measuring Dietary Fat Consumption by African-American Adults. J Am Diet Assoc. 2007;107(5):782–91.
9. Stroehla BC, Malcoe LH, Velie EM. Dietary Sources of Nutrients among Rural Native American and White Children. J Am Diet Assoc. 2005;105(12):1908–16.
10. Hartley D, Anderson N, Fox K, et al. How does the rural food environment affect rural childhood obesity? Childhood Obesity. 2011;7(6):450–61.
11. Yousefian A, Leighton A, Fox K, et al. Understanding the rural food environment–perspectives of low-income parents. Rural Remote Health. 2011;11(2):1631.
12. Lucan SC, Gustafson A, Jilcott Pitts SB. The concept of "rural food deserts" is still meaningful. Childhood Obesity. 2012;8(5):484–5.
13. Maine Food Strategy. Consumer Survey Report. Portland, ME: Maine Food Strategy, Edmund S. Muskie School of Public Service, University of Southern Maine, 2014.
14. Larson NI, Story MT, Nelson MC. Neighborhood environments: disparities in access to healthy foods in the U.S. Am J Prev Med. 2009;36(1):74–81.
15. Hartley D. Rural health disparities, population health, and rural culture. Am J Public Health. 2004;94(10):1675–8.
16. Eberhardt M, Ingram D, Makuc D, et al. Health, United States, 2001: Urban and rural chartbook. National Center for Health Statistics.: Hyattsville, MD; 2001.
17. Pleis JR, Lethbridge-Cejku M. Summary health statistics for U.S. adults: National Health Interview Survey, 2006. Vital Health Stat. 2007;10(235):1–153.
18. Agency for Health Care Research Quality. Health Care in Urban and Rural Areas, Combined Years 2004–2006. Requests for Assistance on Health Initiatives: Update of Content in MEPS Chartbook No. 13 [2012/03/01]. Available from: http://www.ahrq.gov/data/meps/chbook13up.htm.
19. Larson SL, Fleishman JA. Rural–urban differences in usual source of care and ambulatory service use: analyses of national data using Urban Influence Codes. Med Care. 2003;41(7 Suppl):III65–74.

20. Lenardson JD, Ziller EC, Coburn AF, et al. Profile of rural health insurance coverage: A chartbook. Portland: University of Southern Maine, Muskie School of Public Service, Maine Rural Health Research Center; 2009.
21. Wang MC, Kim S, Gonzalez AA, et al. Socioeconomic and food-related physical characteristics of the neighbourhood environment are associated with body mass index. J Epidemiol Community Health. 2007;61(6):491–8.
22. Longacre MR, Primack BA, Owens PM, et al. Public directory data sources do not accurately characterize the food environment in two predominantly rural states. J Am Diet Assoc. 2011;111(4):577–82.
23. Casey AA, Elliott M, Glanz K, et al. Impact of the food environment and physical activity environment on behaviors and weight status in rural U.S. communities. Prev Med. 2008;47(6):600–4.
24. Coburn A, MacKinney AC, McBride T, et al. Choosing rural definitions: implications for health policy. Rural Policy Research Institute Health Panel, 2007.
25. Glanz K, Sallis JF, Saelens BE, et al. Nutrition Environment Measures Survey in stores (NEMS-S): development and evaluation. Am J Prev Med. 2007;32(4):282–9.
26. Gustafson AA, Lewis S, Wilson C, et al. Validation of food store environment secondary data source and the role of neighborhood deprivation in Appalachia. Kentucky BMC Public Health. 2012;12:688.
27. Creel JS, Sharkey JR, McIntosh A, et al. Availability of healthier options in traditional and nontraditional rural fast-food outlets. BMC Public Health. 2008;8:395.
28. Leone AF, Rigby S, Betterley C, et al. Store type and demographic influence on the availability and price of healthful foods, Leon County, Florida, 2008. Prev Chronic Dis. 2011;8(6):A140.
29. Liese AD, Weis KE, Pluto D, et al. Food store types, availability, and cost of foods in a rural environment. J Am Diet Assoc. 2007;107(11):1916–23.
30. Findholt NE, Michael YL, Jerofke LJ, et al. Environmental influences on children's physical activity and eating habits in a rural Oregon County. Am J Health Promot. 2011;26(2):e74–85.
