The Journal of Nutrition
Nutrition and Disease

Child Experience of Food Insecurity Is Associated with Child Diet and Physical Activity[1,2]

Maryah Stella Fram,[3]* Lorrene D Ritchie,[5,6] Nila Rosen,[5] and Edward A Frongillo[4]

[3]College of Social Work and [4]Arnold School of Public Health, University of South Carolina, Columbia, SC; [5]Atkins Center for Weight and Health, University of California, Berkeley, CA; and [6]Nutrition Policy Institute, University of California, Division of Agriculture and Natural Resources, Oakland, CA

Abstract

Background: Food insecurity is associated with deficits in child development and health, but little is known about how children's specific food-insecurity experiences play out through nutritional and non-nutritional pathways that may compromise well-being.

Objective: This study used child self-reports of food insecurity to examine the types of food-insecurity experiences that were most prevalent and the relations between child food insecurity (CFI), child diet, and child physical activity (PA).

Methods: A total of 3605 fourth- and fifth-grade children whose schools participated in the Network for a Healthy California–Children's PowerPlay! campaign completed 24-h diary-assisted recalls and surveys including items from the Child Food Security Assessment and questions about PA. Data were analyzed by using regression and logistic regression models.

Results: CFI was present in 60% of the children and included experiences of cognitive, emotional, and physical awareness of food insecurity. Greater levels of CFI were associated with higher consumption of energy, fat, sugar, and fiber and a diet lower in vegetables. For instance, a child at the highest level of CFI, on average, consumed ~494 kJ/d (118 kcal), 8 g/d of sugar, and 4 g/d of fat more than a food-secure child. Higher CFI was associated with a marginally significant difference ($P = 0.06$) in minutes of PA (17 min/d less for children at the highest level of CFI vs. those who were food secure) and with significantly greater perceived barriers to PA.

Conclusions: CFI is a troublingly frequent, multidomain experience that influences children's well-being through both nutritional (dietary) and non-nutritional (e.g., PA) pathways. CFI may lead to poor-quality diet and less PA and their developmental consequences. Practitioners should consider CFI when assessing child health and well-being and can do so by asking children directly about their CFI experiences. *J Nutr* 2015;145:499–504.

Keywords: child food insecurity, hunger, child diet, child physical activity, child health

Introduction

Household food insecurity is prevalent even in high-income countries (1) and is associated with deficits in child educational, socioemotional, behavioral, and physical health outcomes (2–5). Some research also indicates that children who experience food insecurity are more likely to become overweight or obese (6–8), suggesting connections between food insecurity and proximal causes of weight gain such as increased energy intake and reduced physical activity (PA)[7]. Thus far, empirical evidence linking food insecurity to child dietary quality has been mixed (9–11), and there is a dearth of empirical evidence linking food insecurity to PA (12).

This gap in knowledge results in part from limited data on children's experiences of child food insecurity (CFI). Food insecurity has been conceptualized as a household-level situation that is managed by adults; a household is categorized for food security on the basis of parental reports, including reports of whether children experience cutbacks in food quality or quantity. This approach is limiting in 2 main ways. First, it assumes

[1] Supported by a grant from the Southern Rural Development Center and the Economic Research Service, through the USDA's RIDGE program. The original funding source was the USDA Supplemental Nutrition Assistance Program Education (SNAP-Ed) through a contract with the California Department of Public Health's Network for a Healthy California administered by the Public Health Institute in collaboration with the Atkins Center for Weight and Health.
[2] Author disclosures: MS Fram, LD Ritchie, N Rosen, and EA Frongillo, no conflicts of interest.
* To whom correspondence should be addressed. E-mail: fram@mailbox.sc.edu.

[7] Abbreviations used: CFI, child food insecurity; CFSA, Child Food Security Assessment; HEI, Healthy Eating Index; PA, physical activity.

