

THE RELATIONSHIP BETWEEN FOOD SECURITY STATUS AND OVERWEIGHT
AMONGST WOMEN AGE 16 TO 85 YEARS OLD

By

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Data from the National Health and Nutrition Examination Survey

(NHANES) 2001-2002 were used to examine demographic factors and BMI as it related to household food security status of women 16-85 years of age. Four designations were used to classify households: fully food secure, marginally food secure, food insecure without hunger, and food insecure with hunger. Significant relationships exist between food security and age, education, ethnicity, poverty income ratio and BMI. Women from food insecure households with hunger were at greater risk of becoming overweight. Households of compromised food security status most likely had an income between 0-130% of the poverty level. Women in households at 100-130% of the poverty level had a higher risk of obesity/morbid obesity. The more years of education women completed, the less risk they had for overweight and food insecurity. Women under 40 had a higher risk of marginal food security and food insecurity without hunger.

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CHAPTER I

INTRODUCTION

Can such a seeming contradiction as food insecurity/hunger and overweight/obesity really be related to one another? A growing wealth of research from various sectors suggests that they are, in fact, closely linked. The physiological causes of obesity and overweight are governed by a simple principle: more energy in than energy out. How is it that, given this premise, persons who do not have a safe, adequate, and consistent supply of food and/or are deemed as hungry, meaning that they experience the uncomfortable sensation or uneasiness that is related to having inadequate food, be at risk for overweight and obesity? This relationship seems paradoxical, but only on the surface. There are a variety of factors governing the correlation of food insecurity and overweight/obesity related to behavior, the environment, one's culture, race/ethnicity, and economic situation. This issue must be treated as a puzzle, with interlocking pieces that rely on multiple forces to align them in the correct combination.

Food security is defined by the United States Department of Agriculture (USDA) as possessing consistent, dependable access to enough food for active, healthy living. Included in this definition is obtaining food in socially acceptable ways and having access to an assortment of foods that provide the wide array of vitamins, minerals, and nutrients a person needs to live a healthy, active lifestyle. A small amount (11%) of American households are food insecure, meaning that their lack of access to a safe,

healthy, and secure food supply is hindered. This hindrance could be due to a variety of factors, such as constrained economic resources, food availability, knowledge, or a combination of these factors. When any one person in a household begins to skip meals or restrict the amount of food they normally consume, very low food security, previously referred to as food insecurity with hunger becomes an issue. Hunger is defined as the physiological consequence to the prolonged experience of food insecurity (Andrews, 2005). In 2005, the Economic Research Service decided to measure the degree of food insecurity using the terms “low food security” and “very low food security.” The term ‘hunger’ was eliminated. The rationale behind this decision was that hunger, as an individual’s physical feeling, was an inconsistent way to measure the extent to which someone experiences food insecurity.

According to the National Institutes of Health (NIH), approximately one-third of adults in the United States are overweight and 32.2 % are obese. Many of the nation’s children and adolescents, 17.1%, are obese (WIN, 2006). Overweight is defined as an excess of body weight when compared to set standards for gender, age, and height. Excess weight may be contributed by body water, bone, muscle, and/or fat. However, obesity is referred to specifically as possessing an excess amount of body fat (NIH, 1998). As overweight, obesity, and their related health problems increase, so does the cost of healthcare expenditures. It has been estimated that obesity-related deaths have totaled 300,000 people per year with an annual health care bill of \$117 million in direct costs (Stein, 2004).

Rates of obesity and overweight amongst Americans of all ages, races/ethnicities, and income levels have been on a steady incline, with both men and women being

adversely affected (Mokdad, 2003). In the United States, obesity is secondary only to smoking in the number of preventable deaths that are attributed to it each year (Mokdad, 2004).

The determination of an individual as overweight or obese can be derived in a variety of ways. The most commonly used method is by the calculation of an individual's Body Mass Index (BMI). BMI is a measure that is used to define the adiposity of a person based on a ratio of weight in kilograms (kg) to the square of height in meters (m) (Escott-Stump, 2004). BMI ranges are typically viewed in five different categories for adults. A BMI less than 18.5 is considered underweight, a BMI between 18.5-24.9 kg/m² is considered normal, a BMI between 25-29.9 kg/m² is considered overweight, a BMI greater than or equal to 30 kg/m² is considered obese, and a BMI greater than or equal to 35 kg/m² is considered morbidly obese. All of these ranges apply to adults and provide an easier way to assess disease risk (NIH, 2006)

Drawbacks and inconsistencies can exist when using BMI as an indicator of health status. Persons who have an above average amount of muscle may fall in to the overweight/obese category and the elderly, who may have decreased bone mass may appear to be at a healthy weight when in reality they have lowered nutritional status. Since BMI can be misleading, it should not be used as the only diagnostic tool of an individual patient, but rather as a general indicator of population trends (NIH, 1998).

When assessing children BMI is determined using age and gender specific growth charts developed by the Centers for Disease Control. Children at risk for overweight have a BMI that falls between the 85th and 95th percentile for age and gender.

Overweight for children is defined as a BMI at or above the 95th percentile for age and gender.

In recent years, studies have found a distinct correlation between food insecurity and increased body weight. Both of these grave public health concerns and their origins need to be established so that appropriate measures of prevention can occur. This research, using nationally represented data from the NHANES (2001-2002) will attempt to explore this main idea amongst women 16-85 years old, along with uncovering some of the contributing factors to this proposed phenomenon.

The purpose of this study is to assess the level of a woman's household food security status as it relates to her BMI. Along with examining this specific relationship, other variables that could be possible contributors to household food security status and BMI were analyzed. The other variables are level of completed education, the level of poverty the household existed at, ethnicity, and age of the female. It is hypothesized that women age 16-85 years old who are not fully food secure will have a higher BMI with significant correlations to educational attainment, ethnicity, poverty level, and age.

CHAPTER II
THE RELATIONSHIP BETWEEN FOOD SECURITY STATUS AND OVERWEIGHT
AMONGST WOMEN AGE 18 TO 65 YEARS OLD

Abstract

Data from the National Health and Nutrition Examination Survey (NHANES) 2001-2002 were used to examine demographic factors and BMI as it related to household food security status of women 16-85 years of age. Four designations were used to classify households; fully food secure, marginally food secure, food insecure without hunger, and food insecure with hunger. Significant relationships exist between food security and age, education, ethnicity, poverty income ratio and BMI. Women from food insecure households with hunger were at greater risk of becoming overweight. Households of compromised food security status most likely had an income between 0-130% of the poverty level. Women in households at 100-130% of the poverty level had a higher risk of obesity/morbid obesity. The more years of education women completed, the less risk they had for overweight and food insecurity. Women under 40 had a higher risk of marginal food security and food insecurity without hunger.

