8-2002

Household Food Sufficiency Status and the Qualityof Children's Diets: An Analysis from the Continuing Survey of Food Intakes by Individuals 1994-1996, 1998

Linda Lou Knol
University of Tennessee, Knoxville

To the Graduate Council:

I am submitting herewith a dissertation written by Linda Lou Knol entitled "Household Food Sufficiency Status and the Qualityof Children's Diets: An Analysis from the Continuing Survey of Food Intakes by Individuals 1994-1996, 1998." I have examined the final electronic copy of this dissertation for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy, with a major in Human Ecology.

Betsy Haughton, Major Professor

We have read this dissertation and recommend its acceptance:

Jean Skinner, Eugene C. Fitzhugh, Greer Fox

Accepted for the Council:

Carolyn R. Hodges

Vice Provost and Dean of the Graduate School

(Original signatures are on file with official student records.)

To the Graduate Council:

I am submitting herewith a dissertation written by Linda Lou Knol entitled "Household Food Sufficiency Status and the Quality of Children's Diets: An Analysis from the Continuing Survey of Food Intakes by Individuals 1994-1996, 1998." I have examined the final paper copy of this dissertation for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy, with a major in Human Ecology.

Betsy Haughton

Betsy Haughton, EdD, Major Professor

We have read this dissertation
and recommend its acceptance:

Jean Kerr

Eugene C. Fitzhugh

Grace Kuo

Acceptance for the Council:

Vice Provost and Dean of Graduate Studies

Household Food Sufficiency Status and the Quality of Children's Diets: An Analysis from the Continuing Survey of Food Intakes by Individuals 1994-1996, 1998

A Dissertation
Presented for the
Doctor of Philosophy
Degree
University of Tennessee, Knoxville

Linda L. Knol
August, 2002

Dedication

This dissertation is dedicated to my mom and dad.

Acknowledgements

I would like to take the time to acknowledge those people who provided their wisdom and guidance over the years. I am deeply indebted to Dr. Betsy Haughton who was and will remain instrumental in my development on many levels. I would like to acknowledge Dr. Eugene Fitzhugh for sharing with me his knowledge of data analysis, interpretation, and dissemination. I would also like to acknowledge Dr. Jean Skinner and Dr. Greer Fox not only for serving on my committee, but also for providing the knowledge and tools that will make me a better researcher and teacher. Lastly, I would like to acknowledge Ann Reed for statistical assistance.

Financial support for this project was provided through the 2002 Nutrition Research Project Grant awarded by the Economic Research Service, United States Department of Agriculture and through the James D. and Monica Moran Dissertation and Thesis Award.

Last and by no means least, I would like to thank my family and friends for always being there for me when I needed your support.

Abstract

The relationship between food sufficiency and diet quality was explored among children 2-8 years of age living in households ≤185% poverty with 2-days of dietary recall data from 1994-96, 1998 Continuing Survey of Food Intakes by Individuals. Diet quality was assessed using measures of both adequacy and variety. Diet adequacy was measured by degree of adherence to age-specific daily serving recommendations for the 5 Food Guide Pyramid food groups and by intake of discretionary fat (grams) and added sugars (teaspoons). Variety was measured using the Healthy Eating Index Variety Score (overall variety), the Dietary Diversity Score (among food group variety) and the Sub-Group Contribution Score (within food group variety).

When testing measures of adequacy, this study found that household food sufficiency status did not affect the ability to adhere to the serving recommendations for the major food groups of the Food Guide Pyramid and did not influence discretionary fat intake among low-income children ages 2-8 years. It did, however, affect consumption of added sugars in children 4-8 years of age. Furthermore, although the younger 2-3 year old low-income children seemed to eat a better diet than their 4-8 year old counterparts, both groups of children on average consumed diets that did not conform to the Food Guide Pyramid recommendations.

This study also found that household food sufficiency status did not affect the three measures of variety used. However, participation in the WIC Program was a significant predictor of overall variety (2-3 year olds) and among food group variety (2-8 year olds). Variety within food groups, as measured by the Sub-Group Contribution Scores, lent no support to the concepts set forth in the qualitative research regarding

hunger and its affect on the eating patterns of children. Some trends between age groups and food sufficiency status were noted. However, these trends were not statistically significant when tested while controlling for other variables that may affect eating patterns.

Preface

To aid the reader, and explanation of the format used for this dissertation follows. This dissertation consists of four parts. Part I contains an introduction and an extensive review of the literature. Parts II, III, and IV contain the actual study written in journal style for three publications. An extensive methodology including research questions is included in Appendix A.