Manuscript received March 28, 2014. Initial review completed May 10, 2014. Revision accepted December 9, 2014.
First published online January 7, 2015; doi:10.3945/jn.114.194365.

that parents have complete knowledge about children's food security experiences. Second, it focuses narrowly on children's experiences in terms of food quantity and quality, not attending to the psychosocial domains of food insecurity that may impinge on child development through non-nutritional pathways. Recent research finds that children experience food insecurity more frequently than their parents know (13–15) and in ways that extend beyond compromised food quality and quantity. Children experience awareness of food insecurity, including physical (hunger, discomfort, tiredness), emotional (worry, sadness, anger), and cognitive (knowing that food is running low, vigilance) awareness. Children also may take responsibility for household food management, including participation in adult strategies (helping to choose cheap foods, complying with adult requests to save food for later), initiation of child strategies (cutting back portions, asking siblings to eat less), and generation of resources to augment the household food supply (contributing money from odd jobs, bringing food home from school or a friend's house) (13, 15).

A new child-centered, multidomain understanding of CFI aligns conceptually with the diverse developmental consequences documented among children who have experienced food insecurity. Both food insecurity (7, 16) and a lack of PA (17, 18) are associated with higher BMI, both food insecurity (7, 19) and psychological strain (20, 21) are associated with worse educational outcomes, and both food insecurity (22, 23) and stress (24, 25) are associated with greater consumption of energy-dense foods. A multidomain understanding of CFI raises the possibility that these associations are interconnected. For instance, a child who feels tired and worried because of food shortages may opt out of PA that would help maintain a healthy weight. A child who is worried about running out of food may struggle to focus on school work or become irritable with friends and teachers. A child who knows and worries that food often runs low may overeat energy-dense foods when they are available, anticipating future feelings of hunger and to soothe feelings of stress.

Empirical research is needed to determine children's patterns of experience of food insecurity and the pathways that link these experiences to a range of child developmental consequences. Toward that end, this study examined the patterns of food insecurity that characterize children's experiences and the association of CFI with child diet quality and PA. We used information from a newly developed and validated instrument (14) to assess CFI reported by fourth- and fifth-grade children.

Methods

We conducted a secondary analysis of data originally collected in 2012 as part of the evaluation of the Network for a Healthy California–Children's PowerPlay! campaign (26). PowerPlay! was a school-based social marketing initiative targeting ethnically diverse, low-income fourth- and fifth-grade children and their families in California, encouraging children to eat the recommended amount of fruit and vegetables and get at least 60 min of PA daily.

The sample consisted of fourth- and fifth-grade children in selected San Diego County schools. All county schools were eligible for selection if *1*) at least 50% of students qualified for free or reduced price lunch in the 2010–2011 school year (the latest year for which data were available at the time of recruitment), *2*) the school received no federally funded nutrition intervention program in the previous year, and *3*) the school had no unique characteristics (e.g., juvenile detention school) that would compromise the generalizability of findings. The final sample consisted of 44 schools with rates of eligibility for free or reduced price lunch ranging from 37% to 99% of students (median = 69%) during the 2011–2012 school year. Schools were randomly assigned to intervention (n = 22) or control (n = 22) conditions, with a total of 3605 children for whom dietary, food insecurity, PA, and demographic data were available.

Measures. Postintervention measurements were made of dietary intake and PA. Dietary intake was measured by the diary-assisted recall method, a more rigorous method than traditional dietary recalls, with a higher response rate than is typical for diaries (27). Children received in-class motivational training on how to record 24-h food intake in food diary booklets. Within 2 d of completing the diary, each child was interviewed individually by a trained and certified dietary researcher using a structured multiple-pass method to assist the child to recall details about the foods and drinks consumed and to confirm or add portion-size estimates by using two- and three-dimensional models. All children recorded dietary data for a 24-h period that included a school day rather than on a weekend.

Foods and beverages from diary-assisted recalls were coded and entered by trained dietary coders using the USDA Food and Nutrient Database for Dietary Studies (28). Distributions for selected foods and nutrients were reviewed, and extreme values were verified or corrected on individual records. Dietary variables selected for further analyses included energy intake and foods and nutrients used to score each child's diet using the Healthy Eating Index (HEI)–2005, which assesses diet quality in relation to the *Dietary Guidelines for Americans* (29). Potential HEI-2005 scores range from 0 to 100, with higher scores representing a higher quality diet. Twelve HEI subscales are also generated including the following: total vegetables, dark-green and orange vegetables and legumes, total fruit (including 100% juice), whole fruit (not including juice), total grains, whole grains, milk, meat and beans, oils, saturated fats, sodium, and calories from solid fats, alcohol, and added sugar. The HEI and its subscales are expressed as a percentage of calories or per 4187 kJ (1000 kcal). Participating children also completed a 40-min self-administered survey about their attitudes and preferences related to fruit and vegetable consumption, PA behaviors and attitudes, food-insecurity experiences (postintervention only), and demographic characteristics.

