

Review



Continuing Education Questionnaire, page 1963
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The Food Insecurity–Obesity Paradox: A Review of the Literature and the Role Food Stamps May Play

LAUREN M. DINOUR, MPH, RD; DARA BERGEN, MPH, RD; MING-CHIN YEH, PhD, MEd, MS

ABSTRACT

During the past decade, rates of food insecurity and obesity have risen, and an association has been made between these two seemingly paradoxical states. Although this relationship has not been repeatedly seen in men, research suggests a correlation in women. Studies have not been able to consistently show a relationship in children, because findings differ based on age, race/ethnicity, household income, and sex. Several proposed hypotheses explain why a correlation between food insecurity and obesity exists in adults—especially women—but not in children. This review proposes a conceptual framework linking the Food Stamp Program and other coping strategies to the food insecurity–obesity relationship. This link has implications for Food Stamp Program policy changes, welfare reform, and poverty prevention.

J Am Diet Assoc. 2007;107:1952-1961.

Obesity is one of the most significant public health crises in the United States today. During the past 30 years, the prevalence of adult obesity (body mass index [BMI; calculated as kg/m²] ≥30) has doubled from

15.0% to 32.2% (1,2). Trends in children have shown an even more dramatic increase during this time: the overweight prevalence (BMI ≥95th percentile for age) has nearly tripled in children aged 6 to 11 years (6.5% to 18.8%) and has more than tripled in adolescents aged 12 to 19 years (5.0% to 17.4%) (2,3). The most recent national data show no signs that these prevalence rates are decreasing (2).

Along with the rise in obesity, there has been a significant, though much less dramatic, increase in the number of food-insecure Americans since 1999 (4). Food insecurity, as defined by the Life Sciences Research Office, exists “whenever the availability of nutritionally adequate and safe foods or the ability to acquire acceptable foods in socially acceptable ways is limited or uncertain” (5). Food insecurity may or may not be accompanied by hunger, the “uneasy or painful sensation caused by a lack of food” (5). The most severe form of food insecurity is defined as households where children are experiencing reduced food intake and hunger (6). In 2004, 8% of households in the United States experienced food insecurity without hunger at some time during the year, and an additional 4% experienced food insecurity with hunger. Of the households with children (about one third of all households), 17% were food insecure without child hunger, whereas <1% were food insecure with child hunger (4). It should be noted here that the term food insufficiency is commonly used interchangeably with food insecurity. However, food insufficiency is defined as “inadequacy in the amount of food intake because of a lack of money or resources that provide access to enough food” (7). Thus, food insecurity is a broader term that encompasses food insufficiency, as well as psychological and qualitative aspects of food supply and intake (7).

Ever since Dietz (8) proposed a relationship between hunger and obesity in 1995, there has been increasing discussion regarding a correlation between weight status and food insecurity. Such an association seems paradoxical; whereas food insecurity results from inadequate economic resources to purchase food, obesity is a consequence of overconsumption (8,9). In addition, because the majority of food-insecure households receive assistance

L. M. Dinour is a doctoral student at the Graduate Center, City University of New York, New York, and an adjunct instructor at Hunter College, City University of New York, New York; at the time of the study, she was a graduate student, Urban Public Health Program, Hunter College, City University of New York, New York. D. Bergen is a nutrition counselor in New York, NY, and an adjunct instructor, Hunter College, City University of New York, New York. M.-C. Yeh is an assistant professor, Urban Public Health Program, Hunter College, City University of New York, New York.

Address correspondence to: Lauren M. Dinour, MPH, RD, 11020 71st Ave, Ste 220, Forest Hills, NY 11375.
E-mail: LMDnutrition@gmail.com

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0002-8223/07/10711-0010\$32.00/0

doi: 10.1016/j.jada.2007.08.006

from one or more federal food assistance programs (4), there has been speculation that these programs, specifically the Food Stamp Program, may play a role in this obesity–food insecurity paradox (9).

The Food Stamp Program is a federally funded entitlement program for low-income individuals that provides electronic benefit cards to be used for the purchase of food items (10). To be eligible for food stamps, a household without an elderly or disabled member must have a monthly gross income at or below 130% of the federal poverty guideline (11) (in 2005, this figure was \$2,096 per month for a family of four in the continental United States, based on the 2005 annual poverty guideline of \$19,350 [12]). The federal poverty guideline is based on the Thrifty Food Plan, a market basket of food that serves as a national standard for a nutritionally balanced diet at low cost. In addition, the cost of the Thrifty Food Plan is used to determine maximum food stamp allotments, with an average benefit of about \$86 per person, per month (4).

It was our intent to examine the current literature regarding the obesity–food insecurity paradox in nonelderly adults and children in the United States, as well as hypothesize about the role that the Food Stamp Program may play. We also propose a conceptual framework regarding the Food Stamp Program in the relationship between food insecurity and obesity.