Table of Contents

List of Tables

Table **Page**

Part I: Introduction, Purpose, and Literature Review

Part II: Household Food Sufficiency Status is Related to Added Sugar Intake Among 4-8 Year Old Children

Part III: Household Participation in the WIC Program, But Not Food Insufficiency, is Related to Dietary Variety Among 2-8 Year Old Low-Income Children

Part IV: Household Food Sufficiency Status and Its Relationship to Variety Within Food Groups Among Low-Income Children

Appendix A: Extensive Methodology

List of Figures

Figure **Page**

Part I: Introduction, Purpose, and Literature Review

Part I:
Introduction, Purpose and Review of the Literature

Introduction and Purpose

The term food security is used to describe a household's or an individual's access to safe and nutritious food and/or resources to purchase said food. Hunger is currently seen as a potential but not necessary consequence of household food insecurity (1). In 1999 the prevalence of food insecurity without and with hunger was 5.9% and 2.8% of U.S. households (2). These prevalence rates for food insecurity and hunger vary by household type considerably. At highest risk for food insecurity and hunger are low-income households, especially those with children (2). Therefore, it is important to understand the effects that food insecurity and hunger have on children.

Food insufficiency status has been used as a proxy measure for hunger and food insecurity in many studies (3-11). Since its development in the early 1970s, this one measure has been used in over 20 surveys in the past two decades and has been used in every subsequent United States Department of Agriculture (USDA) food use survey (6,7). This study utilized this measure to understand how food sufficiency status affects the quality of children's diets.

Many studies to date have addressed the impact of food sufficiency/ food security status on the diets of adults, specifically women of childbearing age (3,5,6,12-14), but few studies have looked at the impact of food sufficiency status on the quality of children's diets (3,5,6), especially school age children (6). Women who were experiencing hunger in Upstate New York described the impact of hunger on their children's diets in the following manner: Could not provide adequate amounts of food to their children (adequacy), had limited available foods (variety), and ate a small number of foods again and again (variety) (15,16). The current study used the framework of the

Food Guide Pyramid (17,18) and a food group analysis approach (19-29) to measure two components of interest: adequacy and variety.

Therefore, this study was designed to address how household food sufficiency status affects these two aspects of children's diets: 1) adherence to the Food Guide Pyramid serving recommendations (measuring adequacy of diet) (7,8) and 2) dietary variety (measured as overall variety, variety among food groups and variety within food groups of the Food Guide Pyramid). This study used the Continuing Survey of Food Intakes by Individuals 1994-1996, 1998 (CSFII) data to examine how household food sufficiency status, a proxy for food security, is related to diet quality for children ages 2-3 and 4-8 years living in households who are eligible by income to participate in United States Department of Agriculture (USDA) food assistance programs.

A review of the present available literature is discussed in the following section.

Review of the Literature

This review of the literature provides background information to support the research questions asked and methods used to address them. The key components of the review concern: The impact of food security/ food sufficiency status on the diets of both women and children and the measures used within this study. Since the Pyramid servings database for USDA food codes from the CSFII (22,23) was used to provide the basis for all measures, this chapter includes a discussion of the database and its construction. It also provides a description of the serving recommendations from the Food Guide Pyramid for children and the degree to which children currently meet these guidelines (17,18,23). Three measures of variety/diversity were used to determine the degree to

which food insufficient households rely on a few kinds of foods to feed children. These measures included the Healthy Eating Index Variety Score (30), the Dietary Diversity Score (31), and a measure to obtain within food group diversity based on the methods developed by McCrory et al (32).

A Definition of Hunger

Hunger is defined as a possible consequence of household or individual food insecurity. The term food security is used to describe the status of a household's or an individual's access to safe and nutritious food and/or resources to purchase said foods. Hunger is currently seen as a potential but not necessary consequence of household food insecurity (9). The Life Science Research Office (LSRO) of the Federation of American Societies for Experimental Biology as part of its report, Core Indictors of Nutritional Status for Difficult to Sample Populations, defines hunger in this broader context of food security in the following manner:

> "**Food security**-access by all people at all times to enough food for an active, healthy life. Food security includes at a minimum: (1) the ready availability of nutritionally adequate and safe foods, and (2) an assured ability to acquire acceptable foods in socially acceptable ways (e.g., without resorting to emergency food supplies, scavenging, stealing, or other coping strategies).
>
> **Food insecurity**-limited or uncertain availability of nutritionally adequate and safe foods or limited or uncertain ability to acquire acceptable foods in acceptable ways.
>
> **Hunger**-the uneasy or painful sensation caused by a lack of food. The recurrent and involuntary lack of access to food. Hunger may produce malnutrition over

time. Hunger, as the recurrent and involuntary lack of access to food which may produce malnutrition over time, is discussed as food insecurity... Hunger and its meaning of the uneasy and painful sensation caused by lack of food, is in this definition a potential, although not necessary, consequence of food insecurity. Malnutrition is also a potential, although not necessary, consequence of food insecurity" (9, p. 1596-1598).

These definitions are consistent with the conceptual framework of food security put forth by the Community Childhood Hunger Identification Project (CCHIP) (33,34) and Radimir et al (12,13,15,16) and then later verified by work with the Continuing Survey of Food Intakes by Individuals (CSFII) (3,7) and the Food Security Module, Current Population Survey (35,36).