Review of Literature

Health Consequences and Concerns

One of the *Healthy People 2010* objectives is related to nutrition, with specific focus areas including food security and obesity. Objective number 19-18 states “Increase food security among U.S. households and in so doing reduce hunger.” The goal set forth by these objectives is to increase food secure households to 94% of total households by 2010. Currently, the U.S. has a household food security rate of 89% (Andrews, 2005). A goal to cut U.S. food insecurity in half by 2015 has been set by the U.S. Department of Agriculture’s Food Security initiative. Objective number 19-1 of *Healthy People 2010* states, “Increase the number of adults who are at a healthy weight,” objective 19-2 states, “Reduce the proportion of adults who are obese,” and objective 19-3 states, “Reduce the proportion of adults and adolescents who are obese.”

The food insecure adult can suffer behavioral consequences, and psychological suffering, along with poor physical health as it relates to improper nutrition (Evenson, 2002). Poor nutrition carries a host of risk factors for illness, chronic diseases, and decreased ability for economic generation.

When the diseases associated with overweight or obesity are coupled with the consequences of poor nutrition, the quality of life for persons experiencing them is diminished. Health risks associated with overweight and obesity in adults include an increased risk for; cardiovascular disease, high blood pressure, and type 2 diabetes (Stevens, 1998). An increase in certain types of cancers of the colon and rectum, liver, esophagus, kidney, pancreas, and gallbladder are seen at increased rates in the overweight

and obese. The same is true in regards to cancers of the stomach and prostate in men and cancers of the ovaries, uterus, cervix, and breast in women (Calle, 2003). The NIH has also established links of overweight/obesity with gallbladder disease, sleep apnea and other breathing problems, osteoarthritis, stroke, and high blood cholesterol. Specifically, obesity can attribute to menstrual irregularities, stress incontinence, depression, complication of pregnancy, increased surgical risks, and increased mortality (NIH, 2006).

Overweight and obesity-related health problems are also contributing to an increase in economic expenditures in this country. The effects can be seen in direct ways such as in increased hospital/physician visits, diagnostic tests, and prescription drugs. Other indirect costs of overweight and obesity are from missed days at work, leading to a loss in wages from disability, illness, or injury. Early death that may be brought on by an obesity-related disease also means a loss of future wages (NIH, 2006).

Detrimental consequences exist for both children and adults that experience food insecurity and overweight/obesity. A lowered health status, increased episodes of colds, stomachaches, and headaches along with impaired physical and cognitive growth are issues of concern for food insecure children (Sherman, 1995; Alaimo, 1998). Food insecurity was associated with lowered developmental projections in children. It can also serve as a marker for specific developmental consequences of both a nutritional and non-nutritional nature (Jyoti, 2005). Overweight and obese children are at risk for a multitude of disease and conditions that were at one time only seen in adults such as; type 2 diabetes, hyperlipidemia, and hypertension (Dietz, 1998).

Demographics

The report *Household Food Security Status in America, 2005* surveyed 50,000 households in the U.S. to determine food security status. According to the most recent national estimates of this survey by the Economic Research Service (ERS) of the U.S. Department of Agriculture, 89.0% of households were food secure throughout the 2005 year. This number has increased 0.9 percentage points from 2004 when it was measured at 88.1%, meaning that approximately one million more households have attained a food secure status in 2005. The 11% of food insecure households in 2005 translates into 12.6 million households that did not always have access to safe, adequate and nutritious foods throughout the year due to a lack of resources. In the past, one classification of household food security status was termed ‘food insecurity with hunger.’ Beginning with the 2005 sampling year, the term “hunger” has been replaced by the phrase “very low food security.” Persons who were food insecure and experienced periods of very low food security in 2005 did not significantly change from 3.9% or 4.4 million people in 2004.

On any given day it was found that between 32,000 and 43,000 households with children experience very low food security. This number corresponds to approximately 0.08 % to 0.11% of American households with children who experienced very low food security (Andrews, 2005). In the sampling year of 2003-2004, NHANES reported that 17.1% of children and adolescents were overweight. When this percentage was compared to previous examination years dating back to 1999, it was discovered that there was a significant increase in the amount of overweight children and adolescents (Ogden, 2006). Research has shown a positive correlation has been found to exist between

childhood food insecurity and risk for being overweight (85th –95th percentile), as well as being overweight ($\geq 95^{\text{th}}$ percentile) (Rose, 2006; Bogle, 2006).

Coping mechanisms such as community food pantries and soup kitchens, federal assistance programs, and eating a diet of little variety were used by the food insecure to prevent them from experiencing very low food security or hunger (Youn, 1999).

Approximately 22 % of food insecure households received emergency food from a food pantry at some time during the year, whereas 3.6 % ate one or more meals at an emergency kitchen in their area (Andrews, 2005).

With regards to geographic location, in 2005 more households that were in the Southern portion of the US experienced increased food insecurity as compared to the Northern region. New Mexico, Texas, Mississippi, South Carolina, and Arkansas were the top five states in 2005 for households experiencing the greatest amount of food insecurity. Urban and rural households experienced more food insecurity than those in suburban areas (Andrews, 2005). In contrast when Alaimo (1998) examined results from NHANES III, no difference in food security status was found between differing geographic regions.

Rural areas are often left without a selection of food outlets to purchase their foods (Kaufman, 1998). This means that their lack of access to fresh foods, a variety of foods, and competitive food prices puts them at further disadvantage from their urban and suburban counterparts (Morris, 1992). When the local food environment is diminished, absent, or too expensive to choose foods from, household food insecurity rates rise. Rural areas often rely on informal social support systems to acquire food, such as family and friends. It was found that a household's food insecurity status decreases as the

number of groups they provide food for increases (Garasky, 2006). These households that are providing for others are giving to the point that their own food security status is negatively affected. Evidence shows that families in poverty facing similar or worse hardships often share resources among one other, which could be an explanation for this phenomenon (Payne, 2001).

The 2005 ERS report on food security reveals that minority populations are more inclined to be food insecure. The overall food insecurity status for white, non-Hispanic households was 8.2%. In this same year, 22.4% of black, non-Hispanic households and 17.9% of Hispanic households surveyed experienced food insecurity. Other studies have also confirmed minority populations to be disproportionately affected by issues of food insecurity (Townsend, 2001; Rose, 2006; Alaimo, 1998). The prevalence of concern in regards to having enough food was also highest amongst minority groups in a study of residents from NY and LA. In New York, African-Americans reported concern over enough food at four times the rate of non-Hispanic whites. Hispanics reported this same concern at 14 times the rate of non-Hispanic whites. A similar trend was also observed in Louisiana, where the African-American population was three times more likely to report concern about having enough food than were non-Hispanic whites. However, in Louisiana, Hispanics were not significantly different from non-Hispanic whites in reporting concern over having enough food (Laraia, 2004).

Minority groups, when compared to non-Hispanic whites, carry the greatest risk for being obese and/or overweight. When prevalence data from NHANES was compiled for the years between 1999-2004, it was found that 36.8% of Mexican-Americans were obese, 45% of African-Americans were obese and 30% of non-Hispanic whites were

obese (Ogden, 2006). Children from Hispanic and African-American households are more likely to be overweight than children from non-Hispanic white households (Rose, 2006).