MATERIALS AND METHODS

Articles published from 1990 through February 2006 were located by searching the scientific on-line databases PubMed and the Cumulative Index to Nursing and Allied Health Literature, and the online publications of the Economic Research Service and Center for Nutrition Policy and Promotion of the US Department of Agriculture (USDA). Keywords used were obesity, overweight, food security, food insecurity, food insufficiency, hunger, Food Stamp Program, social programs, low income, adults, adolescents, and children. Every attempt was made to include articles published in peer-reviewed journals. However, literature from sources such as government agencies and hunger research organizations was also included. Studies performed outside of the United States were excluded. In addition, as a result of limited prior literature and insufficient data, articles describing older adult populations and other food assistance programs (ie, Special Supplemental Nutrition Program for Women, Infants, and Children and the National School Lunch Program) were excluded from this review.

RESULTS AND DISCUSSION

The Table presents pertinent information from the studies we reviewed, including details on the subjects, the food insecurity measurement tool used, how the authors defined overweight and obesity, and significant findings.

Food Insecurity and Obesity in Nonelderly Adults

Two studies tested the relationship between obesity and food insecurity using the Behavioral Risk Factor Surveillance System (BRFSS), a cross-sectional telephone survey. The BRFSS has an optional module called the Social Context Module, which defines food insecurity as an af-

firmative answer to the question, “In the past 30 days, have you been concerned about having enough food for you or your family?” Height and weight status was self-reported and BMI was calculated to determine the degree of overweight/obesity (13,14). Laraia and colleagues (13) analyzed the 1999 BRFSS data for Louisiana (N=1,667) and New York (N=2,641), including men and women aged 18 years and older. Initially, the association between concern about enough food and morbid obesity (BMI ≥ 35), compared to all other BMI categories, showed a relative risk of 2.20 (95% confidence interval [CI] 1.24 to 3.90) for Louisiana and a relative risk of 2.23 (95% CI 1.30 to 3.84) for New York. However, after controlling for race/ethnicity, education, income, marital status, and general health, the extent of this association became non-significant in both states. Sex did not seem to modify the relationship between morbid obesity and concern about enough food in this study. However, using the 1995-1999 BRFSS from Washington State (N=17,371 men and women aged ≥ 18 years), VanEenwyk and Sabel (14) found that persons reporting concern about food security were more likely to be obese (BMI > 30) than those who did not report food-security concerns (adjusted odds ratio [OR] 1.29, 95% CI 1.04 to 1.83), after controlling for income and education. The results were not analyzed by sex, although it is noted that female responders were more likely to be obese than male responders in this study.

In an analysis of the 1988-1994 National Health and Nutrition Examination Survey (NHANES III), Basiotis and colleagues (15) selected a cross-sectional sample of women aged 19 to 55 years who did not live alone (N=5,241). The NHANES III survey measured food insufficiency by determining the number of respondents who reported that their households sometimes or often did not have enough to eat. Heights and weights were measured by researchers (15,16). Their results showed a significant relationship between food insufficiency and overweight status (BMI ≥ 25), although no significant differences were seen between women in food-sufficient and food-insufficient households in terms of being obese (BMI ≥ 30). However, a review of NHANES III data for adults aged 18 to 64 years (N=11,853) by Bhattacharya and colleagues (16) did reveal a relationship between self-reported food insecurity and obesity (BMI ≥ 30) among whites and Hispanics, but not African Americans.

A study by Townsend and colleagues (9) used cross-sectional data from the 1994-1996 Continuing Survey of Food Intakes by Individuals to generate a sample of 4,537 women and 5,004 men aged 20 years or older. The Continuing Survey of Food Intakes by Individuals survey used self-reported heights and weights and determined food insecurity based on the response to the question, “Which of the following statements best describes the food eaten in your household in the past 3 months?” Response options were: enough of the kinds of food we want to eat (no food insecurity); enough but not always the kinds of food we want to eat (mild insecurity); sometimes not enough to eat (moderate insecurity); or often not enough to eat (severe insecurity).

For women, analysis of the data showed a significant relationship ($P < 0.0001$) between food insecurity and overweight status (BMI > 27.3), and further tests showed

Table. Selected studies reporting on the relationship between obesity and food insecurity

