

High Food Insecurity and Its Correlates Among Families Living on a Rural American Indian Reservation

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Food insecurity is defined as the state of either having limited or uncertain access to food that is nutritionally adequate, culturally acceptable, and safe or having an uncertain ability to acquire acceptable foods in socially acceptable ways.¹ Food insecurity harms children's physical, social, and emotional health. Compared with food-secure children, children who experience food insecurity are less likely to have a diet that meets recommended guidelines for nutrition²⁻⁴; are more likely to experience chronic illnesses, acute illness,^{5,6} psychosocial problems, and psychiatric distress^{5,7-9}; and are more likely to have lower academic performance.¹⁰ There is some evidence to suggest that food insecurity contributes to overeating and obesity,¹¹⁻¹³ although several studies of preschool- and grade school-aged children have not observed associations between food insecurity and weight status.^{2,12,14,15} The roots of food insecurity for a family often lie in economic factors, such as having insufficient income, limited wealth, excessive debt, and high living expenses. However, psychosocial factors, including maternal mental and physical health status, domestic violence, parental cooking and financial skills, parental education level, and familial social networks, also play roles in food insecurity.^{7,16} Additionally, lack of access to food in their community increases families' likelihood of being food insecure.¹⁶ Nationwide in 2009, 21.3% of US households with children experienced food insecurity during the previous year.¹⁷

Since the middle of the twentieth century, substantial changes have occurred in the availability of and access to healthful food on American Indian reservations.^{18,19} Although, traditionally, American Indian populations used the land they lived on for hunting and growing food, and therefore consumed a plant-based diet supplemented with fish or low-fat meat, today this is no longer the case.²⁰ American Indians living on reservations often

Objectives. We sought to better understand the prevalence and consequences of food insecurity among American Indian families with young children.

Methods. Parents or caregivers of kindergarten-age children enrolled in the Bright Start study (dyad $n = 432$) living on the Pine Ridge Reservation in South Dakota completed a questionnaire on their child's dietary intake, the home food environment, and food security. We assessed food security with a standard 6-item scale and examined associations of food insecurity with family sociodemographic characteristics, parents' and children's weight, children's dietary patterns, and the home food environment.

Results. Almost 40% of families reported experiencing food insecurity. Children from food-insecure households were more likely to eat some less healthful types of foods, including items purchased at convenience stores ($P = .002$), and food-insecure parents reported experiencing many barriers to accessing healthful food. Food security status was not associated with differences in home food availability or children's or parents' weight status.

Conclusions. Food insecurity is prevalent among families living on the Pine Ridge Reservation. Increasing reservation access to food that is high quality, reasonably priced, and healthful should be a public health goal. (*Am J Public Health*. 2012;102:1346-1352. doi:10.2105/AJPH.2011.300522)

rely on food-commodity and nutrition assistance programs^{21,22} and frequently purchase food from fast-food outlets and small grocery or convenience stores, which typically have a limited availability of high-quality produce and low-fat foods.¹⁹

Given the high rates of poverty²³ on American Indian reservations and poor food access on rural reservations, food insecurity and its health impacts among American Indian families living on or near reservations are of great concern.^{24,25} Using data from the 2001-2004 Current Population Survey, Gundersen examined food insecurity among American Indians living on and those living off reservations and found that during this period 28% of American Indian households with children experienced food insecurity, compared with 16% of non-American Indian households with children.²⁴ This disparity remained even after adjusting for education, income, marital status, and age, suggesting that American Indians had additional specific risk factors for food insecurity.

Furthermore, American Indians living in non-metropolitan areas were more likely to be food insecure than were those living in metropolitan areas—although identifying those individuals specifically residing on or near reservations was not possible with this data set.

Small, reservation-specific studies have examined food insecurity among selected groups of American Indians living on reservations, such as young adults, and have similarly observed that food insecurity is a prevalent and significant problem for these subpopulations.²⁶⁻²⁸

Although it is clear that a sizable proportion of American Indians experience food insecurity, the correlates and consequences of food insecurity among American Indian families of young children living on or near reservations are not well understood. To address this need, we examined the prevalence and correlates of food insecurity among Lakota children and their families living on the Pine Ridge Reservation in South Dakota.