31. Sharkey JR, Horel S. Neighborhood socioeconomic deprivation and minority composition are associated with better potential spatial access to the ground-truthed food environment in a large rural area. J Nutr. 2008;138(3):620–7.
32. Sharkey JR, Horel S, Dean WR. Neighborhood deprivation, vehicle ownership, and potential spatial access to a variety of fruits and vegetables in a large rural area in Texas. Int J Health Geogr. 2010;9:26.
33. Walker JN, Del Rosso JM, Held AK. Nutrition and Physical Activity Field Assessment of Children in Rural America. Westport: Save the Children; 2005.
34. Smith C, Miller H. Accessing the Food Systems in Urban and Rural Minnesotan Communities. J Nutr Educ Behav. 2011;43(6):492–504.
35. O'Connell M, Buchwald DS, Duncan GE. Food access and cost in American Indian communities in Washington State. J Am Diet Assoc. 2011;111(9):1375–9.
36. Novotny R, Vijayadeva V, Ramirez V, et al. Development and implementation of a food system intervention to prevent childhood obesity in rural Hawai'i. Hawaii Med J. 2011;70(7 Suppl 1):42–6.
37. Dean WR, Sharkey JR, St John J. Pulga (flea market) contributions to the retail food environment of colonias in the South Texas border region. J Am Diet Assoc. 2011;111(5):705–10.
38. Valdez Z, Dean WR, Sharkey JR. Mobile and home-based vendors' contributions to the retail food environment in rural South Texas Mexican-origin settlements. Appetite. 2012;59(2):212–7.
39. Morton LW, Blanchard TC. Starved for Access: Life in Rural America's Food Deserts. Rural Realities. 2007;1(4):1–10.
40. Bustillos B, Sharkey JR, Anding J, et al. Availability of more healthful food alternatives in traditional, convenience, and nontraditional types of food stores in two rural Texas counties. J Am Diet Assoc. 2009;109(5):883–9.
41. Dean WR, Sharkey JR. Rural and urban differences in the associations between characteristics of the community food environment and fruit and vegetable intake. J Nutr Educ Behav. 2011;43(6):426–33.
42. Sallis JF, Glanz K. Physical activity and food environments: solutions to the obesity epidemic. Milbank Q. 2009;87(1):123–54.
43. Hosler AS, Rajulu DT, Fredrick BL, et al. Assessing retail fruit and vegetable availability in urban and rural underserved communities. Prev Chronic Dis. 2008;5(4):A123.
44. Gibson DM. The neighborhood food environment and adult weight status: estimates from longitudinal data. Am J Public Health. 2011;101(1):71–8.
45. Boehmer TK, Lovegreen SL, Haire-Joshu D, et al. What constitutes an obesogenic environment in rural communities? Am J Health Promot. 2006;20(6):411–21.
46. Gittelsohn J, Vijayadeva V, Davison N, et al. A Food Store Intervention Trial Improves Caregiver Psychosocial Factors and Children's Dietary Intake in Hawaii. Obesity. 2010;18(S1):S84–90.
47. Williamson DA, Champagne CM, Harsha DW, et al. Effect of an environmental school-based obesity prevention program on changes in body fat and body weight: a randomized trial. Obesity (Silver Spring). 2012;20(8):1653–61.
48. Wrigley N, Warm D, Margetts B. Deprivation, diet, and food-retail access: findings from the Leeds 'food deserts' study. Environ Plan. 2003;35:151–88.
49.• An R, Sturm R. School and Residential Neighborhood Food Environment and Diet Among California Youth. Am J Prev Med. 2012;42(2):129–35. *This study examines the relationship between the community food environment and its relationship to diet among California children and adolescents.*
50.• Lee H. The role of local food availability in explaining obesity risk among young school-aged children. Soc Sci Med. 2012;74(8):1193–203. *This study examines the relationship between the community food environment and obesity risk for children using national survey data and national data describing retail food sources.*
51. Morland K, Diez Roux AV, Wing S. Supermarkets, other food stores, and obesity: the atherosclerosis risk in communities study. Am J Prev Med. 2006;30(4):333–9.