Reference	Subjects	Food insecurity measurement	Overweight/obesity definition	Main significant findings
Laraja and colleagues, 2003 (13)	<ul style="list-style-type: none"> • ≥18 y • n=1,667 (LA) • n=2,641 (NY) 	<ul style="list-style-type: none"> • 1999 BRFSS^a Social Context Model^b 	<ul style="list-style-type: none"> • BMI^c 25-29.9 (overweight) • BMI 30-34.9 (obese) • BMI ≥35 (morbidly obese) 	<ul style="list-style-type: none"> • Initial positive association between concern about enough food and morbid obesity in Louisiana (RR^d=2.20, 95% CI^e=1.24-3.90) and New York (RR=2.23, 95% CI=1.30-3.84); insignificant association after controlling for socioeconomic variables • Positive association between concern about food security and obesity (AOR^f=1.29, 95% CI=1.04-1.83)
VanEenwyk and colleagues, 2003 (14)	<ul style="list-style-type: none"> • ≥18 y • n=3,252 	<ul style="list-style-type: none"> • Washington State 1995-1999 BRFSS Social Context Model^b • NHANES III^g 	<ul style="list-style-type: none"> • BMI ≥30 (obese) 	<ul style="list-style-type: none"> • Significantly higher percentage (58% vs 47%) of those in food insufficient households were overweight; no significant differences with obesity
Basiotis and colleagues, 2003 (15)	<ul style="list-style-type: none"> • 19-55 y women (not living alone) • n=5,241 	<ul style="list-style-type: none"> • NHANES III data used to create an original food insecurity measure 	<ul style="list-style-type: none"> • BMI ≥25 (overweight) • BMI ≥30 (obese) 	<ul style="list-style-type: none"> • Food insecurity associated with obesity among whites (OLS^h regression=0.09±0.05, P<0.10) and Hispanics (OLS regression=0.11±0.06, P<0.10), but not African Americans (OLS regression=0.02±0.05)
Bhattacharya and colleagues, 2004 (16)	<ul style="list-style-type: none"> • 18-64 y • n=11,853 • 2-17 y • n=9,502 	<ul style="list-style-type: none"> • 1994-1996 CSFII food insecurity survey questionⁱ 	<ul style="list-style-type: none"> • BMI <5th percentile BMI for age (underweight) • BMI ≥95th percentile BMI for age (overweight) • BMI ≥27.3 (overweight women) • BMI ≥27.8 (overweight men) 	<ul style="list-style-type: none"> • Among 12-17 y Hispanics, food insecurity associated with higher incidence of overweight (P<0.05) • Women: food insecurity was related to overweight status (P<0.0001); continued significance (P<0.01) after adjusting for socioeconomic variables. Main effect for mild food insecurity (OR^j 1.3, 95% CI=1.08-1.52, P=0.005); food stamps significant predictor of overweight (OR 1.38, 95% CI=1.07-1.78, P=0.0139)
Townsend and colleagues, 2001 (9)	<ul style="list-style-type: none"> • ≥20 y • n=4,537 women • n=5,004 men 	<ul style="list-style-type: none"> • Radimer/Cornell measure^k 	<ul style="list-style-type: none"> • BMI >29 (obese) 	<ul style="list-style-type: none"> • Men: no relationship found (P=0.44) • BMI was significantly higher (P<0.05) for women with household food insecurity; continued significance (P=0.06) after adjusting for socioeconomic variables; obesity found in 37% women with household food insecurity vs 26% in food secure households
Olson, 1999 (17)	<ul style="list-style-type: none"> • 20-39 y women (with children at home) • n=193 	<ul style="list-style-type: none"> • 1998-1999 California Women's Health Survey; adapted US Department of Agriculture Household FSS^l 	<ul style="list-style-type: none"> • BMI ≥30 (obese) 	<ul style="list-style-type: none"> • Food insecurity without hunger associated with obesity for non-Hispanic whites (AOR=1.36, 95% CI=1.00-1.84) and in Asians, African Americans, and Hispanics (AOR=1.47, 95% CI=1.07-1.94); food insecurity with hunger associated with obesity for Asians, African Americans, and Hispanics (AOR=2.81, 95% CI=1.84-4.28), but not in non-Hispanic whites (AOR=0.82, 95% CI=0.57-1.55)
Adams and colleagues, 2003 (18)	<ul style="list-style-type: none"> • ≥18 y women • n=8,169 	<ul style="list-style-type: none"> • Subscales of the USDA Household FSS^m 	<ul style="list-style-type: none"> • BMI 25-29.9 (overweight) • BMI ≥30 (obese) 	<ul style="list-style-type: none"> • Significantly greater risk of obesity among food insecure with hunger, using 10-item subscale (P=0.03) or four-item subscale (P=0.02); no association among food insecure without hunger
Kaiser and colleagues, 2004 (19)	<ul style="list-style-type: none"> • ≥18 y low-income Latino mothers • n=559 			

(continued)

Table. Selected studies reporting on the relationship between obesity and food insecurity (continued)