METHODS

We drew data for this study from the baseline survey of Bright Start, a group-randomized controlled school-based trial to reduce excess weight gain among Lakota children residing on or near the Pine Ridge Reservation in South Dakota. We recruited all 14 schools on the reservation (including 1 with 80% American Indian enrollment just outside the border) into the study. We distributed letters of consent to the parents or caregivers (henceforth referred to as parents) of all kindergarten students, inviting them and their child to have their height and weight measured and for the parents to complete a survey. We enrolled 2 cohorts of kindergarten students in the study and collected baseline data in fall 2005 and fall 2006, before randomizing schools to intervention and control conditions. Measurements were voluntary, and all enrolled students were eligible to participate. There were no exclusion criteria, and we allowed children who did not participate in measurements to participate in the intervention activities if parents agreed. Among the 472 kindergarten students attending all 14 schools, parental consent was obtained for 99% of the children, and 97% of children with parental consent agreed to participate in the study; therefore, 454 children (96% of the total eligible) had baseline measurements. Among these 454 children, 432 (95%) parents completed a parent survey and therefore were included in this study. On the basis of parent report and school records, 99.3% of children were of American Indian heritage, with almost all children from the Oglala Sioux Tribe (Lakota people).

Study Measures

Food security. We assessed food security with the 6-item short form of the Household Food Security Scale.²⁹ This scale has been shown to be valid when compared with the full 18-item scale included in the Current Population Survey.³⁰ The 6 items assessed families' ability to obtain food and the behaviors they engaged in to conserve food over the previous 12 months. Parents were excluded from analyses if they had missing data for any of the 6 items ($n = 11$). We categorized parents who responded in the affirmative to fewer than 2 items as experiencing "food security," those that responded

in the affirmative to 2 to 4 items as experiencing "low food security," and those that responded in the affirmative to 5 or more items as experiencing "very low food security."²⁹

Sociodemographic characteristics. Parents answered questions regarding their highest level of education attained; current marital status; total household income in the past year including wages, salaries, social security, public assistance, unemployment compensation, and child support; personal relationship with the kindergarten child enrolled in Bright Start; current work situation; and whether anyone in their household currently received food stamps (now known as the Supplemental Nutrition Assistance Program) or commodity foods (via the Food Distribution on Indian Reservations program) or were enrolled in the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) program.

Ti ole. *Ti ole* is a Lakota tradition to address hunger among families within the community. The phrase can be translated as "looking for a home." The practice involves either going to another home where there is enough food to share a meal or inviting another family who may not have enough food over for a meal. The food received is often exchanged for help around the house, such as construction work. We asked parents a single survey item with dichotomous (yes or no) response options regarding whether in the past 12 months their family had ever gone *ti ole* when there was not enough food.

Children's body mass index. A team of trained, local American Indian research staff traveling to each school took anthropometric measurements. J. H. H. trained team members in anthropometric measurements using the protocols that Lohman et al. developed.³¹ We measured height to the nearest 0.1 centimeter using a portable stadiometer (Perspective Enterprises, Portage, MI). We measured weight using Tanita scales (model TBF-300) to the nearest 0.1 kilogram. We calculated age- and gender-specific body mass index (BMI; defined as weight in kilograms divided by the square of height in meters) percentiles,³² and we categorized children whose BMI was less than the 85th percentile as normal weight, those whose BMI was equal to the 85th percentile to less than the 95th percentile as overweight, and those whose BMI was equal to or greater than the 95th percentile as obese.³³

Parents' BMI. The trained research staff measured parents' body weight (kg) and height (cm) using standardized measurement protocols.³¹ We categorized parents with BMI less than 25 as normal weight, those with a BMI between 25 and 30 as overweight, and those with a BMI of 30 or greater as obese.³⁴ We did not obtain measured height and weight for 17% of parents in the current sample ($n = 72$). For these parents, we imputed BMI using the parents' self-reported height and weight collected at baseline, self-reported height and weight collected during the follow-up measurement period, or measured BMI collected during the follow-up data measurement period.

