

**Food Insecurity and BMI:  
Exploring Mechanisms among American Children**

**Lori Kowaleski-Jones  
Jessie Fan  
Ming Wen**

Food security is defined as “access to enough food for an active, healthy life” (USDA, 1997). Food insecurity for the entire population was measured directly for the first time with an 18-item measure included in the April 1995 Current Population Survey (CPS), creating four categories of security: high food security, marginal food security, low food security, and very low food security based on the number of food-insecure conditions reported.

In 2010, 48 million Americans lived in food insecure households. Approximately 11 million adults lived in households with very low food insecurity. Food insecurity is an issue for approximately 16 million children in the U.S. In addition, approximately 976,000 (or 1.3 of the Nation’s children) children lived in households with very low food security. This remains the highest recorded prevalence rate of food insecurity since 1995 when the first national food security survey was conducted (Nord et al, 2010). Food insecurity varies by household type. Specifically, households with incomes below the poverty line, headed by a single parent, and minority households are more likely to experience food insecurity.

The effects of food insecurity on the development of U.S. children remain an open research issue. Rates of food insecurity are twice as high in households with children as in childless households (Bickel, Carlson, and Nord, 1999). Research in developing countries finds that poor nutrition is related to cognitive delays and temperamental difficulties, among other long-term problems (see Gardner et al., 1999; Aboud and Alemu, 1995; Grantham-McGregor et al., 1994).

Jyoti and colleagues (2005) found that food insecurity was predictive of poor developmental

trajectories in children. Their results also suggest an association between food insecurity and greater weight gain among boys. Boys in households that transitioned from food insecurity to food security gained less weight than boys remaining food insecure, boys remaining food secure, or boys becoming food insecure. Therefore, the association in boys seems to be with change in food security status, giving evidence for a relatively short lag between cause and effect. They conclude that food insecurity in the early elementary years has developmental consequences.

One mechanism that has been proposed to explain the associations between food insecurity and developmental outcomes is that food insecurity results in compromised dietary quality or quantity (Jyoti et al, 2005). Adults in food-insecure households have lower consumption of fruits and vegetables, and potentially consume more energy from carbohydrates (Drewnowski & Spector, 2004) and had lower intakes of dietary fiber and other vital nutrients. Measures of food insecurity are associated with deficits in nutritional consumption. Using a 24-hour diet recall, as well as a survey of household food supplies, Wolfe and colleagues (1998) found that food insecure households have lower rates of consumption of fruits and vegetables and less food on-hand, providing validation that the USDA measure of food insecurity is associated with actual food intake. Food insecurity may be associated with either decreases in diet quality or increases in energy density which could lead to accelerated weight gain in children.

Child energy balance is conceptualized as the combination of behaviors related to food consumption and energy expenditure that culminate in body weight. The prevalence of overweight U.S. youth almost tripled over the past 30 years moving from approximately 5% to 14% among youth age 12-19 (U.S. Department of Health and Human Services, 2008). National surveys from the USDA show that 12 to 18 year olds are consuming about 200 calories more per day in 1996 than they consumed in 1977, particularly from snacks and away from home food (Nielsen, Siega-Riz et al. 2002). The increased preference for food away from home may have may lead to the consumption of larger

portion size by children. Additionally, the prevalence of snacking in American children has increased (Jahns, Siega-Riz, & Popkin, 2001) and snacks are now more likely to be store-bought than home-made (Nielson, Siega-Riz, & Popkin, 2002). These factors have contributed to deterioration in the quality of the American diet (St-Onge et al, 2003). Guthrie and others (2002) found that meals and snacks based on food prepared away from home contained more calories per eating occasion, and "away" food was higher in total fat and saturated fat on a per-calorie basis than at-home food. "Away" food contained less dietary fiber, calcium, and iron on a per-calorie basis. Using diet recall data from the National Health and Examination Survey (NHANES), Mancino and colleagues (2010) find that away from home foods add significant calories per meal to children's diets. Given that Lin and others (1999) document the increase in the trend in away from home foods, the added calories to children's diets are likely to increase.