Reference	Subjects	Food insecurity measurement	Overweight/obesity definition	Main significant findings
Kaiser and colleagues, 2002 (20)	<ul style="list-style-type: none"> • 3-6 y low-income Mexican-American children • n=211 	<ul style="list-style-type: none"> • Radimer/Cornell measure^k 	<ul style="list-style-type: none"> • ≥ 85th percentile weight for height z scores (overweight) 	<ul style="list-style-type: none"> • No significant differences in weight status by level of food insecurity; tendency of heavier children among food insecure
Rose and colleagues, 2006 (21)	<ul style="list-style-type: none"> • Kindergarten children • n=16,889 	<ul style="list-style-type: none"> • USDA Household FSS^l 	<ul style="list-style-type: none"> • BMI >95th percentile BMI for age (overweight) 	<ul style="list-style-type: none"> • Children from food-insecure households 20% less likely ($P=0.027$) to be overweight
Matheson and colleagues, 2002 (22)	<ul style="list-style-type: none"> • Fifth-graders (predominantly Hispanic) • n=124 	<ul style="list-style-type: none"> • USDA Household FSS^m 	<ul style="list-style-type: none"> • BMI; overweight not defined 	<ul style="list-style-type: none"> • Children from food secure households had significantly higher BMIs than from food insecure households ($P=0.04$)
Casey and colleagues, 2001 (7)	<ul style="list-style-type: none"> • 0-17 y children • n=5,669 	<ul style="list-style-type: none"> • 1994-1996 CSFII food insufficiency survey questionⁿ 	<ul style="list-style-type: none"> • BMI >85th percentile BMI for age (overweight) 	<ul style="list-style-type: none"> • No significant differences in overweight among food-insufficient vs food-sufficient youths; significantly more overweight youths in low-income families vs higher-income families
Jyoti and colleagues, 2005 (23)	<ul style="list-style-type: none"> • Children (assessed at kindergarten and third grade) • n=11,460 	<ul style="list-style-type: none"> • USDA Household FSS^o 	<ul style="list-style-type: none"> • BMI; overweight not defined 	<ul style="list-style-type: none"> • Over time, girls from food insecure households had greater gains in BMI ($P<0.021$) than girls from food secure households, although BMIs fell within normal ranges for age • No significant findings among boys
Alaimo and colleagues, 2001 (24)	<ul style="list-style-type: none"> • 2-16 y • n=9,196 	<ul style="list-style-type: none"> • NHANES III^p 	<ul style="list-style-type: none"> • ≥ 85th percentile weight for height (overweight) 	<ul style="list-style-type: none"> • Compared to food sufficient girls, 2-7 y food insufficient girls were 1.6 times less likely to be overweight ($P<0.10$) and 8-16 y non-Hispanic white insufficient girls were 3.5 times more likely to be overweight ($P<0.10$)

^aBehavioral Risk Factor Surveillance System.

^bFood insecurity defined as respondents answering yes to the question, "In the past 30 days, have you been concerned about having enough food for you or your family?"

^cBMI=body mass index, calculated as kg/m².

^dRR=relative risk.

^eCI=confidence interval.

^fAOR=adjusted odds ratio.

^gNHANES III=Third National Health and Nutrition Examination Survey; food insufficiency measured by respondents reporting that their households sometimes or often did not have enough to eat.

^hOLS=ordinary least squares.

ⁱCSFII=Continuing Survey of Food Intakes by Individuals; food insecurity measured by respondents answering the question, "Which of the following statements best describes the food eaten in your household in the past 3 months?"

Response choices were: enough of the kinds of food we want to eat (no food insecurity), enough but not always the kinds of food we want to eat (mild insecurity), sometimes not enough to eat (moderate insecurity), or often not enough to eat (severe insecurity).

^jOR=odds ratio.

^kFour food insecurity categories in order of increasing severity: food secure, household insecure, individual/adult insecure, and child hunger.

^lFSS=food security survey, three food insecurity categories in order of increasing severity: food secure, food insecure without hunger, and food insecure with hunger.

^mUS Department of Agriculture Household Food Security Scale; four food insecurity categories in order of increasing severity: food secure, food insecure without hunger, food insecure with moderate hunger, and food insecure with severe hunger.

ⁿFood insufficiency measured by respondents reporting that their households sometimes or often did not have enough to eat in the past 3 months.

^oUsing the US Department of Agriculture Food Security Scale, subjects in this study were classified as either food secure or food insecure.

that food insecurity continued to be a significant predictor of overweight status, even after adjusting for socioeconomic, demographic, government assistance, environment, and lifestyle variables ($P < 0.01$, effect size data not included in original article). Excluding those women with severe food insecurity, the prevalence of overweight in women increased as the severity of food insecurity increased, from food security, to mild food insecurity, to moderate food insecurity. However, the differences between the food insecurity categories were not significantly different from each other. Only mild food insecurity was positively and significantly associated with overweight status in women after controlling for socioeconomic and demographic variables [OR 1.3, 95% CI 1.08 to 1.52, $P = 0.005$]. Thus the risk of overweight did not increase with increasing severity of food insecurity in this sample of women. Still, food insecurity was not found to be related to overweight status (BMI > 27.8) in men (9), indicating a differential sex relationship.

Olson (17) selected a cross-sectional sample of 193 women, aged 20 to 39 years with children living at home, from a rural county in upstate New York. Using the Radimer/Cornell measure to classify food security status, households were classified into one of four food insecurity groups (in order of increasing severity: food secure, household insecure, individual/adult insecure, and child hunger). Heights and weights were measured by researchers and BMIs were calculated, with obesity defined as a BMI > 29 . The results indicated that women in the household food-insecure group were significantly heavier than women in food-secure households ($P < 0.05$). Even after controlling for height, income level, education level, single parent status, and employment status, women in the household food-insecure group were still an average of two BMI units heavier than women in households that were food secure ($P = 0.06$). However, women in households with individual food insecurity or child hunger did not differ in BMI from women in food-secure households. It appears that the least severe level of food insecurity (household level) was the most strongly related to BMI in this study. Because BMI did not increase with increasing severity of food insecurity in this sample, these results support the findings of Townsend and colleagues (9).