Children's dietary intake. Parents reported the frequency of their child's consumption of specific foods and beverages over the past month. Response categories included never, 1 to 3 times last month, 1 to 2 times a week, 3 to 4 times a week, 5 to 6 times a week, once a day, and more than once a day. Types of foods included fruits, vegetables, whole or 2% milk, nonfat or 1% milk, 100% fruit juice, and calorically dense savory foods, including pizza, fry bread, and fried chicken. We also asked parents the frequency with which their child consumed "food from a fast-food restaurant" and "hot or ready-made food from a convenience store or gas station" over the past month. This measure of dietary intake was used in the Girls' Health Enrichment Multi-Site Studies trial.³⁵ For foods that are commonly consumed on a daily basis (e.g., fruit, vegetables, milk), we recoded the response options to reflect daily intake with never = 0, 1 to 3 times last month = 0.1, 1 to 2 times a week = 0.2, 3 to 4 times a week = 0.5, 5 to 6 times a week = 0.8, once a day = 1, and more than once a day = 2. For foods that are commonly consumed less than daily (e.g., pizza, fast food, hot or ready-made food from a convenience store or gas station), we recoded the response options to reflect weekly intake with never = 0, 1 to 3 times last month = 0.5, 1 to 2 times a week = 1.5, 3 to 4 times a week = 3.5, 5 to 6 times a week = 5.5, once a day = 7, and more than once a day = 9. We calculated total daily intake of sugar-sweetened beverages by summing the intake of fruit drinks, energy drinks, sports drinks, Kool-Aid, and regular soft drinks, and total intake of sweet and salty

snacks by summing intake of cake, potato chips, pretzels, ice cream, donuts, and candy.

Home food availability. We assessed home food availability with a series of yes or no questions asking parents to report whether specific types of fruits, vegetables, beverages, snacks, and energy-dense foods were available in their home during the past week. We adapted this item from the measure of home food availability that Patterson et al. developed³⁶ and that was used in the Girls' Health Enrichment Multi-Site Studies trial.³⁵ The measure has been shown to validly assess home food availability when compared with individuals' dietary intake, nutrition awareness, and nutrition-related stage of change.³⁶ We modified foods assessed by the home food availability inventory on the basis of pilot testing the instrument. Trained research staff, who were members of the tribe, conducted individual semistructured interviews with 36 parents or caregivers to assess factors such as the appropriateness of types of foods listed, response options, and length of time to complete the inventory.

Family food practices. Parents reported the frequency of family dinners per week and family fast-food visits per week. Response options for these questions ranged from never to 7 or more times a week. We assessed food shopping with the question, "How often do you (or someone in your household) make a major food shopping trip?" Response options ranged from more than once a week to less than once a month, and we recoded these to reflect shopping trips per week.

Barriers to healthful food in the home. We asked parents the extent to which they agreed or disagreed with 8 statements of barriers to serving healthful food to their families on a 4-point Likert scale. These items included, "I don't buy many fruits because my family doesn't like them" and "I don't buy many vegetables because they cost too much." We combined items that assessed barriers for fruits and vegetables separately.

Statistical Analysis

We used the χ^2 test to examine associations between the 3 levels of food security and sociodemographic characteristics represented categorically. To examine associations between food security status and children's daily or

weekly intake of specific foods, we square-root-transformed the dietary intake variables to approximate a Gaussian distribution. We then developed hierarchical linear regression models including food security status as the independent variable and children's daily or weekly intake of foods represented continuously as the dependent variable. To account for potential clustering of behaviors among children who attended schools together, we included a school-level variable in the regression models as a random effect. We calculated adjusted daily or weekly mean intake of specific foods by level of food security and back-transformed them to obtain the geometrical mean. If the overall F-statistic was significant, we used an adjusted Tukey test to highlight sources of differences between the adjusted means. We developed similar regression models to examine associations between food security and nontransformed, continuous measures of home food availability, family food practices, and barriers to healthful food in the home.

RESULTS

Approximately 40% of parents reported that their households had experienced food insecurity within the past 12 months. About a third of these 124 families (10.5% of all families) experienced very low food security. Food insecurity was more prevalent among families with a lower total household income and those with the parent not currently employed for pay. We found significant differences in the percentage of families receiving food stamps ($P = .002$) and having gone *ti ole* ($P < .001$) by families' food security status. We did not observe significant differences in either children's or parents' weight status by food security status (Table 1).

We observed few differences in children's dietary intake by food security status. Children whose families experienced very low food security consumed hot food or ready-made food from a convenience store or gas station more than twice as often as did children whose families experienced food security ($P = .002$), and food-insecure children consumed pizza and fried chicken more often than did food-secure children (Table 2). We did not observe any differences in families' home food availability or frequency of families' fast-food visits,

family meals, or food shopping trips by food security status (Table 3).