52. Jilcott SB, Wade S, McGuirt JT, et al. The association between the food environment and weight status among eastern North Carolina youth. Public Health Nutr. 2011;14(9):1610–7.
53. Glanz K, Sallis JF, Saelens BE, et al. Healthy nutrition environments: concepts and measures. Am J Health Promot. 2005;19(5):330–3. *ii*.
54. Todd J. Changes in Eating Patterns and Diet Quality Among Working Age Adults – 2005–2010. Washington, D.C.: U.S. Department of Agriculture, Economic Research Service; 2014.
55. Martin-Biggers J, Spaccarotella K, Berhaupt-Glickstein A, et al. Come and get it! A discussion of family mealtime literature and factors affecting obesity risk. Adv Nutr. 2014;5(3):235–47.
56. Hermstad AK, Swan DW, Kegler MC, et al. Individual and environmental correlates of dietary fat intake in rural communities: a structural equation model analysis. Soc Sci Med. 2010;71(1):93–101.
57. Arcan C, Hannan PJ, Fulkerson JA, et al. Associations of home food availability, dietary intake, screen time and physical activity with BMI in young American-Indian children. Public Health Nutr. 2013;16(1):146–55.
58. Neumark-Sztainer D, Wall M, Perry C, et al. . Correlates of fruit and vegetable intake among adolescents. Findings from Project EAT. Prev Med. 2003;37(3):198–208.
59. Jahns L, McDonald L, Wadsworth A, et al. Barriers and facilitators to following the Dietary Guidelines for Americans reported by

rural, Northern Plains American-Indian children. Public Health Nutr. 2014; FirstView (Supplement −1):1–8.
60. Brown BD, Harris KJ, Harris JL, et al. Translating the diabetes prevention program for Northern Plains Indian youth through community-based participatory research methods. Diabetes Educ. 2010;36(6):924–35.
61. Wenrich TR, Brown JL, Miller-Day M, et al. Family members' influence on family meal vegetable choices. J Nutr Educ Behav. 2010;42(4):225–34.
62. Blanchard TC, Matthews TL. Food Disadvantaged Communities in Rural America. In: Hinrichs CC, Lyson TA, editors. Remaking the North American Food System: Strategies for Sustainability. Lincoln, NE: University of Nebraska Press; 2007.
63. Webber CB, Sobal J, Dollarhite JS. Physical Disabilities and Food Access Among Limited Resource Households. Disability Studies Quarterly. 2007;27(3).
64. Stuff JE, Casey PH, Szeto KL, et al. Household Food Insecurity Is Associated with Adult Health Status. J Nutrition. 2004;134(9): 2330–5.
65. Nanney MS, Johnson S, Elliott M, et al. Frequency of eating homegrown produce is associated with higher intake among parents and their preschool-aged children in rural Missouri. J Am Diet Assoc. 2007;107(4):577–84.
66. Jilcott SB, Laraia BA, Evenson KR, et al. Perceptions of the community food environment and related influences on food choice among midlife women residing in rural and urban areas: a qualitative analysis. Women Health. 2009;49(2–3):164–80.
67. Maley M, Warren BS, Devine CM. Perceptions of the environment for eating and exercise in a rural community. J Nutr Educ Behav. 2010;42(3):185–91.
68. Escoffery C, Kegler MC, Alcantara I, et al. A qualitative examination of the role of small, rural worksites in obesity prevention. Prev Chronic Dis. 2011;8(4):A75.
69. U.S. Department of Agriculture Economic Research Service. Food Security in the U.S. Washington, D.C.: U.S. Department of Agriculture 2014 [July 22, 2014]. Available from: http://ers.usda.gov/topics/food-nutrition-assistance/food-security-in-the-us.aspx#.U86KyhClvB9.
70. Dinour LM, Bergen D, Yeh M-C. The Food Insecurity–Obesity Paradox: A Review of the Literature and the Role Food Stamps May Play. J Am Diet Assoc. 2007;107(11):1952–61.
71. Casey PH, Simpson PM, Gossett JM, et al. The Association of Child and Household Food Insecurity With Childhood Overweight Status. Pediatrics. 2006;118(5):e1406–13.
72. U.S. Department of Agriculture Economic Research Service. Rural Children at a Glance. Washington, D.C: U.S. Department of Agriculture; 2005.