Adams and colleagues (18) used a cross-sectional sample of California women aged 18 years or older ($N = 8,169$) from the 1998-1999 California Women's Health Survey. Heights and weights were self-reported and food insecurity was evaluated using adapted questions from the USDA Household Food Security Survey. Food security status was categorized into three levels of increasing severity: food security, food insecurity without hunger, and food insecurity with hunger. Women were stratified by race/ethnicity into one of two groups: non-Hispanic white or Asian, African American, and Hispanic.

After controlling for income, race/ethnicity, age, education, country of birth, walking, and general health status, food insecurity without hunger was found to be associated with an increased risk of obesity in women (BMI ≥ 30) of both the non-Hispanic white group (adjusted OR 1.36, 95% CI 1.00 to 1.84) and the Asian, African-American, and Hispanic group (adjusted OR 1.47, 95% CI 1.07 to 1.94). Food insecurity with hunger was associated with an increased prevalence of obesity for women in the

Asian, African-American, and Hispanic group (adjusted OR 2.81, 95% CI 1.84 to 4.28), but not in the non-Hispanic white group (adjusted OR 0.82, 95% CI 0.57 to 1.55). Unlike Townsend and Olson and their colleagues, Adams and colleagues (18) reported that the risk of obesity increased with increasing severity of food insecurity, but only in Asian, African-American, and Hispanic women. These results suggest that race/ethnicity may be a moderating variable in the food insecurity-obesity relationship.

Kaiser and colleagues (19) examined the food insecurity-obesity relationship in a cross-sectional sample of 559 low-income Latino mothers (aged 18 years or older) in California. Heights and weights were measured by the researchers, and two subscales (10-item and four-item) of the 18-item USDA Household Food Security Survey were used to measure food security. Four categories of food insecurity in order of increasing severity were identified: food security, food insecurity without hunger, food insecurity with moderate hunger, and food insecurity with severe hunger.

After adjusting for parity, years lived in the United States, and per capita income, women who experienced food insecurity with hunger were at a significantly greater risk of obesity (BMI ≥ 30) than women who were food secure, using either the 10-item subscale ($P = 0.03$) or the four-item subscale ($P = 0.02$). However, food insecurity without hunger was not significantly related to maternal obesity with use of either scale. In addition, no significant association was found between the risk of overweight and food insecurity, either with or without hunger (19). The most severe form of food insecurity was associated with a higher prevalence of obesity in this Latino sample, supporting the findings of Adams and colleagues (18).

From these studies, there seems to be a relationship between increased body weight and food insecurity in women, but not necessarily for men. Although this is likely due to the fact that much of the research to date has only studied women, it may also be related to "maternal deprivation (15)," in which mothers sacrifice their intake so that their children will be less affected. Findings are also inconsistent as to whether there is a positive linear effect, whereby the risk of obesity rises with the severity of food insecurity. However, it may be that this link only exists for women of certain races/ethnicities.

Food Insecurity and Overweight in Children and Adolescents

From the time when Dietz (8) associated hunger and obesity in his pediatric patients, studies have not been able to consistently show a similar relationship in other children.

Food-Insecure Children and Adolescents Are More Likely to Be Overweight. In their cross-sectional survey, Kaiser and colleagues (20) recruited 211 low-income, Mexican-American families in California. The study interviewers measured weight and height for each child (aged 3 to 6 years), and used the Spanish and English versions of the 12-item Radimer/Cornell food security scale to estimate levels of household, adult, and child food insecurity. After controlling for acculturation, parent education, monthly income, past experience of food insecurity, and feeding history, the percent of overweight children (weight-for-height z

score ≥ 1.04 , corresponding to the 85th percentile weight for height) tended to peak among families reporting household food insecurity, compared with families reporting food security, adult food insecurity, and child food insecurity. It should be noted that results were not statistically significant.

Food-Insecure Children and Adolescents Are Not More Likely to Be Overweight. A study by Rose and colleagues (21) analyzed data from the Early Child Longitudinal Study-Kindergarten Cohort. Researchers measured the heights and weights of 16,889 kindergarten children (average age 6.2 years), and assessed food insecurity status using the 18-item USDA Household Food Security Survey. After controlling for anthropometrics, socioeconomic status, place of residence, household food patterns, and physical activity level, children from food-insecure households were 20% less likely ($P=0.027$) to be overweight (>95 th percentile BMI for age). Further analysis of the effects of hunger on children's weight showed similar results.

Matheson and colleagues (22) conducted a cross-sectional survey of 124 predominantly Hispanic, fifth-grade children (average age 10.7 years) and their mothers in northern California. Children's height and weight were taken by the researchers, and mothers reported household food insecurity via the 18-item USDA Household Food Security Survey. Results showed that children from food-secure households had significantly higher BMIs than children from food-insecure households ($P=0.04$), although BMIs remained within normal range. No sex effect was found on the relationship between food insecurity and BMI.