Socioeconomic Factors

Socioeconomic status is a measure that can be related to food insecurity. Persons of lower socioeconomic status, who are the most likely to experience food insecurity, are also at greatest risk for possessing a body mass index that classifies them as overweight or obese (Townsend, 2001; Mokdad, 2001). Households that had an income near or below the federal poverty level were more likely to experience food insecurity (Andrews, 2005; Alaimo, 1998). This means that these households had an income that was 185% or less of the federal poverty level. The U.S. Department of Health and Human Services determines the federal poverty guidelines for each year. These guidelines are used to determine eligibility for federal assistance programs. The poverty level for a family of four for the 2006 year was \$20,000 for the 48 contiguous states; these guidelines are updated every year based on the U.S. Census poverty thresholds.

The Thrifty Food Plan provides guidelines for the minimum amount of money someone would need to spend to be able to eat a diet that meets the Dietary Guidelines for Americans. The guidelines are based on the composition of household size, age, and gender. The average food insecure household spent 1 % less than the cost of the Thrifty Food Plan, while the average food secure household spent 33 % more than the cost of the Thrifty Food Plan. All this means that when household age and gender were controlled,

food secure households spend 34 % more on food than the food insecure households (Andrews, 2005).

Rose (1999) found that approximately 50 % of households that experienced food insecurity had incomes above the poverty line, suggesting that income and employment status may play synergistic roles in food security status. When Townsend (2001) examined the relationship between food security, household income, and overweight (BMI ≥ 27.3 kg/m²) positive correlations existed between these variables. The research found that the food secure population had a higher income and lower rate of overweight (34%) than the mildly (41%) and moderately (52%) insecure groups. The mildly insecure group had a higher income than the moderately food insecure population. The income level to morbid obesity (BMI ≥ 35 kg/m²) relationship for people from Louisiana and New York was examined and analyzed (Laraia, 2004). It was found that with increasing income the level of morbid obesity dropped for persons from Louisiana but a drop in the morbid obesity rate was not seen for the people of New York until the \$50,000 threshold was attained. When this same group was examined for concern about having enough food an increase in income was associated with a decrease in concern about enough food.

Another socioeconomic factor that can be used to indicate risk for overweight and/or food security level is the amount of education completed. When a group of people were examined for comparative risk for morbid obesity in Louisiana, the results were that an inverse relationship between the amount of education completed and level of concern about enough food (Laraia, 2004). This means that the more education a person completed, the less likely their household was to be concerned about having enough food.

Townsend (2001) found that a high school education or less was a significant predictor of overweight in women ($BMI \geq 27.3 \text{ kg/m}^2$). A total of 49.8% of the total population analyzed had less than or equivalent to an 11th grade education. Overall, the group that was moderately food insecure and had an 11th grade education or less had the highest proportion of overweight individuals (63.3 %). The group with the lowest proportion of overweight individuals based on education level was mildly food insecure and had completed four or more years of college. Frongillo (2006) found that among women who were food insecure, they had on average completed 10.5 years of formal schooling. In comparison, women who were food secure, on average completed 13.2 years of formal schooling. It has also been shown that when head of households had a minimum of a high school education, the family was less likely to be food insecure (Alaimo, 1998). Maternal education was also found to have an inverse relationship with the overweight status of their children (Rose, 2006). The more education the mother possessed, the less likely her children were to be overweight.

Data reported from the Behavioral Risk Factors Surveillance System (BRFSS) for the years of 1995-1999 was combined and analyzed to determine the main variables associated along with the characteristics of being obesity and concern about enough food (MMWR, 2003). The persons who reported concern about adequate food, whose annual income was $\leq \$20,000$, who had no college education, or who were female, black, American Indian/Alaska Native, Hispanic, or aged ≥ 45 years were more likely to be obese than the rest of the population. All of these findings show the very complex interrelatedness of a multitude of factors that contribute to overweight, obesity and food security status.

Federal Assistance Programs, Food Security and Weight Change

The goal of nutrition and food assistance programs is to fight food insecurity, hunger, and their related health problems (Service, 1999). The principal beneficiaries of food-assistance programs are low-income families (Basiotis, 2002).

When surveyed by the Economic Research Service in 2005, about 50 % of households that were food insecure had relied on one or more of the three largest federal assistance programs in the past month to obtain food. These three federal assistance programs are the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC), the National School Lunch Program (NSLP), and/or the Food Stamp Program (FSP). This evidence shows a correlation between food insecurity and federal program assistance use in at least half of all people who use them (Andrews, 2005).

The rate of children experiencing food insecurity is typically lower than the relative proportion of adults experiencing food security. Children are usually shielded from the effects of food insecurity due to parents eating less so that the children can have more and because children attend school where they may have the opportunity to qualify for free or reduced lunch (Rose, 2006). When a group of low-income, school-aged children were analyzed to identify the links between FSP participation, school lunch and breakfast participation and food security status, children who participated in all of these programs had a higher household food security rate than those who only participated in the school breakfast and lunch programs (Gorman, 2006). Specifically, a group of girls aged 5-12 years from food insecure households were examined to determine if participation in all three of these programs affected risk of overweight ($BMI \geq 85^{\text{th}}$

percentile) when compared to girl's that did not participate in any of the programs. It was found that participation in all three of the programs reduced the girls odds of being overweight by 68% when compared to their non-participating counterparts (Haughton, 2003).

Gibson (2004) found long-term FSP participation was positively and significantly related to overweight (BMI \geq 95th percentile) in young girl's age 5-11 years. There was a 42.8% increase in overweight for young girls enrolled in the FSP when compared to young girls not on the FSP. Long-term FSP participation was negatively and significantly related to overweight in young boys ages 5-11 years as evidenced by a 28.8% decrease in overweight status when compared to their counterparts not enrolled in the FSP. However, there was no positive correlation amongst long-term FSP participation and overweight amongst boys or girls ages 12-18 years.

Several studies have explored the effects that FSP participation has on adults. When Townsend (2001) examined the relationship between FSP participation and adults, data from the Continuing Study of Food Intake of Individuals (CSFI) were used to analyze 9,451 men and women from 1994-1996. It was found that there was a significant and positive relationship that existed between FSP participation and overweight (BMI >27.3 kg/m²) for women. The total respondents that were both overweight and receiving food stamps was 51.8%. The prevalence of overweight amongst women in the moderately insecure group (68.3%) was found to be significantly higher than the rates of overweight for women in the food secure (48.4%) and mildly insecure (53.7%) group, all of who were receiving food stamps. After controlling for food insecurity status and other potential cofounders it was reported that women who participated in the FSP were 38%

more likely to be overweight. No association was observed between overweight and FSP participation for men. This particular study proposed an interesting hypothesis in regards to the high percentage of women that are on food stamps and overweight. It was named the 'food stamp cycle' and is based upon the acquisition pattern of food that is experienced by food stamp recipients. This cycle is reminiscent of binge eating in that the first three weeks food stamp participants have abundant food supplies and resources, followed by a week of limited food selection due to lack of food stamps and money (Wilde, 2000). When the first of the month comes and food-insecure families have their food purchasing power restored, they may over-consume highly palatable, energy dense foods. Binge eating has been shown to cause weight gain in humans, leading to biological and psychological consequences. This theory has not yet been formally tested. However, the authors of this study feel that it warrants a lot of merit for the relationship it could explain between the food insecurity and overweight relationship. Potentially, it could have major implications for policy revision in regards to the FSP (Polivy, 1996; Policy, 1985).