Parents' experience of barriers to having healthful food in the home differed by food security status. Food-insecure parents were most likely to agree that there was little variety of fruit and vegetables where they buy groceries ($P = .003$) and were more likely to report that where they buy groceries the fruit and vegetables were in poor condition ($P = .03$). Food-insecure parents were also more likely to report that their family does not like fruits and vegetables ($P = .01$) and that it is difficult to find time to cook in the evening ($P = .01$; Table 3).

DISCUSSION

We have extended the results of previous research by demonstrating a high prevalence of food insecurity among American Indians and identifying correlates and potential determinants and consequences of food insecurity such as convenience store use, parents' perceptions of barriers to healthful eating, and participation in *ti ole*. As previously observed among American Indian populations, both those living on and those living off reservations, food insecurity was common. The prevalence of food insecurity (39.9%) was nearly twice as high as that of households with children nationally.¹⁷

We observed few differences in children's dietary intake by food security status. However, children from food-insecure households consumed hot or ready-made foods from convenience stores or gas stations more often than did food-secure children. The differences observed in children's intake of pizza and fried chicken by food security status likely reflect the ready-made foods that children and families purchase from these establishments. Similar positive associations between food insecurity and intake of fried and high-fat foods, and specifically fried chicken, were seen in a study of Mexican-born children of migrant workers in California.³⁷ On the Pine Ridge Reservation, as in many rural areas,^{38,39} convenience stores and gas stations are common and provide fast and inexpensive, although rarely nutritionally adequate, meals for families. Food-insecure families may be particularly reliant on food from convenience stores because

TABLE 1—Sociodemographic Characteristics and Weight Status of Bright Start Families by Household Food Security Status: Lakota People, Pine Ridge Reservation, South Dakota, 2005–2006

Characteristic	% (No.) ^a	Food Security, ^b %	Low Food Security, ^c %	Very Low Food Security, ^d %	P (χ^2)
Parent's educational attainment					.09
< high school	23.3 (98)	58.2	28.6	13.3	
Completed high school	22.6 (95)	63.2	29.5	7.4	
Some college or technical school	35.0 (147)	55.1	29.9	15.0	
Completed college or graduate school	19.1 (80)	67.5	30.0	2.5	
Parent's relationship status					.33
Single or never married	30.6 (128)	59.4	30.5	10.2	
Married	28.4 (119)	64.7	26.9	8.4	
Living in marriage-like relationship	20.3 (85)	65.9	25.9	8.2	
Separated, divorced, or widowed	20.8 (87)	49.4	35.6	14.9	
Total household income, \$					< .001
< 15 000	49.5 (203)	51.2	32.5	16.3	
15 000–34 999	32.2 (132)	65.2	29.6	5.3	
≥ 35 000	18.3 (75)	74.7	21.3	4.0	
Parent's relationship to child					.09
Biological or stepmother	67.8 (284)	63.0	27.5	9.5	
Biological or stepfather	8.8 (37)	67.6	24.3	8.1	
Other	23.4 (98)	48.0	37.8	14.3	
Parent's employment status					.05
Not currently employed for pay	48.1 (202)	54.0	32.7	13.4	
Employed part time	9.3 (39)	76.9	20.5	2.6	
Employed full time	42.6 (179)	63.1	28.0	8.9	
Child's weight status					.4
Normal weight	69.8 (289)	58.8	31.8	9.3	
Overweight	14.7 (61)	63.9	23.0	13.1	
Obese	15.5 (64)	62.5	23.4	14.1	
Parent's weight status					.81
Normal weight	13.8 (58)	60.3	31.0	8.6	
Overweight	24.8 (104)	56.7	33.7	9.6	
Obese	61.3 (257)	61.1	27.6	11.3	
Food support in household, %					
Receive food stamps	63.0 (249)	57.0	67.8	83.3	.002
Receive commodities	37.0 (127)	34.1	39.8	50.0	.31
Receive WIC	43.7 (162)	42.9	43.9	47.4	.88
Those having gone <i>ti oke</i> , %	8.7 (36)	1.2	13.2	38.1	< .001

Note. WIC = Special Supplemental Nutrition Program for Women, Infants, and Children.

^aNo. may vary within descriptive characteristics because of nonresponse.

^bTotal % (no.) = 60.1 (253).