Food Security

Conceptual Framework. In 1987 Radimir et al (16) embarked on a qualitative research study to understand the experience of women living in Upstate New York who had been hungry. The conclusions from this study and that of the CCHIP (33,34) form the current conceptual framework of food security in the United States. This framework has been used to develop indicators that measure food security status at the population level (12,13,16,33-36).

From personal interviews with women who had been hungry or almost hungry in Upstate New York, Radimir et al (12,13,16) developed several hypotheses. The first is that hunger can be conceptualized in two ways: a narrow view and a broad view. The narrow view focuses on lack of food. The broad view focuses on the larger household issues surrounding the feeding of the family, including perceived quality of the diet,

problems in obtaining an adequate and safe food supply, coping strategies of the women as they deal with trying to maintain a sufficient household food supply, and the women's feelings toward their situation (12,13,16).

This conceptualization of hunger appears at two levels: individual and household. The individual level is split further into adult hunger and children's hunger. Radimir et al (16) postulated that both levels of hunger have four components: quantitative, qualitative, psychological, and social (Table 1). The first component consists of insufficient intake at the individual level and food depletion (decreased quantity of the household food supply) at the household level. The second component is food quality, specifically nutritional inadequacy at the individual level and unsuitable food at the household level. Women in the study described their experience with hunger as not being able to provide nutritionally balanced meals, having limited available foods, eating a small number of foods again and again, and buying less expensive foods as a substitute for desired foods. The psychological component is defined as a lack of choice and feelings of deprivation at the individual level and food anxiety (defined as the uncertainty regarding the sufficiency of the household food supply) among gatekeepers at the household level. The last component of hunger is social. At the individual level, this may include a disruption in usual eating patterns that are the social norm (e.g., not eating three meals per day or going days without eating). At the household level, this component would include the acquisition of foods in socially unacceptable ways. In the study by Radimir (16), women considered foods obtained through wages, WIC vouchers, Food Stamps and school breakfast and lunch as socially acceptable ways to maintain the

Table 1: Levels and Components of the Concept of Hunger

Component	Levels	
	Individual	**Household**
Quantitative	Insufficient intake	Food depletion
Qualitative	Nutritional inadequacy	Unsuitable food
Psychological	Lack of choice or feelings of deprivation	Food anxiety
Social	Disrupted eating patterns	Food acquisition in socially unacceptable ways

Source: Radimir, K.L., Olson, C.M., Greene, J.C., Campbell, C.C., Habicht, J.P. Understanding hunger and developing indicators to assess it in women and children. *JNE* 1992:24;38S.

household's food supply, while foods obtained through friends and food pantries were not viewed as acceptable (12,13,16).

A second hypothesis of Radimir et al is that hunger is a "managed and evolving process" (16, p. 37-38S). This hypothesis suggests that when resources to purchase food become tight, the household gatekeeper will make conscious decisions to manage food resources in an effort to feed all household members. Although households may react differently to the stress of limited resources to purchase an adequate supply of food, there is a general sequence of events that occurs among households that is similar. This sequence is depicted in Figure 1.

Hunger is often first experienced at the household level as food anxiety. At this level, the gatekeeper may have concerns about the household food supply and make adjustments to manage the food supply more wisely. These adjustments might include substitutions of one food for a less costly alternative (eg. substituting canned vegetables for fresh). At this stage, food insecurity would most likely impact the quality of

household foods rather than the quantity of food. This stage in the sequence is called food insecurity without hunger. In the United States this may be a chronic condition for many low-income households that usually have just enough resources, but not enough to buy the kinds of foods they would like to purchase. If conditions worsen and food resources dwindle further, then adults, usually women, may reduce their own intake while attempting to maintain the intake of their children. This next stage is referred to as food insecurity with moderate hunger (or adult hunger). At this stage both the quality and quantity of the women's/adults' intakes will be affected, while only the quality of the children's intakes may be affected. Children in the household are usually spared until the point at which food insecurity becomes severe. Food insecurity with severe hunger, the last stage, occurs when food resources dwindle to the point at which the children's intakes decrease. At both stages of food insecurity with hunger, gatekeepers may employ tactics to restrict food intake, such as skipping meals, reducing the number of snacks, and serving smaller portions in an effort to stretch the current household food supply (12,13,16). These last two stages of hunger may be considered acute conditions occurring periodically within U.S. households (36). Therefore, food insecurity with hunger has a potential for malnutrition, but that potential may not be realized due to the episodic nature of domestic hunger.