Casey and colleagues (7) used the 1994-1996 Continuing Survey of Food Intake by Individuals to analyze a cross-sectional sample of 3,790 households and 5,669 children and adolescents (aged 0 to 17 years) nationwide. The percentage of youth at risk for overweight (>85 th percentile BMI for age) in low-income, food-insufficient households was similar to that of low-income, food-sufficient households. However, there was a significantly higher percentage of youth at risk for overweight in low-income families than in higher-income families, despite insufficiency status ($P\leq 0.05$). These results show that income may play a larger role than food insufficiency in the weight status of this sample.

The Relationship between Food Insecurity and Overweight in Children and Adolescents Depends on Sex, Age, Race/Ethnicity, and/or Income. Using the Early Child Longitudinal Study-Kindergarten Cohort, Jyoti and colleagues (23) obtained data from 11,460 children in kindergarten (spring 1999) and again at third grade (spring 2002). At both of these times, children's heights and weights were directly assessed, and household food insecurity was determined through parental response of the 18-item USDA Household Food Security Survey. Many individual, parent, and household variables were controlled for, including sex, age, birth weight, home language, race/ethnicity, health insurance coverage, frequency of exercise, family income, number of parents in the household, parent employment and education, area of residence, and neighborhood safety rating. Over time, children from persistently food insecure households had a 0.35 greater gain in BMI ($P<0.028$) compared with children from persistently food secure households. After sex stratification, this associa-

tion remained significant among girls ($P<0.021$), but not among boys. It is noted that the children's weights and BMIs fell within normal ranges for age. The authors caution about drawing conclusions from the data due to the lag time between cause and effect.

An NHANES III cross-sectional sample of 9,196 children and adolescents was used by Alaimo and colleagues (24) to determine whether food insufficiency is associated with overweight (≥ 85 th percentile weight for height). Data for girls aged 2 to 7 years showed an inverse relationship, whereby those who were food insufficient were 1.6 times less likely to be overweight than those who were food sufficient, after controlling for a variety of demographic, anthropometric, health, physical activity, and socioeconomic factors. However, of the girls aged 8 to 16 years, the non-Hispanic white, food-insufficient girls were 3.5 times more likely to be overweight than food-sufficient girls. For both of these relationships, the authors defined significance at $P<0.10$. Food-insufficient girls of other ethnic backgrounds in the 8- to 16-year-old age group, and food-insufficient boys of both age groups, showed no increased prevalence of overweight when compared to food-sufficient girls and boys.

Bhattacharya and colleagues (16) also used NHANES III data to study 9,502 children and adolescents, aged 2 to 17 years. For children aged 2 to 5 years, food insecurity was not correlated with weight, however those children in poverty were less likely to have a low BMI (<5 th percentile BMI for age, $P<0.05$). In the 6- to 11-year-old and 12- to 17-year-old age groups, neither food insecurity nor poverty status was associated with weight. After analyzing the data by race/ethnicity, it was found that poverty increased the incidence of overweight (≥ 95 th percentile BMI for age) only among Hispanic children aged 2 to 5 years (the authors defined significance at $P<0.10$). Among 12- to 17-year-old Hispanic adolescents, self-reports of food insecurity were associated with a higher incidence of overweight ($P<0.05$). No relationships between food insecurity and weight status were found for African-American or white children of any age.

The results of these studies show inconsistent results in the association between overweight status and food insecurity in children and adolescents. Findings differ based on age, race/ethnicity, household income, sex, and definition of food insecurity.

Proposed Hypotheses Surrounding the Food Insecurity-Obesity Paradox

Adults. There are several hypotheses as to why a correlation exists between food insecurity and obesity in adults. First, it has been suggested that children who grow up in poverty are more likely to become obese adults (25) and, thus, childhood food insecurity as a result of poverty may amplify the effect of poverty on adult obesity (26). Second, the low cost of energy-dense foods may promote overconsumption of energy, leading to weight gain. To maintain adequate energy intake, people who must limit food costs will select lower-quality diets, consisting of high-energy, inexpensive foods (8,15,18,26,27). The frequency of fruit and vegetable consumption, on the other hand, declines significantly as food insecurity status worsens (28). Food insecurity may also lead to various psychological and behavioral changes, such as a preoccupation with food,

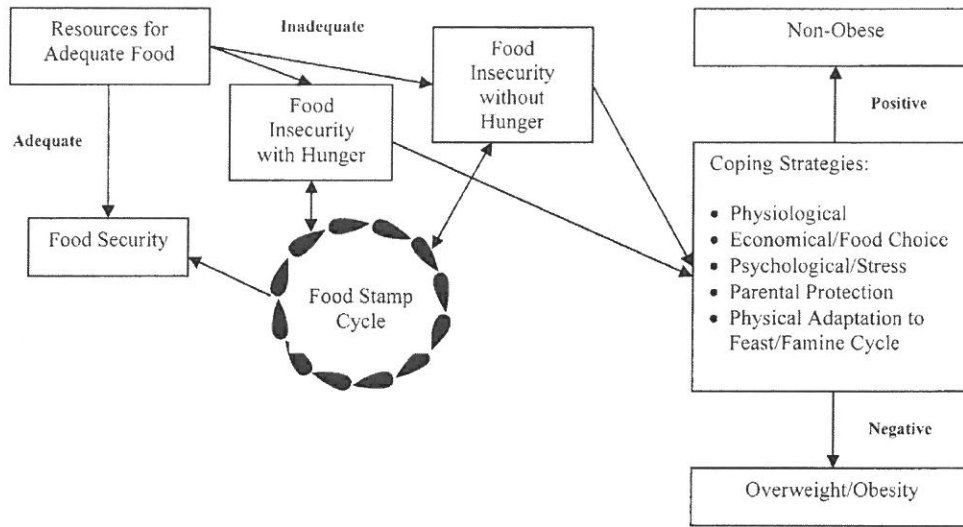


Figure. Conceptual framework of household food security/insecurity and its relation to the Food Stamp cycle and body weight.