^cTotal % (no.) = 29.5 (124).

^dTotal % (no.) = 10.5 (44).

of the inability to travel to larger grocery stores, which are farther away, or to budget and plan for less frequent shopping trips. American Indian parents may also be more likely to feed their children high-fat, calorically dense foods because

of their communities' histories of food scarcity and the desire to have heavier children who can withstand illness and leaner times.^{20,37,40,41}

Among the Lakota Indians participating in Bright Start, food-insecure families were more

likely to be receiving Supplemental Nutrition Assistance Program benefits than were food-secure families, and a higher proportion of food-insecure families received assistance through the Food Distribution Program on Indian Reservations and WIC programs, although the differences across level of food security were not statistically significant. The high enrollment in these programs of food-insecure American Indian families suggests that improvements to the quantity and quality of food offered through these programs, as well as the complementary nutrition education components, may be important mechanisms through which to improve the food security and dietary intake patterns of participating families. Specifically, a focus on helping parents reduce their children's consumption of unhealthy choices frequently available at convenience stores, as well as increasing menu planning and food budgeting skills, may be particularly beneficial. Additionally, although federal food assistance programs are making progress in the promotion of healthful foods,⁴² the majority of food retailers on reservations are convenience stores that do not consistently stock fresh produce, whole grain products, or low and nonfat dairy products. To address this need, policies that encourage larger grocery stores that have the purchasing power to provide lower cost fresh foods to open on or near rural reservations and enable the proprietors of small grocery and convenience stores to stock healthful food in an economically viable manner would help Supplemental Nutrition Assistance Program and WIC participants to make the best use of the nutrition assistance services they receive.

In this study, food insecurity was consistently associated with parents' perceptions of barriers to obtaining healthful food for their families. Several of these barriers are likely a reflection of families' economic limitations; however, barriers such as family members not liking fruits and vegetables and not having time to cook in the evenings have little obvious association with food access. Although in this cross-sectional study we cannot ascertain the causal mechanisms that drive these findings, the consistency with which food-insecure parents reported barriers to obtaining healthful food suggests that the accumulation of stress or experience of depression that often accompanies

TABLE 2—Parent-Reported Children’s Mean Weekly Dietary Intake by Food Security Status: Lakota People, Pine Ridge Reservation, South Dakota, 2005–2006

Food Item	Food Security	Low Food Security	Very Low Food Security	<i>P</i> _{df = 2}
Fruit, times/d	0.77	0.70	0.56	.08
Vegetables, times/d	0.95	0.86	0.81	.41
French fries or fried potatoes, times/wk	1.72	1.94	1.99	.38
Pizza, times/wk	1.12	1.32	1.68	.03
Fried chicken, times/wk	0.78	1.03	1.16	.04 ^a
Sugar-sweetened beverages, times/d	1.13	1.02	1.31	.23
Sweet and salty snacks, times/d	1.36	1.51	1.49	.45
Skim or 1% milk, times/d	0.13	0.16	0.15	.63
Whole or 2% milk, times/d	0.84	0.80	0.61	.17
Chocolate milk, times/d	0.34	0.31	0.34	.8
Fast food, times/wk	0.81	0.95	0.99	.41
Hot or ready-made foods from a convenience store or gas station, times/wk	0.64	0.96	1.30	.002

Note. Means and *P* values derived from square-root-transformed outcome variables. Means with different superscripts are statistically significantly different using Tukey-Kramer adjusted *P* < .05.

^aBecause the adjusted Tukey-Kramer test is more conservative than the overall *F* test, the post hoc comparison of means resulted in no significant differences between means.

food insecurity^{9,43,44} may contribute to a pervasive feeling that feeding one’s family healthfully is a very difficult or even unachievable

goal. These findings suggest a need for food security programs to not only increase access to food but also work with families and

communities to address the mental health concerns that may accompany a history of food insecurity and increase individuals’ self-efficacy for feeding their families healthfully.