CFI was measured by using 5 items from the Child Food Security Assessment (CFSA) (14), which tapped all 3 domains of child awareness of food insecurity. Like the USDA child self-report food security module (30), the CFSA asks children to report the frequency of a number of food-insecurity experiences. Although the USDA measure is used only with children aged ≥12 y, the CFSA is validated for use with children as young as 7 y. In addition, although the USDA measure adapted language used in the related adult measure, the CFSA is derived from interviews with children and thus is based on children's experiences and their ways of thinking about and explaining those experiences. Finally, although the USDA measure asks about only food quality and quantity, the CFSA taps children's cognitive, emotional, and physical awareness of food insecurity. In each item, children reported how frequently they had experienced an aspect of food insecurity over the past school year, with response options of "never," "one or two times," and "many times" coded as 0, 1, and 2, respectively. The 5 experiences queried were as follows: not getting wanted food (cognitive awareness), worry about how hard it is for parents to get enough food (emotional awareness), worry about not having enough to eat (emotional awareness), feeling hungry (physical awareness), and getting really tired (physical awareness). Items and response options were previously validated with diverse children in the study age range (14), and comparison of item responses to child in-depth interview data indicated that the items distinguished food-insecurity experiences from potentially similar experiences such as instances of transient hunger and not being able to get a wanted food treat. CFI scores were calculated by summation overall (0–10) and by domain (0–4 for physical and emotional awareness and 0–2 for cognitive), with higher scores indicating more frequent awareness of more aspects of food insecurity.

PA was measured by 4 variables. Total minutes of PA in the past 24 h was estimated as the sum of child-reported minutes in a variety of activities on the basis of items from a modified version of the Self-Administered Physical Activity Checklist (31). Preference for PA was measured by child level of agreement or disagreement with the statement "I like being physically active," dichotomized to contrast those who

agree or strongly agree with those who are neutral, disagree, or strongly disagree. Two perceived barriers to PA were measured: tiredness ("I am too tired to do physical activities") and weight ("My weight makes it hard for me to do physical activities"). Responses to both were dichotomized to contrast children for whom the statement was always true to those for whom it was sometimes or never true.

Additional variables were used in the analysis to adjust for child age (y), gender, and intervention group (intervention, control). The child's school was also included to account for the effect on SEs of clustering from the school-based design. Because information on household income was not available, and the purpose of this analysis was a child-centered analysis of pathways linking CFI to child outcomes, household factors that are typically considered in analysis of household food insecurity (e.g., household income and nonfood expenses, cultural context) were not included.

Analytic strategies. Child experiences and patterns of experience of food insecurity were assessed by using descriptive statistics. Associations of CFI with diet and PA were examined by using mixed-effects linear and logistic regression (for dichotomous outcomes) with the Stata 12 xtmixed and xtlogit commands, respectively, with clustering (i.e., random effects) by school and controlling for child age, gender, and intervention group. Residual plots were examined to confirm assumptions of linear relations. We replicated the regression analyses accounting for clustering using a Huber-White estimator instead of random effects; the results were quite similar, so only results from the mixed-effects analysis are reported here. We used $\alpha = 0.05$ for significance, with $\alpha < 0.10$ considered evidence of marginal significance.

The evaluation study was approved by the Institutional Review Board of the Public Health Institute. Deidentified postintervention data only were used for the secondary analyses for this study, because there was no baseline measure of CFI. The Institutional Review Board of the University of South Carolina determined that the secondary analysis of the deidentified data were exempt from human subjects review.