There is some overlap of behaviors between each classification of food security status. For example, a household that is food insecure with moderate hunger would also demonstrate behaviors associated with the previous classification, or food insecure

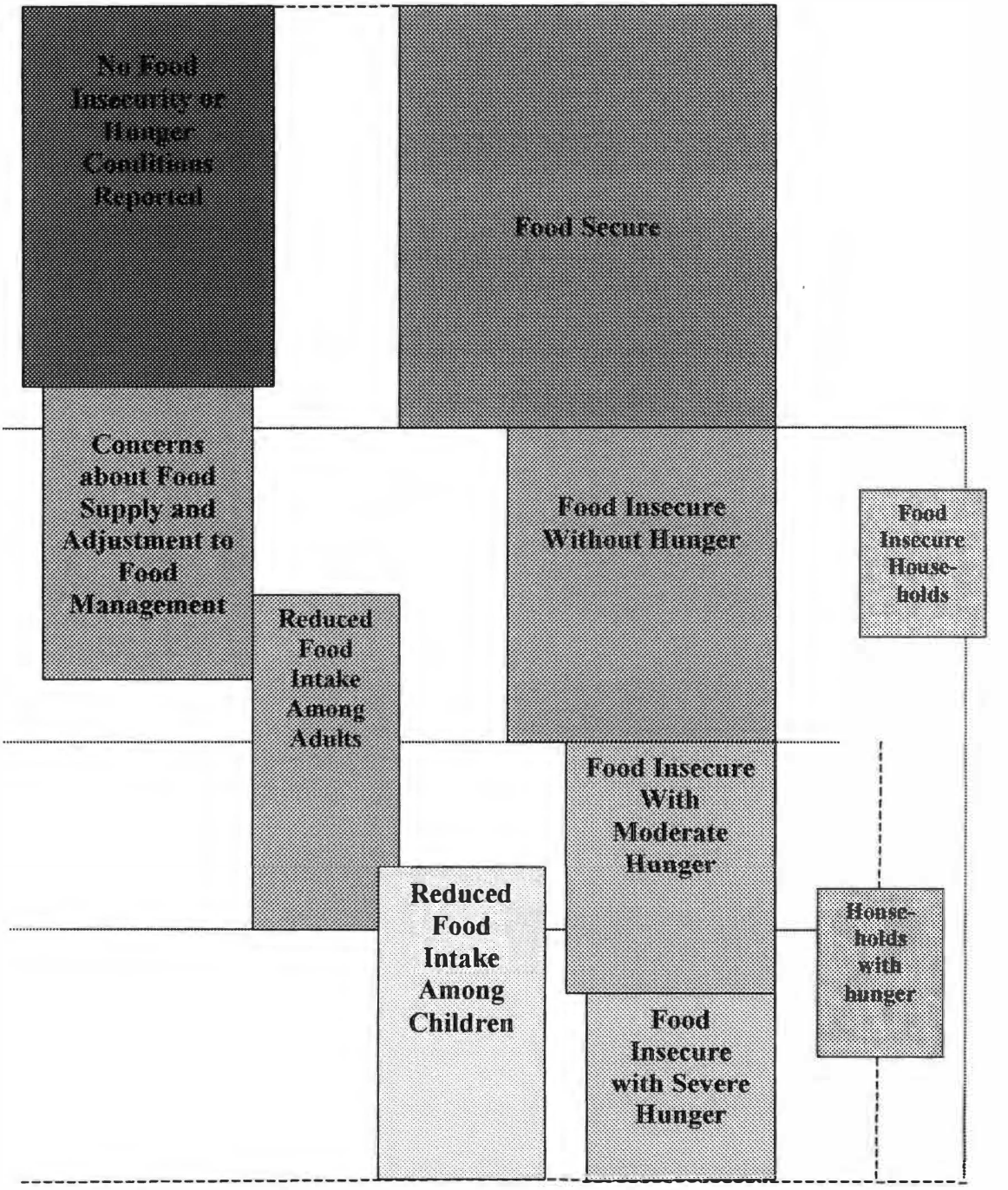

Figure 1: The Food Security Status Categories

Source: Hamilton, W.L. Cook, J.T., Thompson, W.W. Buron, L.F., Frongillo Jr., E.A, Olson, C.M., Wehler, C.A. Household Food Security in the United States in 1995. Summary Report of the Food Security Measurement Project. Alexandria, VA: United States Department of Agriculture, Food and Consumer Service, Office of Analysis and Evaluation, 1997. p. vii.

without hunger. Thus the sequence of events is ordered. Households can move from one category to another as food resources become available or diminish (16,36).

The CCHIP model (33,34) also characterizes hunger into three foci, or household, adult, and child. This model of the sequential processes of hunger, shown in Figure 2, is similar to that of Radimir et al (16). The CCHIP model suggests that as household economic resources dwindle, access to food will decrease, which can change food-related behaviors in the household. These changes in household food-related behaviors can impact food intake and eventually, but not necessarily, lead to hunger. In addition, the CCHIP model depicts the relationship of hunger with its antecedents and consequences, which will be discussed later (33,34).