stress, depression, and physical limitations in adults, all of which can lead to an increased risk for obesity (17,18,26,29).

Children and Adolescents. The lack of consistent correlation between food insecurity and overweight in children may be a result of parental protection as previously mentioned, whereby caregivers (especially low-income mothers) allocate resources or sacrifice their own food consumption quality or quantity in a way that protects young children from experiencing hunger (15,16,22,26,30,31). This may also be the reason why women, more so than men, show a positive relationship between body weight and food insecurity. Federally funded meal programs, such as the Child and Adult Care Food Program, National School Lunch Program, School Breakfast Program, and Summer Food Service Program, may help keep participating children and adolescents at a level of food security that their parents are not able to achieve. More specifically, older children in food-insecure households may have a greater ability to supplement their food consumption outside of the home (16), potentially accounting for the age-related differences found in the previous studies.

The Role of the Food Stamp Cycle

Obesity may result from an adaptive physiological response to episodic food insecurity, which can lead to binge eating habits when food is plentiful (9,19). Cyclical food restriction has been associated with an increase in body fat, decrease in lean muscle mass, and a quicker weight gain with response to refeeding (8). One such feast-famine cycle has been linked with food stamps. The “food stamp cycle” refers to a 3-week period of overeating when food stamps and money are available, followed by a 1-week period of involuntary food restriction when resources have been depleted, followed by overeating when the monthly food stamp allotment has been restored, and so on (9,32,33). Several studies have shown that families receiving food stamps use their monthly allotment before

the end of the month (10,33). In addition, the number of days since the receipt of food stamp benefits has been found to be significantly negatively associated with food energy intake (32,34). Such a cycle may also affect children; during times of relative plenty, parents may be more liberal with snacks and fast foods. Once resources are depleted, parents may then restrict treats, thereby increasing child demand and intake of these foods when families later have more money to spend (20).

One study has examined the relationship of the Food Stamp Program in the food insecurity–obesity paradox. In their study of the relationship between food insecurity and overweight previously described, Townsend and colleagues (9) examined food stamp status as an independent variable of overweight prevalence. Receiving food stamps was a significant predictor of overweight status (OR 1.38, 95% CI 1.07 to 1.78, $P=0.0139$). In addition, among women who received food stamps, the prevalence of overweight increased as the severity of food insecurity increased from food security (48.4%), to mild insecurity (53.7%), to moderate insecurity (68.3%). The prevalence of overweight among the moderately food insecure food stamp recipients was significantly higher than the food secure and mildly insecure groups.

CONCEPTUAL FRAMEWORK

The aforementioned hypotheses may play a role in the relationship between food insecurity and obesity, as shown in the conceptual framework (Figure).

Food Security/Insecurity Status

Starting at the upper left-hand corner of the proposed framework, having adequate resources for food—via income, savings, credit, and food stamps—can determine a person’s food security status. Several studies show that the most frequently reported reason for not having enough food or the desired types of foods to eat is not having enough money, food stamps, or other financial

sources (35,36). Food-insufficient households have been found to have lower average incomes, more likely to have lost earnings and lost food stamp benefits (due to ineligibility as a result of increased income), and less able to endure these losses with savings or credit than food-sufficient households (37). In addition, food-insufficient children are more likely to live in low-income families than food-sufficient children (38). Thus, adequate resources for food allow for food security, whereas inadequate resources for food can lead to food insecurity with or without hunger.

Food Stamp Cycle

The relationship between the Food Stamp Program and food security can be looked at from two ways. On one hand, households are expected to become more food secure after receiving and using food stamps. Conversely, it is those food-insecure households, unable to meet their food needs, that seek assistance through the Food Stamp Program (27,30) as a potential coping strategy. In fact, half of food stamp households were food secure in 2004, whereas 31% were food insecure without hunger and another 19% were food insecure with hunger (4). The food stamp cycle seems to affect people at all three levels of food security, and households may transition between these levels depending on the time of month of the food stamp cycle. Still, several researchers have found that food stamps do not ensure consumption of nutritionally adequate diets (39), nor do levels of food insecurity differ between food stamp participants and nonparticipants (40,41). The inability of the Food Stamp Program to bring all households to a level of food security (42) may be a result of insufficient benefits (33), the duration of monthly benefits (33,34,41,42), inefficient household budget management (34,41), and/or inadequate nutrition education (41).