The relationship between household food insecurity and childhood overweight has mixed support in the research literature. Studies relying on cross sectional data (Casey et al, 2006) have found significant associations between household food insecurity and childhood overweight status but find the association varies across gender and racial categories. Using data from the Panel Study of Income Dynamics, Garasky and colleagues (2008) do not find significant evidence of a significant relationship between food insecurity and childhood overweight, but instead find evidence of the role of financial and community stress.

To aid in resolving the conflicting evidence surrounding the linkages between food insecurity and child overweight (Larson and Story, 2011), the need for research using models that also simultaneously consider different mechanisms by which food insecurity might influence child BMI is a research priority. Results from the current analysis speak to this mixed literature.

Using data from the NHANES 2007-2008 release, this study examines three related research questions: 1) Does household food insecurity affect child BMI? 2) What are the mechanisms by which

food insecurity affects children's BMI? 3) Do these relationships vary by gender?

## **Data**

Data for this analysis were drawn from the 2007–2008 National Health and Examination Surveys (NHANES). The NHANES is an ongoing survey of the general U.S. population conducted by the National Center for Health Statistics within the Centers for Disease Control and Prevention. NHANES is a cross-sectional survey that uses a stratified, multistage probability design to sample the civilian, noninstitutionalized population residing in the 50 states and the District of Columbia. NHANES participants undergo a survey as well as a medical examination that includes blood work and measured height and weight. Responses to questions were obtained directly from those aged 16 years or older; all others were obtained from the parent or guardian. The study sample for this paper was 2089 (999 girls and 1070 boys) aged 2–11 years.

## **Measures**

The main outcome variable of interest is Body Mass Index (BMI). In the NHANES, children's weight and height are clinically measured and BMI is calculated by the standard formulation the ratio of weight and height squared. Food security status of the children's families was assessed based on responses to 18 food security questions which measured a wide range of food insecurity and reduced food intake issues. They were combined into a scale using statistical methods based on the Rasch measurement model. Calculations of the Household Food Security scale variables were carried out in accordance with the standard methods described in *Guide to Measuring Household Food Security, Revised 2000* (U.S. Department of Agriculture 2000). In these analyses, a categorical measure of Household Food Security status is formed by dividing food insecurity into two USDA-defined categories: food secure and food insecure.

Four variables are selected to represent family food behaviors that might be important mechanisms by which food insecurity operates to affect child BMI. Frequency of Food shopping was measured by asking the parent how often does an adult do major food shopping. This variable ranges from 1 which corresponds to adults rarely shopping for food to 6 which designates shopping more than once a week. Time to Grocery Store is measured by the number of minutes per trip to a major grocery store. Cooking at Home was measured by number of times in the last seven days did family members cook meals at home. Frequency of Family Meals was measured by number of meals the family sat down and ate together in last seven days. These variables reflect family food behaviors that might be affected by food insecurity status within the home.

Key individual controls were also included in these analyses. Race/ethnicity was self-reported; non-Hispanic whites, non-Hispanic blacks and Hispanics were included in the analyses. Child Age in years, gender (male versus female), and household income (11 categories ranging from the lowest level of \$4,999 or below to the highest level of \$75,000 or above) were also included in all models.

### **Preliminary Results**

Table 1 presents weighted characteristics for the children aged 2 to 11 years old. Among the children in this sample, approximately 20 percent live in a food insecure household. Children eat dinner with their families about 6 times in the past week (5.6) and slightly times were reported for cooking meals at home. On average, it takes about 14 minutes to get to the grocery store and adults in the household report major food shopping about every two weeks. Over half of the sample is Caucasian and approximately 18 percent identify as African American and 15 percent as Hispanic. The majority of children live in married parent families (72 percent) but this percent is much lower (37 percent) among African American children. Equal portions of the study sample are boys and girls.

Table 2 present results from preliminary regression analysis that assesses the associations

between food insecurity and child BMI for the total sample of children and separately for boys and girls. Results suggest that food insecurity has a positive effect on child BMI in the overall sample. However, sub analysis reveals that this pattern of association between food insecurity and child BMI are present for girls but not for boys.