Based on their qualitative studies, both Radimir et al (15,16) and CCHIP (33,34) developed and validated questionnaires to assess the prevalence of hunger within the larger population. Their work was incorporated into the Food Security Module of the Current Population Survey, US Census Bureau (12,13,33-36). This instrument is utilized currently to assess both the national and state prevalence of food security and three levels of food insecurity: Food insecure without hunger (anxiety at the household level), food insecure with moderate hunger (hunger at the adult level), and food insecure with severe hunger (hunger at both the adult and child level) (2,37). The next section will describe measures of food security/food sufficiency further.

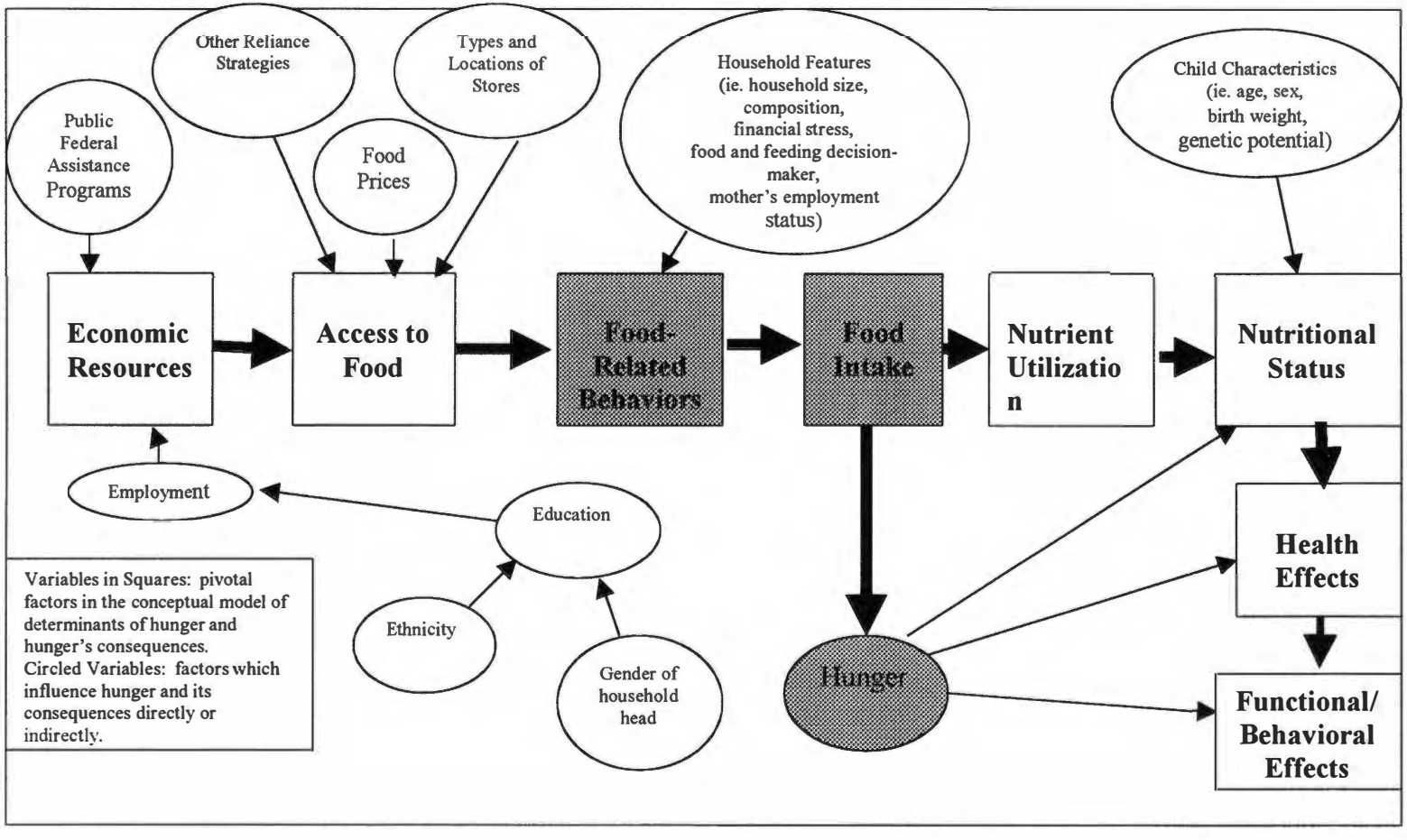

Figure 2: CCHIP Conceptual Model. Factors associated with hunger and its outcomes.
Reproduced from: Wehler CA, Scott RI, Anderson JJ. The Community Childhood Hunger Identification Project: A Model of Domestic Hunger Demonstration Project in Seattle, Washington JNE 24:29S-35S, 1992.

Measures of Hunger, Food Security and Food Sufficiency. The federal government's interest in measuring food security and hunger can be traced back to the early 1970s when the United States Department of Agriculture (USDA) in its 1977-78 Nationwide Food Consumption Survey asked a single question regarding the quantity and quality of food resources within the household (1,19). This one question has been used to assess food sufficiency status, a proxy for hunger, in over 20 surveys within the past two decades and has been used in every subsequent USDA food use survey (3,4).