A strength of this study is that it is among the first to examine the correlates of food insecurity among a rural reservation-residing American Indian tribe, a population that experiences high rates of poverty and is at great risk for nutrition-related chronic diseases. However, this study is not without limitations. Specifically, the measures of home food availability we used in this study assessed only whether a limited number of foods were available in the home during the past week and did not determine the quantity or quality of such foods. Future research examining food availability among food-insecure families in greater detail would benefit from using a more comprehensive measure of home food availability and assessing food availability at multiple points in time, as the quantity and quality of food in the home are likely to vary on the basis of proximity to the time when financial food support is received.^{45,46}

TABLE 3—Parent-Reported Home Food Availability, Food Practices, and Barriers to Healthful Eating by Food Security Status: Lakota People, Pine Ridge Reservation, South Dakota, 2005–2006

Variable	Range	Food Security, Mean	Low Food Security, Mean	Very Low Food Security, Mean	<i>P</i> _{df = 2}
Weekly home food availability					
Fruit	0.00–8.00	5.65	5.80	6.24	.14
Vegetables	0.00–9.00	6.49	6.29	6.23	.51
French fries or fried potatoes	0.00–1.00	0.77	0.77	0.81	.8
Sugar-sweetened beverages	0.00–5.00	2.21	2.43	2.65	.06
Salty snacks	0.00–3.00	1.42	1.52	1.46	.6
Sweet snacks	0.00–5.00	2.59	2.92	2.78	.1
Energy-dense foods (e.g., lunch meat, fried meat, ramen noodles)	1.00–9.00	5.98	6.25	6.42	.19
Family food practices/wk					
Fast-food visits	0.00–5.50	0.80	0.63	0.61	.09
Family meals	0.00–7.50	6.20	5.95	5.92	.43
Food shopping trips	0.15–2.00	0.59	0.56	0.45	.13
Barriers to healthful food in the home ^a					
Little variety of fruit and vegetables		2.95	2.70	2.56	.003
Poor condition of fruit and vegetables		3.07	2.99	2.76	.03
Family doesn’t like fruit and vegetables		3.28	3.14	3.03	.01
Fruit and vegetables cost too much		3.24	3.00	2.76	< .001
Difficult to find time to cook in the evening		3.21	2.99	2.91	.01
Not easy to buy food near where I live		2.69	2.45	2.26	.003

Note. Means are statistically significantly different using Tukey-Kramer adjusted *P* < .05.

^astrongly agree = 1; strongly disagree = 4.

Factors at multiple socioecological levels affect families' experience of food insecurity, from individuals' health status and food preparation skills to governmental policies. Specifically among the Lakota people residing on the Pine Ridge Reservation, community- and family-based efforts such as shared gardens, organized transportation to high-quality supermarkets, home economics classes for adults and children that teach skills to create simple and healthful meals, and cooking and canning collectives may increase access to and knowledge about healthful food while building social networks and social capital in communities, which can buffer the harmful effect that poverty, unemployment, and discrimination have on health.^{47,48} As the Lakota people specifically have a cultural foundation for sharing food and ensuring that others are fed, community-driven efforts built on the *ti ole* tradition may be particularly successful. ■

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Contributors

K. W. Bauer conducted the statistical analysis and wrote the article. J. H. Himes, M. Smyth, B. Holy Rock, P. J. Hannan, and M. Story were responsible for the development, implementation, and evaluation of the Bright Start intervention. All authors contributed to the conceptualization of the study and provided significant editing of the article.

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Human Participant Protection

The University of Minnesota's institutional review board Human Subjects Committee and the Oglala Sioux Tribal

Council and Aberdeen Indian Health Service Area institutional review boards approved all study procedures.