When Gibson (2003) examined the relationship that FSP participation had on adult weight the findings were similar to Townsend (2001). The group of people that were used for this analysis were taken from the National Longitudinal Survey of Youth 1979. They were analyzed for predicted probability of obesity ($BMI \geq 30 \text{ kg/m}^2$) based on current participation and long-term participation. Long-term participation was defined as at least five years. There was no correlation found between obesity and long-term or current FSP participation for men. However, there was a significant and positive correlation found between women and both current and long-term FSP participation in

relation to obesity. Current participation for women corresponded with a 9.1% increase in the predicted probability of current obesity. Each year a woman participated in the FSP over the previous five years corresponded to a 20.5% increase in the predicted probability of obesity for each year when compared to a woman who had never participated. Women who participated in the FSP 100% of the time over the five year period increased their probability of being obese by four percentage points after controlling for income and other fixed effects. The author of this study did not control for food insecurity but rather based it upon the perceived assumption that FSP participation is an indicator of food insecurity (Gibson, 2003).

Using data from the 1999 and 2001 Panel Study of Income Dynamics, Frongillo (2006) examined the effects of the FSP participation on the relationship between food insecurity and weight change in women. The hypothesis of this study took on a different approach to the possible causal relation of the above-mentioned variables. The authors felt that food insecurity could be assumed as a stressor in a woman's life, therefore leading to a stress-induced weight change. When the woman became eligible to receive food stamps, this added food resource could possibly eliminate the effects of food insecure stress and remove the effects of food insecurity on weight gain. This study did find a correlation between food insecurity and weight change in women of -7 kg at baseline among women who changed their food security status during the study period and women who remained food insecure. This means that women who remained food insecure from 1999-2001 had a lowered body weight on average of 7 kg. For women that were food insecure before their weight change but became food secure during the study period, no effect of food security on weight change was observed. When persistently

food insecure women gained access to full participation in the FSP, a positive weight change of 7.8 kg was recorded. After controlling for baseline and changing factors in a woman's life, it was estimated that FSP participation increased the persistently food insecure woman's weight by 0.8 kg in a one year period. Among women who changed food security status to either food secure or insecure during the study period, full participation in the FSP was not associated with additional weight gain. The only significant results of this study were found among women who were persistently food insecure.

Women's Weight Status in Relation to Food Security

In 2005, households with a single mom were more likely to be food insecure (Frongillo, 2006; Andrews, 2005). Numerous studies indicate women as being the group primarily affected by overweight and obesity when food insecurity exists. Adams et al (2003) examined this relationship in California's women using data collected from the California Women's Health Survey from 1998-1999. Interviews were conducted by telephone on 8,169 women ages 18 or older who were asked a series of four questions that were adapted from U.S. Household Food Security Module. The variables for this study were education, race/ethnicity, and income, country of birth, general health status and walking. Obesity ($BMI \geq 30 \text{ kg/m}^2$) affected 31% of the food insecure women as opposed to only 16.2% of food secure women. Caucasian women were at an increased risk of obesity associated with food insecurity without hunger as opposed to all other racial/ethnic groups. Asian, African-American, and Hispanic women had an increased risk of obesity when they were food insecure with hunger as opposed to Caucasian

women. This study concluded that food insecurity is associated with increased probability of obesity with greatest risk in the Hispanic, African-American, and Asian racial/ethnic groups.

Townsend (2001) found that the prevalence of overweight ($\text{BMI} \geq 27.3 \text{ kg/m}^2$) increased linearly with the degree of food insecurity. Overweight status was 34% for women with no food insecurity, 41% for women with mild food insecurity, 52% for women with moderate food insecurity, and 20% for women with severe food insecurity. In all statistical models that were presented for this study, the food insecurity/overweight relationship was positive and significant. These results show the high correlation between overweight and food security status for women involved in this study. These numbers also show that on both extremes of the food security categories, a lower risk for being overweight exists. Polivy (1996) found that food intake restriction might be voluntary among the food secure to prevent weight gain and to maintain current weight. These women may also feel more social pressures to be thin, which could influence them to voluntarily restrict their food intake as a means of avoiding excess weight gain. Lack of access to food, transportation, and other resources could all be reasons that hinder the severely food insecure women from being able to eat enough.

Another study by Peterman (2006) used the National Health and Nutrition Examination Survey to assess food security status and weight change over time using the data sets for 1999-2000 and 2001-2002. Household food security status was determined by using the 18-item U.S. Food Security Survey Module. After the data were analyzed the researchers found that women in fully food secure households had the lowest rate (30.9 %) of obesity ($\text{BMI} \geq 30 \text{ kg/m}^2$) and had the lowest risk (20.7 %) for gaining 10

pounds within a year. Women in households classified as marginally food secure had a 43.1% obesity rate with a 34.6% prevalence rate of a 10 pound weight gain in one year. Women who fall into the food insecure without hunger category had an obesity rate of 46.3% with a corresponding 32.9% prevalence of gaining 10 pounds in a year. Finally, women in households that were designated as food insecure with hunger had an obesity rate of 39.6% and 30.6% of this group were at risk of gaining 10 pounds in a year.

Women who were food insecure without hunger were the most likely group to be obese and women who were considered marginally food secure were the most likely group to put on at least 10 pounds in a year. This study is congruent with the results found in both the Townsend (2001) and (Adams, 2003) studies that revealed women with mild to moderate food insecurity are the most likely to be overweight or obese as compared to food secure women.

Methods

Survey Design and Data Collection

Data used for analysis was obtained from the National Health and Nutrition Examination Survey (NHANES) for the survey period of 2001-2002 (CDC 2006). The National Center for Health Statistics of the Centers for Disease Control and Health Statistics (CDC) collected the data. Beginning in the 1960's, NHANES focused on different health topics and population groups on a periodic basis. However, in 1999 NHANES became a continuous survey that examines approximately 5,000 persons per year. The NHANES survey design is a stratified, multistage, probability sample that

targets the civilian, non-institutionalized population of the U.S. Certain groups such as low-income persons, adolescents 12-19 years, persons 60+ years of age, Mexican-Americans, and African-Americans are over-sampled to ensure more reliable statistics for these groups. Information regarding the health and nutrition of the United States household population is gathered in two ways, a home interview and health examination. Before starting, written and informed consent is obtained from each participant. A trained interviewer administers all of the questionnaires to household participants. The home interview asks participants questions regarding disease history, health status, and diet. Mobile examination centers (MEC) are setup to provide a standardized, controlled environment where the health examinations take place. The MEC provides medical and dental examinations, laboratory tests, and physiological measurements that are carried out by teams of health and medical technicians, physicians, health and dietary interviewers.