Food insufficiency is defined as an "an inadequate amount of food intake due to a lack of money or resources" (8, p.24S). The question is as follows:

> Which of the following statements best describes the food eaten in your household?
>
> 1) Enough of the kinds of food we want to eat
> 2) Enough but not always the kinds of food we want to eat
> 3) Sometimes not enough to eat
> 4) Often not enough to eat (3,7).

The first two response categories reflect food sufficiency status, while the last two response categories reflect food insufficiency. Since this question serves as a proxy for food security in this study, a discussion of its validity and relationship to the Food Security Module follows.

Validity of the Food Sufficiency Question. The food sufficiency question has been validated in four studies (3,5,7,8) and compared to the newer Food Security Module (FSM) in two studies (36,38). All four validity studies found this question to be a valid means of assessing food sufficiency status within a population (1,2,14,20). In both studies comparing the food sufficiency question to the FSM, classifications of food

sufficiency status were found to overlap with food security status (16,21). Thus, this single question can be used as a proxy for food security.

The first validation study by Cristofar et al (3) found that individuals who were food insufficient consumed significantly less energy and nutrients than individuals who were food sufficient. The effects of food insufficiency on the children, ages 1-5 years, were less severe than those seen for adult women, which is consistent with the conceptual model of food security. Therefore, the researchers concluded that study participants were able to classify themselves by food sufficiency status appropriately. Rose et al (5) came to the same conclusion while using a later version of CSFII (1989-1991).

Rose et al (7), using CSFII 1989-1991 data, also validated the food sufficiency question using a measure of overall household intake, or the household nutrient adequacy ratio. They compared overall household nutrient intake between food sufficient and food insufficient households. They found that households reporting food insufficiency had significantly lower intakes of food energy and 9 of the 14 nutrients tested (7). Therefore the household level respondent was able to correctly classify the household into a food sufficiency category.

Finally, the question was tested at the National Center for Health Statistics, Questionnaire Design Research Lab before use with the National Health and Nutrition Examination Survey III (NHANES III). Researchers there also concluded that respondents are capable of assessing their food sufficiency status accurately (8).

In both studies comparing the food sufficiency question to the FSM, classifications of food sufficiency status were found to overlap with food security status (36,38). The first study consists of the validation work of Hamilton et al for the Food

Security Module (36). This study found a clear overlap between the two measures. When participants were classified as having "enough of the kinds of food we want to eat," 95.9% were also found to be food secure, while only 0.7% were classified as food insecure with moderate or severe hunger. Of the study participants who were classified as having "sometimes not enough to eat" and "often not enough to eat," 46.8% and 55.2% reported food insecurity with hunger (either moderate or severe).

These two measures were compared again in a study on the relationship between food security and nutrient availability within the Food Stamp population (38). Again, a substantial degree of overlap was found between the classifications for food sufficiency status and food security status (38). In this study, when participants were classified as having "enough of the kinds of food we want to eat," 85.2% were also found to be food secure while 4.5% were classified as food insecure with moderate or severe hunger. Of the study participants who were classified as being food insufficient ("sometimes not enough to eat" and "often not enough to eat"), 48.9% and 66.5% reported food insecurity with hunger (either moderate or severe), while only 14.8% and 15.3% were classified into the food secure group (38). The results of both studies suggest an overlap between the two measures. Therefore, the food sufficiency question within the CSFII 1994-1996, 1998 can serve as a proxy for food security.

As mentioned previously, this one question has been replaced with the more sophisticated 18-item Food Security Module of the Current Population Survey, US Census Bureau (35,36). The food security module is based on the original food sufficiency question, the qualitative work of Radimir et al (15,16) and the CCHIP study (33,34). It is currently used in the continuous National Health and Nutrition Examination

Survey (NHANES, 1999-2001) and the Current Population Survey (CPS), US Census Bureau. However, survey data from the CPS do not include dietary variables and the continuous NHANES (1999-2001) is not ready for release as of this date. Therefore the study described in this dissertation utilized the latest Continuing Survey of Food Intakes of Individuals (CSFII) 1994-1996, 1998, which includes: The food sufficiency question, dietary data from two-24 hour recalls, the Food Guide Pyramid servings database, and a large sample of children ages 2-8 years. Therefore, this dataset provided the best available information to address the research questions for this study.

Prevalence. Since 1995 the prevalence of food security and food insecurity with and without hunger has been measured using the 18-item Food Security Module (FSM) from the Current Population Survey (CPS), US Census Bureau (2). From 1995-1999, the prevalence of food security, food insecurity without hunger and food insecurity with hunger (both moderate and severe) ranged from 89.6% to 91.3%, 5.9% to 6.6%, and 2.8% to 4.1% of U.S. households, respectively. This equates to 31 million persons living in food-insecure households. Households with children experience food insecurity at double the rate of households without children. During this same time period, 1995-1999, the prevalence of food insecurity without and with hunger in households with children ranged from 10.5% to 12.8% and 3.7% to 6.2%, respectively. This equates to approximately 12 million children living in food insecure households (2).