Coping Strategies

The association of the Food Stamp Program with both obesity and food insecurity may signify that the food stamp cycle plays an important role between the two conditions. The studies reviewed here seem to point to a specific relationship between food insecurity and increased body weight, especially in adult women. Thus, food insecurity with or without hunger (because severity seems dependent on race/ethnicity) appears to force an individual or household to deal with one or more of the coping strategies described as proposed hypotheses (eg, physiological changes during childhood, economic changes and food choice, psychological changes and stress, parental protection, and physical adaptation to the feast/famine cycle). It is the way in which one responds to these mechanisms that in part determines body weight. Those households or individuals who are able to positively deal with these coping strategies will likely maintain a nonobese body weight, whereas those who are not able to will likely be overweight or obese.

STRENGTHS AND LIMITATIONS

This review provides a current and comprehensive look at the literature regarding the correlation between food insecurity and obesity in nonelderly adults and children. In

addition, it examines the potential role of the Food Stamp Program in the association between food insecurity and obesity. Particularly, this review proposes a unique conceptual framework linking the Food Stamp Program and other coping strategies to the food insecurity–obesity relationship in both non-elderly adults and children.

There are several limitations of the literature, and therefore this review, for looking at the relationship between food insecurity and obesity. First, several of the studies included here measured food insufficiency; others determined food insecurity status. As previously mentioned, food insecurity is a broader term that encompasses food insufficiency and, therefore, the two are not exactly comparable. Another limitation lies in the fact that several food security/insecurity measures have been developed, and a variety was used in the research presented in this review. Because each measure differs in the level to which it has been evaluated and administered (43), outcomes may vary depending on what scale is used (19). It is therefore difficult to compare results across studies that use different measurement scales. Despite the varying measures and scales, trends were observed among adult women, whereby increased body weight seems related to food insecurity status (9,15,17-19).

RECOMMENDATIONS FOR RESEARCH

Due to the limited research regarding the relationships between food insecurity, obesity, and the Food Stamp Program, more studies are essential to support the proposed framework. Specifically, previous studies have mainly been cross-sectional; therefore, longitudinal or prospective studies exploring the link between food insecurity and obesity are needed to determine causality and the roles that sex and ethnicity may play. It would also be useful to have a standard definition and evaluation method for determining food insecurity to better compare future research.

Further evaluation (both qualitative and quantitative) of the Food Stamp Program with regard to food insecurity and food purchasing and consumption patterns would provide greater insight into the benefits of the program, as well as which needs are currently not being met. Several such studies are beginning or already underway (44). Future food security surveys should include questions regarding specific food assistance programs, including the Food Stamp Program, to further explore the federal program's link to both food insecurity and obesity.

RECOMMENDATIONS FOR POLICY

Several federal and nonfederal programs and organizations currently address a variety of aspects of food security in the United States (42). However, because food insecurity is associated with overweight and obesity in certain populations, modification of current policies and/or the addition of new policies and programs are needed to diminish the prevalence of food insecurity. For one, the proposed role of the food stamp cycle in the food insecurity–obesity relationship has several policy implications. First, current talks of reduced spending and eligibility requirement changes for the Food Stamp Program would actually worsen the food insecurity situation

in the United States. One agricultural economist has calculated that a 1% decrease in food stamp benefits, holding all else constant, would result in an increase of about 4,000 to 13,000 food-insufficient households (30). Because nutrient-dense foods—fresh fruits and vegetables, lean meats, and fish—are more costly than energy-dense foods—soft drinks, chips, and chocolate—few low-income households are able to spend less than the Thrifty Food Plan while simultaneously purchasing foods that contribute to a nutritionally balanced diet (27). Therefore, increased budget allotments for the Food Stamp Program are needed to ensure the benefit amount received is adequate to purchase not only enough food, but also food of high nutritional quality.

Several researchers have suggested additional interventions that promote budgeting across the food stamp cycle to reduce end-of-the-month food shortages. Ideas such as changing the distribution of food stamp benefits from monthly to weekly or biweekly intervals (32,34,45) and providing education on financial planning (41,45) have been proposed. Others have recommended redesigning the Food Stamp Program altogether. Townsend (46) argues that the US government inherently supports energy-dense foods by allowing these items to be purchased with food stamps, despite the government's recommendation to consume less of these products. Instead, food stamps should only be used for foods that support the Dietary Guidelines for Americans (47), thus tightening restrictions and changing the emphasis of the Food Stamp Program from energy intake to nutritional quality (45,46). Fruits, vegetables, and whole grains can also be promoted through food stamp subsidies for these foods, whereby discounts are given directly to the recipient at grocery store check-out. Finally, the Food Stamp Nutrition Education program, currently allotted 1% of the total annual Food Stamp Program budget, is an optional means for states to provide nutrition education to low-income families. Evaluations of these nutrition education programs, along with increasing the number of food stamp recipients participating in these programs, may help to reverse the growing trend of obesity in this population (45,46). Still, it is consistently apparent that overweight and obesity disproportionately affect low-income individuals, and further work in welfare reform and poverty prevention may provide significant improvements in the food security of this country.

The authors thank the Dorothy Epstein Fellowship.

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