NHANES designates household food security status based upon responses to questions asked during the home interview. The questionnaire used is the 18-item U.S. Food Security Survey Module that asks questions about food insecure conditions or behaviors that occurred during the previous 12 months. Regardless of household size or number of families residing within the house, only one person per household answered questions from the module. There are four classifications used to represent the degree of food security; food secure, marginally food secure, food insecure with hunger, and food insecure without hunger. Example questions that households asked were “In the last 12 months, did you ever eat less than you felt you should because there wasn’t enough money for food?” and “In the last 12 months, did you lose weight because you didn’t have enough money for food?”

Demographic information for gender, age, race/ethnicity, poverty income ratio (PIR) were obtained from the demographic questionnaire. The MEC collected current heights and weights of study participants.

Study Sample

Using data from NHANES 2001-2002 survey years, 2,737 total respondents were used for analysis. Respondents used for analysis were all female, between the ages of 16-85, who participated in the interview portion and were MEC examined.

Variable Selection

The analysis variables were comprised of demographics, food security status, and anthropometric measurements. Demographic variables included gender, age at screening, ethnicity, educational attainment, and poverty income ratio. Anthropometric variables included BMI (kg/m²) that was calculated from the measurements taken at the MEC.

Data Analysis

All data management procedures such as grouping persons according to food security status, Poverty Income Ratio (PIR), BMI, and race/ethnicity and education were analyzed using SAS System 9.0. The mean and standard error of all data were calculated with SUDAAN, a statistical analysis program that takes into account the sample weights and design when calculating estimates. The chi-square test for of independence was applied in SUDAAN to test for significant differences between variables. An alpha value of 0.05 was used for determination of significance between variables.

Results and Discussion

Of the 2,737 female led households included for analysis from the 2001-2002 NHANES survey years, 2,118 (77.38%) lived in households considered fully food secure, 244 (8.91%) were marginally food secure, 271 (9.9%) were food insecure without hunger, and 143 (5.22%) were food insecure with hunger.

Table 1 reveals the percentages of women living in households of variable food security statuses as identified by their individual body mass index (BMI). A significant relationship was found between household food security status and BMI groups ($P < 0.01$, chi-square = 89.09). Women living in households that were classified as food insecure without hunger were more likely to be underweight ($BMI < 18.5$) than women living in all other households. When a woman was identified as belonging to a fully food secure household, she most often had a desirable BMI (18.5-24.9). Women from households that were food insecure with hunger had a significantly higher risk of falling into the overweight category with a BMI equal to 25-29.9. Women living in households considered marginally food secure (36%) were found to be more likely to have a BMI of 30-39.9 followed by women who are food insecure without hunger (32%), which classifies them as obese.

Table 1

The Relationship Between Body Mass Index (BMI) of Adult Women to Household Food Security Status¹

BMI	Fully food secure n(%) (n=2098)	Marginally food secure n(%) (n=225)	Food insecure without hunger n(%) (n=271)	Food insecure with hunger n(%) (n=143)	χ^2	p-value ¹
<18.5	189 (7.82)	16 (8.27)	28 (16.85)	14 (6.94)		
18.5 - 24.9	727 (36.96)	62 (26.44)	77 (23.54)	34 (24.58)		
25 - 29.9	602 (27.36)	66 (21.98)	69 (19.32)	44 (33.58)	89.09	< 0.01
30 - 39.9	465 (22.1)	67 (36.07)	75 (31.56)	43 (26.96)		
≥ 40	115 (5.77)	14 (7.23)	22 (8.73)	8 (7.95)		

¹Significance at the p<0.05 level was obtained for all data by applying a chi-square test for significance.

Table 2 shows the relationship that was found to exist between Poverty Income Ratio (PIR), BMI, and household food security status. PIR is the measure of a household's income, taking into account all members that reside in the household and comparing it to the appropriate poverty threshold as set forth by the U.S. census bureau (Census, 2006). Significant relationships were found to exist between PIR and BMI, as well as between PIR and food security status. Women residing in households that had a total income less than 100% (PIR<1) of the federal poverty level for their specific poverty threshold were the most at risk (13.96%) for being underweight with a BMI <18.5. When the PIR rises above 3.5 or 350% of the federal poverty level, the percentage (4.55%) of women who are underweight significantly drops. It can also be observed that women living in a household with a PIR greater than 3.5 are more likely to be of normal weight. When women lived in a household that had a PIR of 1.31-1.85 (131-185% of federal poverty level) they were at higher risk of being overweight (BMI 25-29.9).

However, when women belonged to a household at 100%-130% (PIR 1-1.3) of the federal poverty level, they were at significantly higher risk for being obese (BMI 30-39.9) and morbidly obese (BMI \geq 40). This same group of women (PIR 1-1.3) were the most likely to live in households of compromised food security status (marginally food secure, food insecure without hunger, food insecure with hunger). As PIR rises, the percentage of persons belonging to the fully food secure category rises with it. This trend is also observed with an inverse relationship seen between a lower PIR and an increase in persons that are food insecure with hunger.

Table 2

The Relationship Between BMI, Household Food Security Status and Poverty Income Ratio (PIR)¹

BMI	PIR Levels					x ²	p-value
	<1 n(%) (n=600)	1-1.3 n(%) (n=295)	1.31-1.85 n(%) (n=357)	1.86-3.5 n(%) (n=661)	>3.5 n(%) (n=824)		
<18.5	81 (13.96)	27 (10.85)	41 (11.55)	52 (8.48)	46 (4.55)		
18.5 - 24.9	170 (31.3)	88 (25.98)	110 (27.66)	216 (32.8)	316 (41.53)		
25 - 29.9	155 (21.98)	69 (22.34)	106 (30.8)	201 (27.66)	250 (28.04)	446.3	<0.01
30 - 39.9	156 (25.96)	81 (29.47)	78 (23.52)	157 (25.46)	178 (20.93)		
≥ 40	38 (6.81)	30 (11.36)	22 (6.47)	35 (5.6)	34 (4.96)		
Food Security Status							
Fully food secure	276 (49.44)	183 (64.55)	271 (79.92)	562 (86.48)	806 (97.61)		
Marginally food secure	98 (16.37)	36 (13.34)	30 (6.26)	52 (6.92)	9 (0.98)		
Food insecure without hunger	142 (19.09)	50 (12.22)	38 (9.03)	32 (4.04)	9 (1.41)	355.3	<0.01
Food insecure with hunger	84 (15.1)	26 (9.89)	18 (4.79)	15 (2.57)	0 (0)		

¹Significance at the p<0.05 level was obtained for all data by applying a chi-square test for significance.

² PIR is the ratio of income to the households appropriate poverty threshold as determined by the U.S. census bureau.

When the association between race/ethnicity and food security status was examined (Table 3), a significant relationship (P< 0.01, chi-square = 160.32) was found. The majority of respondents of all ethnicities were classified as fully food secure. However, Mexican-American and other Hispanic females were found to be at increased risk of living in a household that was marginally food secure or food insecure without hunger.