The prevalence of food insecurity with and without hunger is highest among low-income households (2). Andrews et al (2) found that when the income to poverty ratio was under 1.85, or when household income was less than 185% of the federal poverty guideline, the prevalence of food insecurity without and with hunger increased to 18.0%

and 8.1%, respectively. Conversely, when the income to poverty ratio was at or above 1.85, the prevalence of food insecurity without and with hunger dropped to 3.1% and 1.0%, respectively. These findings suggest that few households with incomes at or above 185% of the federal poverty guidelines are food insecure (2). Furthermore, the prevalence of food insecurity with and without hunger increases as income decreases. Andrews et al (2) also found that when the income to poverty ratio is under 1.3 (the level at which a household would qualify for Food Stamps), the prevalence of food insecurity without and with hunger increased to 21.6% and 10.7% of U.S. households (2). When the household contained children under 18 years of age and the income to poverty ratio was below 1.3, the prevalence of food insecurity without and with hunger increased to 30.0% and 10.3%, respectively (2). Because low-income households with children are the most vulnerable to food insecurity (18), it is important to study the effects of household food insufficiency status on the quality of the children's diets.

Determinants and Consequences of Food Security. The CCHIP model, shown previously in Figure 2, describes the sequential nature of hunger and its possible determinants and consequences (33,34). As economic resources dwindle and access to food is reduced, then changes in household food-related behaviors occur, leading to changes in food intake and then hunger. Central features of the CCHIP model that represent food security are hunger, changes in food intake, and changes in household food-related behaviors due to limited resources. The CCHIP model also suggests possible determinants and consequences of hunger. Economic resources, access to food, and food-related behaviors are proposed as determinants of food intake, which in turn determine hunger. Nutritional status, health effects and functional/behavioral effects are

proposed as the consequences of hunger (33,34). What follows is a more detailed description of these relationships.

Economic Resources. The first component of the CCHIP model, economic resources, suggests that gender, educational status, and employment status of the household head, ethnicity of the household, and participation in federal food assistance programs affect the economic resources of the household and eventually household hunger (33). Information from the Current Population Survey, Food Security Module, NHANES III, and CSFII supports this portion of the model (3-5,35). Since food insecurity is, by definition, a result of constrained resources, income and food insecurity are highly related. However, this is not a perfect correlation, because the cost of living, specifically shelter, by location, is variable, as are the economic resources gained through participation in food assistance programs. In two studies using CSFII data, tenancy (owning one's own home versus renting), urbanization, region of the country, and participation in food assistance programs were all found to be significantly related to food sufficiency status (3,5).

Race/ethnicity and employment status are also related to food insecurity. Households headed by a female with no spouse were more likely to be food insecure without hunger (21.6%) and with hunger (8.1%) than households headed by married couples (8.0%, 1.6%, respectively). Black, Non-Hispanic (21.2%) and Hispanic households (20.8%) were also more likely to be food insecure than white, Non-Hispanic households (8.0%) (2). In the NHANES III study food insufficient individuals were less likely to live in homes where the family head was employed (53.5%) or had graduated

from high school (42.7%) than food sufficient individuals (75.1% and 75.7%, respectively) (37).

Participation in federal food assistance programs varies with food security status (36). Of those households classified as food secure, only 8.4% participated in at least one food assistance program (36). This compares to the much higher percentage of food insecure households that participated in at least one food assistance program: 44.0% of those classified as food insecure without hunger, 46.7% of those classified as food insecure with moderate hunger, and 51.2% of those food insecure with severe hunger. The findings reveal that as food insecurity increases, participation in food assistance programs also increases. Based on the information presented, research exists that supports this portion of the CCHIP model.

Access to Food. Access to food is the second component of the CCHIP model. Since having economic resources from participation in food assistance programs and income may not always be adequate to purchase food, reliance on other strategies may be necessary. These strategies include the use of emergency food pantries (e.g. soup kitchens and food pantries) and reliance on friends and family. The CCHIP study confirmed the relationship between food security status and reliance on other food strategies. Of the hungry families with young children, 14% had visited a soup kitchen for meals, 52% had used food pantries or other commodity distribution centers, and 82% had relied on friends for money to buy food or meals (33).

The CCHIP model also suggests that location and type of food stores may play a role in access to food and hunger. To date, there is only one study that addresses the issue of store location and its relationship to food security (38). This study about the

relationship between Food Stamp participation and food security found that the distance to the nearest supermarket was not significantly correlated with food security status among Food Stamp participants (38). Except for the location of food stores, which needs further study, research supports this portion of the CCHIP model.