References

- Core indicators of nutritional state for difficult-to-sample populations. *J Nutr*. 1990;120(suppl 11):1559-1600.
- Kaiser LL, Melgar-Quinonez HR, Lamp CL, Johns MC, Sutherland JM, Harwood JO. Food security and nutritional outcomes of preschool-age Mexican-American children. *J Am Diet Assoc*. 2002;102(7):924-929.
- Melgar-Quinonez HR, Kaiser LL. Relationship of child-feeding practices to overweight in low-income Mexican-American preschool-aged children. *J Am Diet Assoc*. 2004;104(7):1110-1119.
- Widome R, Neumark-Sztainer D, Hannan PJ, Haines J, Story M. Eating when there is not enough to eat: eating behaviors and perceptions of food among food-insecure youths. *Am J Public Health*. 2009;99(5):822-828.
- Weinreb L, Wehler C, Perloff J, et al. Hunger: its impact on children's health and mental health. *Pediatrics*. 2002;110(4):e41.
- Alaimo K, Olson CM, Frongillo EA Jr. Food insufficiency and American school-aged children's cognitive, academic, and psychosocial development. *Pediatrics*. 2001;108(1):44-53.
- Melchior M, Caspi A, Howard LM, et al. Mental health context of food insecurity: a representative cohort of families with young children. *Pediatrics*. 2009;124(4):e564-e572.
- Belsky DW, Moffitt TE, Arseneault L, Melchior M, Caspi A. Context and sequelae of food insecurity in children's development. *Am J Epidemiol*. 2010;172(7):809-818.
- Whitaker RC, Phillips SM, Orzol SM. Food insecurity and the risks of depression and anxiety in mothers and behavior problems in their preschool-aged children. *Pediatrics*. 2006;118(3):e859-e868.
- Jyoti DF, Frongillo EA, Jones SJ. Food insecurity affects school children's academic performance, weight gain, and social skills. *J Nutr*. 2005;135(12):2831-2839.
- Dietz WH. Does hunger cause obesity? *Pediatrics*. 1995;95(5):766-767.
- Jiménez-Cruz A, Bacardi-Gascon M, Spindler AA. Obesity and hunger among Mexican-Indian migrant children on the US-Mexico border. *Int J Obes Relat Metab Disord*. 2003;27(6):740-747.
- Metallinos-Katsaras E, Sherry B, Kallio J. Food insecurity is associated with overweight in children younger than 5 years of age. *J Am Diet Assoc*. 2009;109(10):1790-1794.
- Rose D, Bodor JN. Household food insecurity and overweight status in young school children: results from the Early Childhood Longitudinal Study. *Pediatrics*. 2006;117(2):464-473.
- Bhargava A, Jolliffe D, Howard LL. Socio-economic, behavioural and environmental factors predicted body weights and household food insecurity scores in the Early Childhood Longitudinal Study-kindergarten. *Br J Nutr*. 2008;100(2):438-444.
- Gorton D, Bullen CR, Mhurchu CN. Environmental influences on food security in high-income countries. *Nutr Rev*. 2010;68(1):1-29.
- Nord M, Coleman-Jensen A, Andrews M, Carlson S. *Household Food Security in the United States, 2009*. Washington, DC: US Department of Agriculture; November 2010. Economic Research Report no. 108.
- Story M, Strauss KF, Zephier E, Broussard BA. Nutritional concerns in American Indian and Alaska Native children: transitions and future directions. *J Am Diet Assoc*. 1998;98(2):170-176.
- Styne DM. Childhood obesity in American Indians. *J Public Health Manag Pract*. 2010;16(5):381-387.
- Companion M. *An Overview of the State of Native American Health: Challenges and Opportunities*. Washington, DC: International Relief and Development; April 2008. Available at: <http://www.ird-dc.org/who/PDFs/Companion%20-%20Indian%20Health%20Report.pdf>. Accessed January 3, 2011.
- Dillinger TL, Jett SC, Macri MJ, Grivetti LE. Feast or famine? Supplemental food programs and their impacts on two American Indian communities in California. *Int J Food Sci Nutr*. 1999;50(3):173-187.
- Finegold K, Pindus N, Wherry L, Nelson S, Triplett T, Capps R. *Background Report on the Use and Impact of Food Assistance Programs on Indian Reservations*. Washington, DC: US Department of Agriculture, Economics Research Service; June 2005. Available at: www.urban.org/uploadedpdf/411133_food_assistance.pdf. Accessed January 3, 2011.
- Bishaw A, Semega J. *US Census Bureau, Income, Earnings, and Poverty Data From the 2007 American Community Survey*. Washington, DC: Government Printing Office; August 2008. American Community Survey Reports ACS-09.
- Gundersen C. Measuring the extent, depth, and severity of food insecurity: an application to American Indians in the USA. *J Popul Econ*. 2008;21(1):191-215.
- White L, Stauss JJ, Nelson CE. Healthy families on American Indian reservations: a summary of six years of research by tribal college faculty, staff, and students. *Am Indian Cult Res J*. 2006;30(4):99-114.
- Davis J, Hiwalker R, Ward C, Dahlin E. *How Have Welfare Reforms Affected Access to Food Assistance Programs Among Two High Needs Groups at Northern Cheyenne: Young Families and Families Depending on Seasonal Employment?* Tucson, AZ: Native Peoples Technical Assistance Office; 2002.
- Henry LR, Bear-Little Boy R, Dodge B. *A Summary of Findings of Assessment of Food Concerns, Nutrition Knowledge and Food Security of Oglala Lakota College Students on the Pine Ridge Reservation*. Tucson, AZ: Native Peoples Technical Assistance Office; 2000.
- McCloskey J, Chee M. *An Ethnographic Study of the Factors Affecting the Nutritional Patterns of Navajo Women and Their Children in the WIC Program*. Tucson, AZ: Native Peoples Technical Assistance Office; 2006.
- US Department of Agriculture, Economic Research Services. *Food Security in the United States: Household Survey Tools*. Washington, DC; 2006.
- Blumberg SJ, Bialostosky K, Hamilton WL, Briefel RR. The effectiveness of a short form of the Household Food Security Scale. *Am J Public Health*. 1999;89(8):1231-1234.
- Lohman TG, Roche AF, Martorelli R. *Anthropometric Standardization Reference Manual*. Champaign, IL: Human Kinetics Books; 1998.