Table 3

Race/Ethnicity Characteristics¹ according to Household Food Security Status

Ethnicity	Fully food secure n(%) (n=2098)	Marginally food secure n(%) (n=225)	Food insecure without hunger n(%) (n=271)	Food insecure with hunger n(%) (n=143)
Mexican American	371 (61.25)	75 (9.99)	128 (21.76)	42 (7)
Other Hispanic	66 (54.77)	21 (18.13)	19 (13.79)	58 (13.31)
Non-Hispanic, White	1188 (88.28)	64 (4.48)	58 (4.51)	35 (2.73)
Non-Hispanic, Black	388 (68.75)	58 (11.8)	62 (10.57)	45 (8.88)
Other/Multi Racial	85 (82.48)	7 (7.54)	4 (2.94)	8 (7.04)

¹NHANES weights were applied to data to account for over sampling of specific population groups.

²Significance at the $p < 0.05$ level was obtained for all data by applying a chi-square test for significance.

The level of education obtained by adult women and their individual BMI (Table 4) was examined as a function of household food security status. As the level of education obtained rises from less than high school to more than high school, the amount of women residing in food secure households also increases ($P < 0.01$, chi-square = 74.38). The same relationship is observed with the amount of women that have a normal BMI (18.5-24.9) and an increase in amount of education obtained ($P < 0.01$, chi-square = 43.3). The percentage of women grouped into the overweight category (BMI 25-29.9) declined with an increase in education. This illustrates an inverse relationship between amount of education obtained and percentage of overweight women. When comparing this with the results from Table 1, a relationship between household food security status, BMI, and education is reinforced. When a woman has a higher level of education she is more likely to be both of a normal weight and food secure. A parallel relationship presents itself here between normal, healthy BMI and food secure status as shown in Table 1 and again in Table 4.

Table 4

The Relationship Between Household Food Security Status, BMI, and Education ¹

Variable	Less than high school n(%) (n=1004)	High school diploma n(%) (n=613)	More than high school n(%) (n=1119)	x ²	P value
Household food security status					
Fully food secure	648 (69.08)	472 (79.97)	977 (88.19)	74.38	< 0.01
Marginally food secure	104 (9.25)	62 (8.27)	59 (4.86)		
Food insecure without hunger	169 (13.13)	51 (6.55)	51 (4.33)		
Food insecure with hunger	83 (8.54)	28 (5.21)	32 (2.62)		
BMI					
<18.5	110 (13.17)	59 (7.41)	78 (6.89)	43.3	< 0.01
18.5-24.9	320 (27.77)	191 (32.45)	388 (38.78)		
25-29.9	289 (29.22)	167 (27.16)	325 (25.49)		
30-39.9	225 (24.02)	162 (26.33)	263 (22.74)		
≥40	60 (5.82)	34 (6.65)	65 (6.1)		

¹Significance at the p<0.05 level was obtained for all data by applying a chi-square test for significance.

Table 5 shows the results of the analysis of age groups as it relates to food security status. A significant correlation between the variable was found (P <0.01, chi-square = 88.47). The data shows that women less than 40 are at significantly higher risk of being marginally food secure and food insecure without hunger. Women over 60 had the lowest incidence (2.18%) of food insecurity with hunger. As the women increased in age, their chances of food insecurity with hunger declined.

Table 5

Age Classifications of Women Residing in Households of Differing Food Security Levels¹

Age	Fully food secure n(%) (n=2098)	Marginally food secure n(%) (n=225)	Food insecure without hunger n(%) (n=271)	Food insecure with hunger n(%) (n=143)
16-21	369 (76.15)	54 (7.7)	80 (8.81)	37 (7.33)
21-40	648 (75.72)	91 (9.58)	101 (9.52)	54 (5.18)
41-60	519 (85.89)	37 (4.2)	54 (5.36)	36 (4.56)
≥61	562 (89.54)	43 (4.93)	36 (3.35)	16 (2.18)

¹Significance at the p<0.05 level was obtained for all data by applying a chi-square test for significance.

Summary and Conclusions

The factors that were directly measured for this study included poverty indices, education level, food security status, BMI, and age. These findings have major implications for public health concern, as well as for federal policy legislation. There are many other factors that could have been examined to demonstrate a relationship between food insecurity and overweight. Some things that were not researched in this study were participation in federal assistance programs, geographic location, household composition, and marital status.

This study demonstrates that overweight and obesity does exist among those with compromised food security status, as well as amongst women that are living in households near or below the federal poverty level (0-185%). This positive correlation is most likely due to a wide variety of influencing factors such as education, economics, food availability, and job status.

Women who are the most likely to have a BMI that is not within the desirable, healthy range of 18.5-24.9 from households that are marginally food secure and food

insecure both with and without hunger (Table 1), are 185% or less of the federal poverty level (Table 2), and/or have at least a high school diploma. A weight that is higher than the desirable BMI range puts a person at increased risk for health complications and diseases such as Type 2 diabetes, heart disease, and certain cancers (Stevens J, 1998 #43). When these health complications occur in people who are more likely to be limited resource, as demonstrated by their reduced food security status, it may also be concluded that they may have a decreased disposable income to spend on health insurance and hospital expenses. Thus, it is necessary to increase national spending on health care for those who are least likely to be able to afford it but need its benefits regardless. A positive association between food insufficiency and lack of health insurance has been found by Alaimo (2004) that further supports this line of reasoning.

When looking at the positive correlations that exist between food security and overweight (Table 1), women who were in the two outlying brackets of food security levels, fully food secure and food insecure with hunger, had the lowest percentages of obesity (BMI 30-39.9). Women in the two middle categories of marginally food secure and food insecure with hunger had the largest percentages of obesity. When Wilde (2000) measured weight change and household food security status using NHANES 1999-2000 data an inverted U-shaped pattern was also found amongst women classified as obese amongst the four descending levels food security measurement.

In 2006, the poverty level for a family of four was \$20,000 (Census 2006). To be eligible for certain programs such as the Food Stamp Program (FSP) a family must have a net income that is 130% of the federal poverty level or less. To be at 130% of the federal poverty level a family of four would have an annual net income total \$26,000.

The WIC program requires a net income of 185% or less of the federal poverty level. A family of four would have a net annual income of \$37,000 or less to meet these criteria. The National School Lunch and Breakfast Program provides free lunches to children living in households at or below 130% of the federal poverty level and reduced price lunches are given to those living in households that are 131-185% of the federal poverty level (USDA, 2006).

When the PIR to food security status was examined (Table 2) persons who were members of households considered 0-130% of the federal poverty level were the most likely to experience reduced food security status. Despite all of the programs that they could possibly qualify for, they still experienced lowered food security. Further research should examine to what extent this populations does participate. When income as a percent of the poverty threshold (PIR) rose, so did the amount of women who were considered fully food secure. These findings are consistent with the research of Townsend (2001), who found that food security amongst women was related to income with a dose-response effect. Frongillo (2006) also found that, on average, women who were food secure had a household income of 484% of the federal poverty level and women who were food insecure had an average household income that was 174% of the federal poverty level.