Results

Considering an affirmative response to any CFI item as evidence of food insecurity (e.g., at least one item was experienced at least "1 or 2 times"), three-fifths (60.9%) of sample children reported experiencing food insecurity during the academic year (**Table 1**), and the average total CFI score was 2.0 (range: 0–10; IQR: 0–3; skewness = 1.2; median = 1). Looking at CFI by domain, 34.6% of children reported some experience of cognitive awareness, with 39.5% reporting physical awareness and 45.4% reporting emotional awareness of food insecurity. The most frequent pattern among children experiencing food insecurity was at least one affirmative response in all 3 domains (18.9%), and the least frequent pattern was those who reported experiencing both physical and cognitive awareness but not emotional awareness (3.7%) (**Table 2**).

CFI was associated with differences in both quantity and quality of diet in this sample (**Table 3**). Higher CFI score was associated with a higher consumption of total energy ($P = 0.02$), fat ($P = 0.05$), sugar ($P = 0.05$), and fiber ($P = 0.02$) (Table 3). On average, a child with the highest CFI score consumed about 494 kJ (118 kcal), 4 g fat, and 8 g sugar more in a day than did a child who experienced no food insecurity. A higher CFI score was also associated with a lower HEI total vegetable subscale score ($P = 0.02$), so although children with food insecurity appeared to eat more overall, their diets were less healthy in terms of energy-adjusted vegetable consumption. In additional analysis (data not shown), we examined each CFI domain separately and found that physical awareness was significantly related to increased total calories and fat and reduced vegetable consumption, whereas emotional awareness was significantly related to increased consumption of total calories and sugar. Cognitive awareness showed no independent relation to dietary outcomes.

TABLE 1 Demographic, dietary, and PA characteristics of the study sample[1]

Variable	Value
Child characteristics	
Male, %	49.7
Age, y	10.1 ± 0.8
School-level factors, %	
Free/reduced lunch eligible	71 ± 13
Intervention (vs. control)	45.3
Child dietary measures	
Energy, kJ/d	6710 ± 2870
Sugar, g/d	96.4 ± 55.7
Fat, g/d	56.6 ± 31.8
Vegetables, mL/d	173 ± 186
Fruit, mL/d	264 ± 273
Fiber, g/d	13.4 ± 8.0
HEI-2005 score	
Total scale (0–100)	56.8 ± 12.3
Total fruit (0–5)	3.0 ± 2.0
Whole fruit (0–5)	2.7 ± 2.3
Total vegetables (0–5)	2.1 ± 1.7
Dark-green and orange vegetables and legumes (0–5)	0.9 ± 1.6
Total grains (0–5)	4.7 ± 0.8
Whole grains (0–5)	1.3 ± 1.4
Milk (0–10)	7.1 ± 3.3
Meat and beans (0–10)	7.7 ± 2.9
Oils (0–10)	4.8 ± 3.7
Saturated fats (0–10)	6.3 ± 3.4
Sodium (0–10)	3.4 ± 2.8
Energy from SoFAAS (0–20)	12.9 ± 5.7
Child PA indicators	
Minutes of PA, min/past 24 h	134 ± 128
PA preference,[2] %	91.2
PA barrier,[3] %	
Tired	5.1
Weight	5.0
CFI	
Total CFI score (0–10)	2.0 ± 2.4
Emotional awareness, % with any affirmation	45.4
Cognitive awareness, % with any affirmation	34.6
Physical awareness, % with any affirmation	39.5

[1] Values are means ± SDs unless otherwise indicated, $n = 3605$. CFI, child food insecurity; HEI-2005, Healthy Eating Index–2005; PA, physical activity; SoFAAS, saturated fats, alcohol, and added sugar.
[2] Preference for PA was measured by child agreement (agree or strongly agree) with the statement "I like being physically active."
[3] Two perceived barriers to PA were measured by child endorsement ("always true") for tiredness ("I am too tired to do physical activities") and weight ("My weight makes it hard for me to do physical activities").