### Discussion and Next Steps

The relationship between household food insecurity and childhood overweight has mixed support in the research literature. Studies relying on cross sectional data (Casey et al, 2006) have found significant associations between household food insecurity and childhood overweight status but find the association varies across gender and racial categories. Using data from the Panel Study of Income Dynamics, Garasky and colleagues (2008) do not find significant evidence of a significant relationship between food insecurity and childhood overweight. These preliminary research results suggest that there is a positive association between household food insecurity and child BMI. Sub group analysis suggests however that this connection is not consistent across gender. Specifically, results suggest a significant association between living in food insecure households and elevated BMI for boys but not girls. This finding is consistent with international evidence of girls' health being differentially impacted by food insecurity (Belachew et al, 2011). Much of the prior research on gender differences in the association between food insecurity and child health has focused on boys nutritional needs being elevated to the detriment of girls within the home. These results suggest that an equally complex model is at play in American food insecure homes that has implications for child weight. One conjecture from the prior literature and these results could be that boys are given better access to food and this could trigger potentially maladaptive eating patterns among girls that translate into issues with body weight. These findings should inform future efforts to interdict in childhood weight imbalance that certain household conditions such as food insecurity may have differential impacts depending on the gender of the child.

An important intervening process that will be considered in this paper is the food behaviors in the households of children in food insecure home and how this may differ across gender. Family food behaviors that will be evaluated in these analyses are of interest as these were healthy practices linked to better diet quality (Burgess-Chappouz et al, 2009) that could be adopted by families in a wide range of economic and food security situations. Hammons (2011) finds that the frequency of shared meals is significantly related to nutritional health among children. Children are more likely to be in a normal weight range and have healthier eating patterns. Results from this research confirm this with models that account for non random selection over time. Food insecure youth have reported eating more fast food but fewer family meals (Widome et al, 2009). These findings suggest that making shared meals a priority is a relatively modifiable behavior that could be considered a resource for healthy weight, and should be an educational priority for youth living in food insecure households.

Emerging research has begun to explore how children experience household strategies (Fram, Frongillo and Jones, 2011). Preliminary results suggest that children are more aware of parental coping strategies and implement strategies of their own in food insecure households. Food insecure children are more likely to experience depressive symptoms and this may impact a child's motivation to be physically active.

In analysis completed in the following months, the potential for these family food behaviors to explain the differential effects of food insecurity on boys and girls will be explored. Preliminary analyses suggest that family food behaviors that center on shared family meals have a significant association with both food insecurity and BMI but only among girls.

At present, record numbers of Americans are experiencing food insecurity, as measured as the lack of consistent access to adequate food (Wright et al, 2010). Food insecurity poses real consequences for children's health and well-being. Further, research suggests that food insecurity, even at very small levels, has consequences for children. Important gaps in our understanding of the

determinants and consequences of food insecurity remain. Future research should begin to consider the mechanism by which food insecurity exerts effects on children's on coping strategies and how this might impact energy balance behaviors.



Table 1. Sample Weighted Descriptive Characteristics<sup>a</sup>, N= 2089 Children age 2 to 11.

	Mean	Std. Dev.
Child BMI	17.92	3.90
Percent Household Food Insecure	.24	.48
Family Food Behaviors		
Time to get to grocery store	14.35	22.21
How often food shopping	4.58	.96
Number of times spent cooking meals at home	4.95	2.06
Number of meals eaten together as a family	5.82	4.29
Male	.48	.50
Income	6.52	2.99
White	.28	.45
Black	.33	.47
Hispanic	.33	.47
Other race	.06	.24
Age	6.09	2.97

<sup>a</sup> Data Source: 2007-2008 National Health and Nutrition Examination Survey.

Table 2. BMI Among Children Ages 2-11 Years, NHANES 2007-2008.

	Total		Boys	Girls	
HH Food Insecure	.87	***	-.05	1.68	***
Individual characteristic					
Male	.89	***			
Household Income	-.02	**	-.01	-.03	*
Black	1.55	***	.14	2.87	***
Hispanic	.78	***	.50	1.03	***
Other race	-2.29	***	-2.60 ***	-2.05	**
Age	.06	***	.05 ***	.06	**

\*  $p \leq 0.05$ ; \*\*  $p \leq 0.01$ ; \*\*\*  $p \leq 0.001$  (two-tailed tests)

Source: 2007-2008 National Health and Nutrition Examination Survey.

Note: Cell entries represent parameter estimates.

N = 2089 children, 1070 boys and 999 girls.