A lowered PIR not only put women at an increased risk for food insecurity, it also had a significant relationship with weight status. Table 3 shows that women who are at or below 185% of the federal poverty level had increased risk of being overweight and obese. When income as a percent of the poverty level (PIR) rose from 100% to greater than 350%, so did the percentage of women who were of normal weight. Townsend

(2001) found that as PIR increases amongst women, their prevalence of overweight significantly decreased.

Level of higher educational attainment had a significant correlation to both food security and BMI (Table 4). As women achieve educational attainment (less than high school, high school diploma, more than high school), their household food security status became more favorable. It was also demonstrated that as a woman became more educated she became more likely to have a normal, healthy BMI. Percentages of women in the overweight category decreased as the level of education increased. This finding aligns itself with several other studies that have used education as an indicator of food security status and BMI. Laraia (2004) found an inverse relationship to exist between the amount of education a woman completed and her degree of concern over food security. Similarly, Townsend (2001) observed that women who were moderately food insecure had an educational level of 11th grade or less and were the most likely to be overweight. This same study also found that women who were the least likely to be overweight had completed four or more years of college and had mild food insecurity.

Racial and ethnicity characteristics were shown to have positive correlations between levels of food security (Table 3). Women classified as belonging to households that were considered Mexican-American or as belonging to another Hispanic culture were more likely to be at risk for food insecurity without hunger and marginal food security when compared to non-Hispanic blacks, whites and members of other races. Another study that found similar results used NHANES data to show Mexican-Americans were at a higher risk of being food insecure as compared to all other ethnicities (Alaimo, 1998). Amongst the non-Hispanic black community, persons were

more likely to experience marginal food security and food insecurity without hunger. Non-Hispanic whites had the lowest prevalence of experiencing diminished food security, which was also demonstrated by data released from the Economic Research Service's report of food security, 2005.

When age as it relates to food insecurity (Table 5) was examined, trends indicated that as a woman's age increases she is more likely to live in a fully food secure household and less likely to live in a household that is of compromised food security status. Women that are younger than 40 are at a higher risk of residing in a household of marginal food security or food insecure without hunger. A study by Adams (2003), examined the age and food security relationship between California women, which showed that as women age their prevalence of food insecurity diminishes.

Future study of this dynamic between food security and weight status should take into consideration other factors not looked at in this work. Participation of persons enrolled in individual as well as multiple federal feeding programs should be examined. Some limitations to this research were the groupings of food security and the questions that were asked in NHANES interviews in the years prior to 2001-2002. Due to differing categorizations I was unable to combine data sets from previous years to examine a larger sample size. When the data sets from the food security modules for NHANES 2003-2004 and beyond are released, they should be examined both separately and collectively to see if these same trends exist. If they do exist, it should be determined if they have increased or decreased and what some of the confounding factors are for this change.

As demonstrated by this research and in comparisons with other research that has been done, it can be concluded that connections do exist between food security status and

weight of women. The expansive topic of food insecurity, weight status, and all of the variables that play a role in it has major implications for a variety of disciplines that should be further examined. In a land of overabundance, it will require considerable work and innovation to help alleviate the inexcusable presence of food insecurity, poverty, and diet-related diseases. Clearly, these issues are of great concern to our country because of the multitude of health consequences and economic expenditures that arise from these issues to plague the public's health and economic sovereignty.

While conducting my research I was exposed to a wide variety of food questionnaires and assays that assess hunger and food insecurity. A multitude of surveillance systems are utilized by different governmental and non-governmental organizations, which are meant to assess the nation's food security status. These agencies use different interviewing techniques, terminology and questions meant to capture an accurate picture of the state of food insecurity in the country. To gain a more comprehensive view of our nation's food insecure constituents, state-by-state, there may be a need to combine some of these methods and procedures so that agencies, which are typically at the state level, can formulate a more accurate plan of intervention with better funding. Such agencies are playing a large role in decreasing food insecurity and increasing nutritional adequacy amongst our nations vulnerable. However, closer examination of the ways that their interventions are helping or hurting their participants may need to be examined. This research did not look at feeding or supplemental programs as influencers to weight status or food security level. However, examining these programs more closely may provide us with a better understanding of the issues.

Our nation has food costs in relation to income that are well below other countries. Agricultural subsidies and technological advances have made much of this possible. But along with lowering food costs, we also have the world's highest rate of overweight and obesity. Many of our overabundant crops are refined into high-fat, high-salt and sugar-laden foods that are highly palatable but devoid of major nutrients. These foods often cost less money per kilocalorie, making them more appealing to consumers, especially those with limited resources for food. This phenomenon may be leading many consumers to spend their money on foods that they see as the best economic bargain, while remaining ignorant of the major health cost they may pay now or in the future. Change must begin through educating the general public, lawmakers, and everyone else about the dangers of increasing access to foods that do not align themselves with the Dietary Guidelines for Americans. We must also begin to spread the knowledge that present day malnutrition and food insecurity may not have the same gaunt faces they did 40-50 years ago. The faces have changed and so to must our policies, attitudes, and interventions.

References

- Adams E, Grummer-Strawn L, and Chavez G. "Food Insecurity Is Associated with Increased Risk of Obesity in California Women " Journal of Nutrition 133 (2003): 1070-74.
- Alaimo K, Briefel RR, Frongillo EA Jr, Olson CM. "Food Insufficiency Exists in the United States: Results from the Third National Health and Nutrition Examination Survey (Nhanes III)." American Journal of Public Health 88 (1998): 419-26.
- Andrews M, Carlson M, Nord M. "Household Food Security in the United States." Ed. Economic Research Service USDA, 2005. Vol. 29.
- Barbara A. Laraia, Ph.D., M.P.H., R.D., Anna Maria Siega-Riz, Ph.D., M.S., R.D., and Kelly Evenson, Ph.D. "Self-Reported Overweight and Obesity Are Not Associated with Concern About Enough Food among Adults in New York and Louisiana." Preventive Medicine 38 (2004): 175-81.
- Basiotis PP, Lino M. "Food Insufficiency and Prevalence of Overweight among Adult Women." Nutrition Insights 26 (2002): 1-2.
- Bogle M, Robbins JM, Stuff J, Weber J, Champagne CM, Connell C, Harsha D, McCabe-Sellers B, Casey P, Simpson P, Gossett J, . "The Association of Child and Household Food Insecurity with Childhood Overweight Status." Journal of the American Academy of Pediatrics 118 (2006): 1406-13.
- Calle EE, Rodriguez C, Walker-Thurmond K, Thun MJ "Overweight, Obesity, and Mortality from Cancer in a Prospectively Studied Cohort of U.S. Adults." New England Journal of Medicine 348.17 (2003): 1625–38.
- Census, Bureau. 2006. March 1, 2007.
<<http://www.census.gov/hhes/poverty/povdef.html>>.
- Core, Jim. "Changing Lifestyles to Fight Obesity in the Delta-- a Tale of Three Communities." Agricultural Research 54.3 (2006): 16.
- Crisofar SP, Basiotis PP "Dietary Intakes and Selected Characteristics of Women Ages 19-50 Years and Their Children Ages 1-5 Years by Reported Perception of Food Sufficiency." Journal of Nutrition Education 24 (1992): 53-58.