Higher CFI score was associated with marginally significant lower minutes of self-reported PA ($P = 0.06$), averaging ~17 min/d less PA for a child at the highest CFI score compared with a child who experienced no food insecurity (Table 3). Although a minority (~5%) of children reported feeling too tired for PA or that weight made PA difficult, each unit increase in CFI score was associated with 8% lower odds of liking PA ($P < 0.001$), 20% higher odds of always feeling too tired for PA ($P < 0.001$), and 25% higher odds of always feeling that weight makes PA hard ($P < 0.001$). On average, the ORs comparing children across the IQR of CFI score (0 compared to 3) were 0.78 (95% CI: 0.70, 0.86), 2.0 (95% CI: 1.7, 2.3), and 1.7 (95% CI: 1.4, 2.0) for liking PA, weight barrier to PA, and too tired for PA,

TABLE 2 Patterns of affirmation of Child Food Security Assessment items

Affirmation pattern	*n*	%
No domains	1409	39.1
All 3 domains	681	18.9
Emotional and physical	360	10.0
Emotional only	342	9.5
Emotional and cognitive	255	7.1
Physical only	247	6.9
Cognitive only	176	4.9
Physical and cognitive	135	3.7
Total	3605	100.0

respectively. When we assessed PA outcomes in relation to each CFI domain separately (data not shown), physical, emotional, and cognitive awareness were each significantly related to lower odds of liking PA and increased odds of feeling too tired for PA and that weight made PA difficult.

Discussion

CFI was frequent within this sample of children in high-poverty elementary schools. When children were food insecure, they were most likely to know and worry about the situation and to feel hungry or tired due to food running low, affirming items in each of the 3 domains. Although emotional awareness (e.g., worry) was the most common domain, physical awareness (e.g., hunger) was also common. This finding conflicts with the understanding, based on parent-report research, that the overwhelming majority of children are protected from hunger, even in food-insecure households in the United States (32). It also suggests that CFI tends to be a holistic, multidomain experience rather than either a narrow one (e.g., food-specific) or one that begins with only worry in the least severe situation and expands to include hunger in the most severe situations.

Consistent with our finding of a multidomain experience of food insecurity, this study's findings show that CFI is associated with both nutritional and non-nutritional consequences. Higher CFI was associated with consuming more total calories, more fat and sugar, and a diet that was lower in vegetables. These findings expand on other research showing negative child dietary consequences of household food insecurity (10) and reveal that children's, as well as parents', experiences of the food environment are important contexts for child diet. Moreover, although some significant differences may not be clinically important (e.g., a difference of 0.03 HEI points for each point in CFI), some dietary differences are likely important. If a child at the highest level of CFI consumes, on average, 494 kJ (118 kcal) more per day than a child with no food insecurity, as this study suggests, this is a substantive difference given that a reduction of 553 kJ/d (132 kcal/d) has been estimated as the amount needed to reverse

TABLE 3 Association of CFI total score (0–10) with child diet and physical activity[1]

Outcome	β or OR (95% CI)[2]	*P*
Diet		
Energy, kJ/d	49.61 (9.80, 89.43)	0.02
Sugar, g/d	0.79 (0.0098, 1.57)	0.05
Fat, g/d	0.45 (0.013, 0.89)	0.04
Vegetables, mL/d	−1.52 (−4.11, 1.08)	0.25
Fruit, mL/d	1.36 (−2.44, 5.16)	0.48
Fiber, g/d	0.13 (0.023, 0.24)	0.02
HEI-2005 score		
Total scale (0–100)	−0.0025 (−0.17, 0.17)	0.97
Total fruit (0–5)	0.0030 (−0.025, 0.031)	0.83
Whole fruit (0–5)	0.014 (−0.017, 0.045)	0.40
Total vegetables (0–5)	−0.027 (−0.050, −0.0036)	0.02
Dark-green and orange vegetables and legumes (0–5)	−0.0043 (−0.027, 0.018)	0.71
Total grains (0–5)	0.0020 (−0.0084, 0.012)	0.71
Whole grains (0–5)	−0.0053 (−0.025, 0.014)	0.60
Milk (0–10)	0.038 (−0.0071, 0.084)	0.10
Meat and beans (0–10)	−0.0014 (−0.042, 0.040)	0.95
Oils (0–10)	−0.0071 (−0.058, 0.044)	0.78
Saturated fats (0–10)	0.0037 (−0.043, 0.050)	0.88
Sodium (0–10)	0.0049 (−0.034, 0.044)	0.81
Energy from SoFAAS (0–20)	−0.024 (−0.10, 0.054)	0.54
PA		
Minutes of PA, min/past 24 h	−1.67 (−3.44, 0.09)	0.06
Prefer PA[3]	0.92 (0.89, 0.95)	<0.001
Weight barrier to PA[4]	1.25 (1.19, 1.32)	<0.001
Too tired for PA[4]	1.20 (1.13, 1.27)	<0.001