32. Kuczmarski RJ, Ogden CL, Guo SS, et al. 2000 CDC growth charts for the United States: methods and development. *Vital Health Stat 11*. 2002;(246):1–190.
33. Barlow SE. Expert committee recommendations regarding the prevention, assessment, and treatment of child and adolescent overweight and obesity: summary report. *Pediatrics*. 2007;120(suppl 4):S164–S192.
34. Flegal KM, Carroll MD, Ogden CL, Curtin LR. Prevalence and trends in obesity among US adults, 1999–2008. *JAMA*. 2010;303(3):235–241.
35. Story M, Sherwood NE, Himes JH, et al. An after-school obesity prevention program for African-American girls: the Minnesota GEMS pilot study. *Ethn Dis*. 2003; 13(1, suppl. 1):S54–S64.
36. Patterson RE, Kristal AR, Shannon J, Hunt JR, White E. Using a brief household food inventory as an environmental indicator of individual dietary practices. *Am J Public Health*. 1997;87(2):272–275.
37. Rosas LG, Harley K, Fernald LC, et al. Dietary associations of household food insecurity among children of Mexican descent: results of a binational study. *J Am Diet Assoc*. 2009;109(12):2001–2009.
38. Liese AD, Weis KE, Pluto D, Smith E, Lawson A. Food store types, availability, and cost of foods in a rural environment. *J Am Diet Assoc*. 2007;107(11):1916–1923.
39. Adams AK, Harvey H, Brown D. Constructs of health and environment inform child obesity prevention in American Indian communities. *Obesity (Silver Spring)*. 2008;16(2):311–317.
40. Kaufman L, Karpati A. Understanding the sociocultural roots of childhood obesity: food practices among Latino families of Bushwick, Brooklyn. *Soc Sci Med*. 2007;64(11):2177–2188.
41. Adams AK, Quinn RA, Prince RJ. Low recognition of childhood overweight and disease risk among Native-American caregivers. *Obes Res*. 2005;13(1):146–152.
42. Oliveira V, Frazao E. *The WIC Program: Background, Trends, and Economic Issues*. Washington, DC: US Department of Agriculture; 2009.
43. Siefert K, Heflin CM, Corcoran ME, Williams DR. Food insufficiency and the physical and mental health of low-income women. *Women Health*. 2001;32 (1–2):159–177.
44. Heflin CM, Siefert K, Williams DR. Food insufficiency and women's mental health: findings from a 3-year panel of welfare recipients. *Soc Sci Med*. 2005;61(9):1971–1982.
45. Dinour LM, Bergen D, Yeh MC. The food insecurity–obesity paradox: a review of the literature and the role food stamps may play. *J Am Diet Assoc*. 2007;107 (11):1952–1961.
46. Sharkey JR, Dean WR, St John JA, Huber JC Jr. Using direct observations on multiple occasions to measure household food availability among low-income Mexicano residents in Texas colonias. *BMC Public Health*. 2010;10:445.
47. Vega WA, Ang A, Rodriguez MA, Finch BK. Neighborhood protective effects on depression in Latinos. *Am J Community Psychol*. 2011;47(1–2):114–126.
48. Romans S, Cohen M, Forte T. Rates of depression and anxiety in urban and rural Canada. *Soc Psychiatry Psychiatr Epidemiol*. 2011;46(7):567–575.