## CITATIONS

- Aboud, F.E., & Alemu, T. (1995). "Nutrition, maternal responsiveness, and mental development of Ethiopian children". *Social Science and Medicine*, 41(5): 725-32.
- Belachew, C. Hadley, D. Lindstrom, A. Gebremariam, K. W. Michael, Y. Getachew, C. Lachat, P. Kolsteren. Gender Differences in Food Insecurity and Morbidity Among Adolescents in Southwest Ethiopia. *Pediatrics*, 2011;
- Casey, P., P. M. Simpson, J. M. Gossett, M. L. Bogle, C. M. Champagne, C. Connell, D. Harsha, B. McCabe-Sellers, J. M. Robbins, J. E. Stuff, and J. Weber. 2006. "The association of child and household food insecurity with childhood overweight status." *Pediatrics* 118:1406-1413
- Drewnowski A., Spector S. E. Poverty and obesity: the role of energy density and energy costs. *Am. J. Clin. Nutr.* 2004;79:6-16.
- Feinberg, Emily, Kavanagh, Patricia. Young, Robin, and Proudent, Nicole. 2008. Food insecurity and compensatory feeding practices among urban black families. *Pediatrics* 122: 854-860.
- Frongillo EA, Nanama S. Development and validation of an experience-based measure of household food security within and across seasons in northern Burkina Faso. *J Nutr.* 2006;136(5):1409S–1419S
- Fram, Maryah., Frongillo, Edward., and Sonya Jones. The Family food decision making study. RDGE working paper.  
[http://srdc.msstate.edu/ridge/publications/fanis/childrens\\_views/childrens\\_views.pdf](http://srdc.msstate.edu/ridge/publications/fanis/childrens_views/childrens_views.pdf)
- Garasky, S., Stewart, Susan, Gunderson, Craig, Lohman, Brenda, Eisenmann, Joey. 2008. Food insecurity, economic stressors and child overweight. National poverty center working paper series. #08-04
- Grantham-McGregor, S., Powell, C., Walker, S., Chang, S., and Fletcher, P. (1994). "The long-term follow-up of severely malnourished children who participated in an intervention program". *Child Development*, 65: 428-39.
- Hadley C, Lindstrom D, Tessema F, Belachew T. 2008 Gender bias in food insecurity experiences of adolescents in Jimma zone. *Soc Sci Med.* 2008;66(2):427–438
- Hammons, Amber and Fiese, Barbara. 2011. Is Frequency of Shared Family Meals Related to the Nutritional Health of Children and Adolescents? *Pediatrics* 127(6): 1-10.
- Jahns, L., A.M. Siega-Riz, and B.M. Popkin, 2001 *The increasing prevalence of snacking among US children from 1977 to 1996*. *Journal of Pediatrics* 138(4): p. 493-498.
- Jones S, Jahns L, Laraia B, Haughton B. Lower risk of overweight in school-aged food-insecure girls who participate in food assistance: results from the panel study of income dynamics child development supplement. *Arch Pediatr Adolesc Med* 2003;157(8):780–4.
- Larson, Nicole .Story, Mary. 2011. Food Insecurity and Weight Status Among U.S. Children and Families. A Review of the Literature. *Am J Prev Med* 2011;40(2):166–173
- Lin, B., J. Guthrie, and E. Frazao. Away-From-Home Foods Increasingly Important to Quality of American Diet. USDA, ERS, AIB-749, January 1999.
- St-Onge, M.P., K.L. Keller, and S.B. Heymsfield, *Changes in childhood food consumption patterns: a cause for concern in light of increasing body weights*. *American Journal of Clinical Nutrition*, 2003. **78**(6): p. 1068-1073.
- Story, M., Kaphingst, K., & French, S. (2006). The Role of Schools in Obesity Prevention. *The Future of Children*, **1**, 109-131.
- Widome, Rachel. Neumark-Sztainer, Dianne., Hannan, Peter., Haines, Jess. Story, Mary. 2009.

Eating when there is not enough to eat: eating behaviors and perceptions of food among food-insucre youths. *American Journal of Public Health*. 99(5): 822-828.

Wright, Vanessa., Thampi, K. and Briggs, J. 2010. Who are Americas poor children: examining food insecurity among children in the United States. National Center for Children in Poverty. Columbia University