[1] Values are adjusted βs or ORs of the outcome associated with a 1-unit difference in CFI total score (0–10). CFI, child food insecurity; HEI-2005, Healthy Eating Index-2005; PA, physical activity; SoFAAS, saturated fats, alcohol, and added sugar.
[2] Estimates are adjusted regression coefficients (β), except for the last 3 values, which are ORs.
[3] Preference for PA was measured by child agreement (''agree or strongly agree'') with the statement ''I like being physically active.''
[4] Two perceived barriers to PA were measured by child endorsement (''always true'') for tiredness (''I am too tired to do physical activities'') and weight (''My weight makes it hard for me to do physical activities'').

the obesity epidemic among elementary school–aged children (33). Even making the more modest comparison of a food-secure child to a child scoring at the 90th percentile of CFI involves an average difference of 300 kJ/d (71.7 kcal/d), or more than half of the difference that would be needed to reverse the obesity epidemic.

Not all dietary variables were related to CFI, and there was no relation between CFI and HEI; thus, consideration is warranted regarding how and why CFI influences specific aspects of child diet. For instance, the higher costs of fresh produce compared with other foods may constrain vegetable consumption at times of food insecurity (22), but this would not explain why children eat more of foods other than vegetables (given that total energy, fat, and sugar are higher) when they are food insecure. It may be that the psychological stress associated with food insecurity leads some individuals to use food to self-soothe and cope with negative emotions and to overeat and/or eat foods higher in fat or sugar (34). Linkages between stress, emotion, and ultimately body weight may involve behavioral, neurological, and endocrine processes. For example, chronic stress may lead to changes in the functioning of the hypothalamic-pituitary-adrenal axis. Resultant increased concentrations of cortisol and insulin can, in turn, lead to dysregulation of appetite and visceral fat accumulation (35). Leptin may also be involved in the regulation of eating in response to stress (36). Coping with stress through changes in amount or quality of food consumed may help to explain the relation between food insecurity (i.e., the stressor) and obesity (37).

Turning to non-nutritional consequences, our findings linking CFI and PA provide new insight into how and why food insecurity may influence child physical health and potential connections with obesity (6, 7). We are not aware of any previous research that has examined CFI and child PA using children's reports of their own experience. Children in this study reported marginally significant lower minutes of PA when they were food insecure, but the generally high error in child self-reports of PA (38) and the absence of other research to either support or contradict this finding point to the need for additional study of this potentially important mechanism. That children were more likely to report substantially more frequent barriers to PA when they were food insecure suggests that CFI exerts an influence at the intersection of physiologic and psychological processes: children's feelings of being too tired or too heavy for PA may be consequences of inadequate diet and also may be indicators of emotional distress or depression. An emotional distress explanation is also supported by the lower preference for PA among children who were food insecure, because lack of PA is associated with depression (39).

Study findings should be interpreted with some caution because of limitations in the sample and study design. First, this population was geographically limited, with a different racial/ethnic composition (i.e., higher proportion of Latinos) than is typical in the United States. Second, although a gold-standard 24-h diary-assisted recall was conducted and we would not expect this to lead to any systematic differences between food-insecure and food-secure children, it would be ideal to expand on this study and examine multiple days of intake, including intake during non–school days. Food insecurity is a product of individual and household economic factors but also involves contextual factors involving culture and place, so additional research will need to examine the relations between CFI, diet, and PA in different geographic areas and for different groups of children. In addition, our data did not include information about household income, any other indicators of material hardship, or any other measures of emotional, physical, or mental stressors. Some of the observed relations between CFI and our outcomes may ultimately be attributable to household income poverty, which is partially experienced by the child in terms of food insecurity. Finally, this study considered only one non-nutritional pathway (i.e., PA) linking CFI to child well-being; additional research should address a broader set of child outcomes, including mental health, social skills, and cognitive development.