- Dietz, WH. "Does Hunger Cause Obesity?" Pediatrics.5 (1995): 766-67.
- Dietz, WH. "Health Consequences of Obesity in Youth: Childhood Predictors of Disease." Journal of the American Academy of Pediatrics 101 (1998): 518-25.
- Escott-Stump S., Mahan K. Krause's Food, Nutrition, and Diet Therapy. 2004 ed. Philadelphia: Elsevier, 2004.
- Evenson, Barbara A. Laraia, Verna L. Lamar Welch, April L. Perry. Statewide Prevalences of Concern About Enough Food, 1996-1999: U.S. Department of Health and Human Services, 2002.
- Frongillo, Sonya J. Jones and Edward. "The Modifying Effects of Food Stamp Program Participation on the Relation between Food Security and Weight Change in Women." The Journal of Nutrition 136 (2006): 1091-94.
- Garasky S, Morton L, Greder K. "The Effects of the Local Food Environment and Social Support on Rural Food Insecurity." Journal of Hunger and Environmental Nutrition 1.1 (2006): 83-100.
- Gibson, Diane. "Food Stamp Program Participation Is Positively Related to Obesity in Low Income Women." Journal of Nutrition 133 (2003): 2225-31.
- Gibson, Diane. "Long-Term Food Stamp Program Participation Is Differentially Related to Overweight in Young Girls and Boys." Journal of Nutrition 134 (2004): 372-79.
- Gorman, K., Horton, K., Houser, R. "Food Security, Hunger, and Food Stamp Participation among Low-Income Working Families in Rhode Island." Journal of Hunger and Environmental Nutrition 1 (2006): 105-23.
- Haughton, B, Jahns, L, Laraia, 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 Pediatric Adolescent Med. 157.8 (2003): 780-84.
- Jyoti DF, Frongillo EA, Jones SJ. "Food Insecurity Affects School Children's Academic Performance, Weight Gain, and Social Skills." Journal of Nutrition 135.12 (2005): 2831-9.
- Kaufman, PR. "Rural Poor Have Less Access to Supermarkets, Large Grocery Stores." Rural Development Perspectives 13 (1998): 19-26.

- Kendall A, Olson C, Frongillo EA Jr. "Relationship of Hunger and Food Insecurity to Food Availability and Consumption." Journal of American Dietetic Association 96 (1996): 1019-24.
- Laraia B, Siega-Riz AM, Evenson K. "Self-Reported Overweight and Obesity Are Not Associated with Concern About Enough Food among Adults in New York and Louisiana." Journal of Preventive Medicine 38 (2004): 175-81.
- Lucia L Kaiser, Marilyn S Townsend, Hugo R Melgar-Quinonez, Mary L Fujii, and Patricia B Crawford. "Choice of Instrument Influences Relations between Food Insecurity and Obesity in Latino Women " American Journal of Clinical Nutrition 80 (2004): 1372-78.
- Mokdad AH, Bowman BA, Ford ES, Vinicor F, Marks JS, Koplan JP. "The Continuing Epidemics of Obesity and Diabetes in the United States." Journal of the American Medical Association 286 (2001): 1195-2000.
- Mokdad AH, Ford ES, Bowman BA, Dietz WH, Vinicor F, Bales VS, Marks JS. "Prevalence of Obesity, Diabetes, and Obesity-Related Health Risk Factors, 2001." Journal of the American Medical Association 289.1 (2003): 76–79.
- Mokdad AH, Mark JS, Stroup DF, Gerberding JL. "Actual Causes of Death in the United States, 2000." Journal of the American Medical Association 291.10 (2004): 1238-46.
- Morris PM, Neuhauser L, Campbell C "Food Security in Rural America: A Study of the Availability and Costs of Food " Journal of Nutrition Education 24 (1992): 52S-8S.
- National Institutes of Health (NIH). Body Mass Index (2006). Retrieved March 8, 2007 from <http://www.nlm.nih.gov/medlineplus/ency/article/007196.htm>
- NIH, National Heart, Lung, and Blood Institute. Clinical Guidelines on the Identification, Evaluation, and Treatment of Overweight and Obesity in Adults., 1998.
- Ogden CL, Carroll MD, Curtin LR, McDowell MA, Tabak CJ, Flegal KM. "Prevalence of Overweight and Obesity in the United States, 1999-2004." Journal of the American Medical Association 295 (2006): 1549–55.
- Payne, RK. A Framework for Understanding Poverty. Highlands, TX: Process, Inc, 2001.
- Peterman J., Wilde P. "Individual Weight Change Is Associated with Household Food Security Status." Journal of Nutrition 136 (2006): 1395-400.

- Peterman, Parke E. Wilde and Jerusha N. "Individual Weight Change Is Associated with Household Food Security Status." The Journal of Nutrition 136 (2006): 1395-400.
- Policy, J. Herman, C.P. "Dieting and Binging: A Causal Analysis." American Psychologist 40 (1985): 193-201.
- Polivy, J. "Psychological Consequences of Food Restriction." Journal of American Dietetic Association 96 (1996): 589-92.
- Rose, D "Economic Determinants and Dietary Consequences of Food Insecurity in the United States." Journal of Nutrition 129 (1999): 517-20.
- Rose D, Bodor, JN. "Household Food Insecurity Status in Young School Children: Results from the Early Childhood Longitudinal Study." Journal of the American Academy of Pediatrics 117.2 (2006): 464-73.
- Rose D, Oliveria V. "Nutrient Intakes of Individuals from Food-Insufficient Households in the United States." American Journal of Public Health 87 (1997): 1956-61.
- Sherman, LP. Statement of the Link between Nutrition and Cognitive Development in Children Tufts University of School of Nutrition, Center of Hunger, Poverty, and Nutrition Policy, 1995.
- Stein CJ, Colditz GA. "The Epidemic of Obesity." Journal of Clinical Endocrinology and Metabolism 89.6 (2004): 2522-25
- Stevens J, Jianwen C, Pamuk E, Williamson D, Thin M, Wood, J. "The Effects of Age on the Association between Body Mass Index and Mortality." New England Journal of Medicine 338 (1998): 1-7.
- Tarasuk V, Beaton G. "Women's Dietary Intakes in the Context of Household Food Insecurity." Journal of Nutrition 129 (1999): 672-79.
- Townsend MS, P. J., Love B, Achterberg C, Murphy SP "Food Insecurity Is Positively Related to Overweight in Women." Journal of Nutrition 131.6 (2001): 1738-45.
- Wilde, Ranney CK. "The Monthly Food Stamp Cycle: Shopping Frequency and Food Intake Decisions in an Endogenous Switching Regression Framework." American Journal of Agriculture Economics 82 (2000): 200-13.
- Youn, Andrew, Ollinger, Michael. "Characteristics of Mid-Atlantic Food Banks and Food Rescure Organizations." Food Review 22.1 (1999): 45-51.