73. National Association of Counties. Rural Obesity: Strategies to Support Rural Counties in Building Capacity. Washington, D.C.: National Association of Counties; 2008. *Available from: http://www.leadershipforhealthycommunities.org/images/stories/ruralobesity_naco.pdf.*
74. Zenk SN, Odoms-Young A, Powell LM, et al. Fruit and vegetable availability and selection: federal food package revisions, 2009. Am J Prev Med. 2012;43(4):423–8.
75. Rickman JC, Barrett DM, Bruhn CM. Nutritional comparison of fresh, frozen and canned fruits and vegetables. Part 1. Vitamins C and B and phenolic compounds. J Sci Food Agric. 2007;87(6):930–44.
76. Graves A, Haughton B, Jahns L, et al. Biscuits, sausage, gravy, milk, and orange juice: school breakfast environment in 4 rural Appalachian schools. J Sch Health. 2008;78(4):197–202.
77. Dutko P, Ver Ploeg M, Farrigan T. Characteristics and Influential Factors of Food Deserts. U.S. Department of Agriculture Economic Research Service: Washington, D.C; 2012.
78. Holsten JE. Obesity and the community food environment: a systematic review. Public Health Nutr. 2009;12(03):397–405.
79. Ver Ploeg M. Access to Affordable, Nutritious Food is Limited in "Food Deserts". Amber Waves. 2010
80. Hartley D, Anderson N, Fox K, et al. Redirecting the conversation on rural food deserts: reply to Lucan et al. Childhood Obesity. 2012;8(5):492–3.
81. Ver Ploeg M, Breneman V, Farrigan T, et al. Access to Affordable and Nutritious Food: Measuring and Understanding Food Deserts and Their Consequences: Report to Congress. U.S. Department of Agriculture Economic Research Service: Washington, D.C; 2009.
82. Smith C, Morton LW. Rural food deserts: low-income perspectives on food access in Minnesota and Iowa. J Nutr Educ Behav. 2009;41(3):176–87.
83. Hamilton LC, Hamilton LR, Duncan CM, et al. Place Matters: Challenges and Opportunities in Four Rural Americas. Durham, NH: University of New Hampshire Carsey Institute; 2008.
84.• Barnidge EK, Radvanyi C, Duggan K, et al. Understanding and addressing barriers to implementation of environmental and policy interventions to support physical activity and healthy eating in rural communities. J Rural Health. 2013;29(1):97–105. *This study describes barriers to healthy eating interventions in rural communities based on key informant interviews*.
85. Fleischhacker SE, Rodriguez DA, Evenson KR, et al. Evidence for validity of five secondary data sources for enumerating retail food outlets in seven American Indian communities in North Carolina. Int J Behav Nutr Phys Act. 2012;9:137.
86. The Nemours Foundation. Childhood Obesity Prevention Strategies for Rural Communities. Wilmington, DE: The Nemours Foundation, 2014.
87. Rural Assistance Center. Rural Obesity Prevention Toolkit Grand Forks, ND: Rural Assistance Center; 2012 [July 22, 2014]. Available from: http://www.raconline.org/communityhealth/obesity/files/obesity-prevention-toolikit.pdf.
88. Carney PA, Hamada JL, Rdesinski R, et al. Impact of a community gardening project on vegetable intake, food security and family relationships: a community-based participatory research study. J Community Health. 2012;37(4):874–81.
89. Ries AV, Blackman LT, Page RA, et al. Goal setting for health behavior change: evidence from an obesity intervention for rural low-income women. Rural Remote Health. 2014;14:2682.
90. Cohen JF, Kraak VI, Choumenkovitch SF, et al. The CHANGE study: a healthy-lifestyles intervention to improve rural children's diet quality. J Acad Nutr Diet. 2014;114(1):48–53.
91. Cohen JF, Rimm EB, Austin SB, et al. A food service intervention improves whole grain access at lunch in rural elementary schools. J Sch Health. 2014;84(3):212–9.
92. Smith LH, Holloman C. Piloting 'Sodabriety': A School-Based Intervention to Impact Sugar-Sweetened Beverage Consumption in Rural Appalachian High Schools. J Sch Health. 2014;84(3): 177–84.