In conclusion, children experience food insecurity in emotional, cognitive, and physical domains that tend to co-occur. A brief set of 5 items can be used to screen for children experiencing these domains of food insecurity (14). These experiences are associated with greater energy intake, a diet lower in vegetables, and greater barriers to PA. Health, social work, educational, and other professionals who work with children should be aware of food insecurity as a possible contributing factor to obesity risk when a child's dietary or PA behaviors are a concern or when a child is overweight or exhibits other health problems that may be consequent to poor diet or lack of PA. In addition, professionals across many sectors who work with children should investigate and respond to CFI as a multidomain problem, with attention to child mental health, stress, tiredness, worry, and strained familial relations as well as more overtly food-related difficulties.

Acknowledgments

Karen Webb, Patricia Wakimoto, Lauren Goldstein, Angie Keihner, Patricia Crawford, Sharon Sugerman, and Mark Hudes made valuable scientific contributions to the Power Play study. MSF analyzed the data; EAF provided statistical expertise; MSF, LDR, NR, and EAF wrote the manuscript, designed the research, and share responsibility for final content. All authors read and approved the final manuscript.

References

1. Coleman-Jensen A, Nord M, Singh A. Household food security in the United States in 2012, ERR-1544. Washington (DC): USDA, Economic Research Service; 2013.
2. Hamelin AM, Beaudry M, Habicht JP. Characterization of household food insecurity in Quebec: food and feelings. Soc Sci Med 2002;54:119–32.
3. Skalicky A, Meyers AF, Adams WG, Yang A, Cook JT, Frank DA. Child food insecurity and iron-deficiency anemia in low-income infants and toddlers in the United States. Matern Child Health J 2006;10:177–85.
4. National Research Council. Food insecurity and hunger in the United States: an assessment of the measure. Washington: The National Academies Press; 2006.
5. Cook JT, Black MM, Chilton M, Cutts DB, Ettinger de Cuba S, Heeren T, Rose-Jacobs R, Sandel M, Casey PH, Coleman S, et al. Are food insecurity's health impacts underestimated in the U.S. population? Adv Nutr 2013;4:51–61.
6. Alaimo K, Olson CM, Frongillo EA. Family food insufficiency, but not low family income, is positively associated with dysthymia and suicide symptoms in adolescents. J Nutr 2002;132:719–25.
7. Jyoti DF, Frongillo EA, Jones SJ. Food insecurity affects school children's academic performance, weight gain, and social skills. J Nutr 2005;135:2831–9.
8. Slack KS, Yoo J. Food hardship and child behavior problems among low-income children. Soc Serv Rev 2005;79:511–36.
9. Bhattacharya J, Currie J, Haider S. Poverty, food insecurity, and nutritional outcomes in children and adults. J Health Econ 2004;23:839–62.
10. Dave JM, Evans AE, Saunders RP, Watkins KW, Pfeiffer KA. Associations among food insecurity, acculturation, demographic factors, and fruit and vegetable intake at home in Hispanic children. J Am Diet Assoc 2009;109:697–701.

11. Kirkpatrick SI, Tarasuk V. Food insecurity is associated with nutrient inadequacies among Canadian adults and adolescents. J Nutr 2008;138: 604–12.
12. To QG, Frongillo EA, Gallegos D, Moore JB. Association of food insecurity and physical activity in U.S. children and adults. J Nutr 2014; 144:1797–802.
13. Bernal J, Frongillo EA, Herrera H, Rivera J. Children live, feel, and respond to experiences of food insecurity that comprise their development and weight status inperi-urban Venezuela. J Nutr 2012;142:1343–9.
14. Fram MS, Frongillo EA, Draper CL, Fishbein EM. Development and validation of a child report assessment of child food insecurity and comparison to parent report assessment. J Hunger Environ Nutr 2013;8:128–45.
15. Fram MS, Frongillo EA, Jones SJ, William RC, Burke MP, DeLoach KP, Blake CE. Children are aware of food insecurity and take responsibility for managing food resources. J Nutr 2011;141:1114–9.
16. Casey PH, Simpson PM, Gossett JM, Bogle ML, Champagne CM, Connell C, Harsha D, McCabe-Sellers B, Robbins JM, Stuff JE, et al. The association of child and household food insecurity with childhood overweight status. Pediatrics 2006;118:e1406–13.
17. Jago R, Baranowski T, Baranowski JC, Thompson D, Greaves KA. BMI from 3–6 y of age is predicted by TV viewing and physical activity, not diet. Int J Obes (Lond) 2005;29:557–64.
18. Kimm SYS, Glynn NW, Obarzanek E, Kriska AM, Daniels SR, Barton BA, Liu K. Relation between the changes in physical activity and body-mass index during adolescence: a multicentre longitudinal study. Lancet 2005;366:301–7.
19. Alaimo K, Olson CM, Frongillo EA. Food insufficiency and american school-aged children's cognitive, academic, and psychosocial development. Pediatrics 2001;108:44–53.
20. Owens M, Stevenson J, Hadwin JA, Norgate R. Anxiety and depression in academic performance: An exploration of the mediating factors of worry and working memory. Sch Psychol Int 2012;2012:433–49.
21. Fröjd SA, Nissinen ES, Pelkonen MUI, Marttunen MJ, Koivisto A-M, Kaltiala-Heino R. Depression and school performance in middle adolescent boys and girls. J Adolesc 2008;31:485–98.
22. Drewnowski A, Specter S. Poverty and obesity: the role of energy density and energy costs. Am J Clin Nutr 2004;79:6–16.
23. Oh SY, Hong MJ. Food insecurity is associated with dietary intake and body size of Korean children from low-income families in urban areas. Eur J Clin Nutr 2003;57:1598–604.
24. Zellner DA, Loaiza S, Gonzalez Z, Pita J, Morales J, Pecora D, Wolf A. Food selection changes under stress. Physiol Behav 2006;87:789–93.
25. Torres SJ, Nowson CA. Relationship between stress, eating behavior, and obesity. Nutrition 2007;23:887–94.
26. California Department of Public Health. Network for a Healthy California–Children's Power Play! campaign [cited 2013 Nov 7]. Available from: http://www.cdph.ca.gov/programs/cpns/Pages/ChildrensPowerPlayCampaign.aspx.
27. Crawford PB, Obarzanek E, Morrison J, Sabry ZI. Comparative advantage of 3-day food records over 24-hour recall and 5-day food frequency validated by observation of 9- and 10-year old girls. J Am Diet Assoc 1994;94:626–30.
28. USDA, Agricultural Research Service, Food Surveys Research Group. USDA Food and Nutrient Database for Dietary Studies, version 3.0. Beltsville (MD): USDA; 2008.
29. Guenther PM, Reedy J, Krebs-Smith SM. Development of the Healthy Eating Index-2005. J Am Diet Assoc 2008;108:1896–901.
30. Connell CL, Nord M, Lofton KL, Yadrick K. Food security of older children can be assessed using a standardized survey instrument. J Nutr 2004;134:2566–72.
31. Sallis JF, Strikmiller PK, Harsha DW, Feldman HA, Ehlinger S, Stone EJ, Williston J, Woods S. Validation of interviewer- and self-administered physical activity checklists for fifth grade students. Med Sci Sports Exerc 1996;28:840–51.
32. Nord M. Food insecurity in households with children: prevalence, severity, and household characteristics. Washington: USDA, Economic Research Service; 2009.
33. Wang YC, Hsiao A, Orleans C, Gortmaker S. The caloric calculator: average caloric impact of childhood obesity interventions. Am J Prev Med 2013;45:e3–13.
34. Moore CJ, Cunningham SA. Social position, psychological stress, and obesity: a systematic review. J Acad Nutr Diet 2012;112:518–26.
35. Adam TC, Epel ES. Stress, eating and the reward system. Physiol Behav 2007;91:449–58.
36. Tomiyama AJ, Schamarek I, Lustig RH, Kirschbaum C, Puterman E, Havel PJ, Epel ES. Leptin concentrations in response to acute stress predict subsequent intake of comfort foods. Physiol Behav 2012;107: 34–9.
37. Franklin B, Jones A, Love D, Puckett S, Macklin J, White-Means S. Exploring mediators of food insecurity and obesity: a review of recent literature. J Community Health 2012;37:253–64.
38. Tucker JM, Welk G, Beyler N. Physical activity in U.S. adults: compliance with the physical activity guidelines for Americans. Am J Prev Med 2011;40:454–61.
39. Steptoe A. Depression and physical activity. In: Steptoe A, editor. Depression and physical illness. New York: Cambridge University Press; 2007.