Food-Related Behaviors. The CCHIP model proposes that household size and composition are factors that influence food-related behaviors and hunger. Two studies using the CSFII database plus information collected from the Food Security Module (FSM) support this proposition. Households with children and households headed by a female are at greatest risk for food insecurity (2). Cristofar et al (3) found that household size/composition and economic resources were the best estimators for predicting food sufficiency status using the CSFII data (3). Demographic information from the NHANES III study also confirmed that food insufficient individuals lived in larger families than food sufficient individuals (9). Both studies support the model's proposal that the number of people in a household and the household's composition influence food insufficiency. A larger discussion of the effect food sufficiency/food security status has on the diets of both women and children is addressed in a later section of this chapter.

Nutritional Status, Health and Functional/Behavioral Related Outcomes of Hunger. To date most of the research into the health outcomes associated with hunger has focused on children. Two studies addressed nutrition and health outcomes by food sufficiency status (6,10). Using NHANES III data, Alaimo et al (10) found that food insufficient children were more likely to have poorer overall health and to experience more frequent stomachaches and headaches than food sufficient children after controlling for confounding factors, including poverty status. They also found that food insufficient

pre-school children had colds more frequently than food sufficient children (10). Lastly, although not statistically significant, they found a higher percentage of food insufficient preschool children were anemic than their food sufficient counterparts. Casey et al (6) used CSFII data to study food sufficiency status and obesity among 1–17 year-old children below 130% of the federal poverty guidelines. They found no significant differences in the prevalence of overweight (>85th percentile) or underweight (<10th percentile) by food sufficiency status. However, weights and heights were self-reported and the researchers did not address confounding conditions, such as age, in the study design (6).

Using CSFII 1994-1996 data, Townsend et al (39) found that food insufficiency was related to overweight status among women, but not men, after adjusting self-reported intake to reflect the underreporting of weight and the overestimation of height. Among the women reporting "enough of the kinds of food we want to eat," 34% were overweight while the percentages of overweight among the women reporting "enough but not always the kinds of food we want to eat" and "sometimes not enough to eat" were 41% and 52%, respectively. Body Mass Index (BMI) was found to be statistically different between the three groups after controlling for variables that would affect BMI. The fourth food security category, "often not enough to eat," was not included in the analysis due to small sample size (n=11) (41). At present, more research is needed to understand the relationship between food sufficiency status and possible health effects.

Food security and behavioral, psychosocial and academic outcomes also have been investigated. From the early CCHIP study in 1991, Murphy et al (40) investigated teacher perceptions of hyperactivity, absenteeism, and tardiness by hunger status in

school children under 12 years of age. They found that teachers reported higher levels of hyperactivity, absenteeism, and tardiness among hungry or at risk for hunger children compared to not-hungry children. Using NHANES III data, Alaimo et al (11) while controlling for confounding factors also found that food insufficient children, ages 6-11 years, had significantly lower arithmetic scores and were more likely to have repeated a grade than those students who were food sufficient. In both studies a relationship between academics and food security was found.

There is also a relationship between hunger or food insufficiency and psychosocial functioning among children. Alaimo et al (11) found that food insufficient children (ages 6-11 years) were more likely to have seen a psychologist than food sufficient children. In a small sample from the CCHIP study (n=338), children classified as hungry were more likely to have had a history of mental health counseling than those who were at risk for hunger or food secure (41). In this sample of CCHIP participants, selected parents of 6-11 year old children filled in a Pediatric Symptom Checklist, a screening tool for psychosocial dysfunction. Those defined as hungry on the CCHIP scale were more likely to have clinical levels of psychosocial dysfunction on the Pediatric Symptom Checklist (PSC) than children classified as at-risk for hunger or not hungry. Of those items tested on the PSC, irritability/anxiety/worry and oppositional behavior/aggression had the strongest degree of association with hunger (41).

Recently, Alaimo et al (42) found that food insufficiency was associated with dysthymia and suicide symptoms in adolescents (15-16 years of age), but not a lifetime history of major depressive disorder (MDD). MDD, dysthmia and suicide symptoms were determined using DSM-IV criteria and the Diagnostic Interview Schedule (DIS)

within NHANES III. Dysthymia was diagnosed when an adolescent reported a low mood for two or more years and two or more of the following six symptoms: poor appetite or overeating, insomnia or hypersomnia, low energy or fatigue, low self-esteem, poor concentration or feelings of hopelessness. Four symptoms of suicide were assessed as well. These symptoms include: thoughts of death, a desire to die, suicide ideation and a previous attempted suicide. Although the percentage of food insufficient adolescents with a lifetime history of major depression was higher (12.1 +/- 7.2) than that of the food sufficient group (5.9 +/- 1.4), it was not statistically different after controlling for confounding factors. However, food insufficient adolescents were found to be significantly more likely than food sufficient adolescents to have had dysthymia and three of the four suicide symptoms: thoughts of death, a desire to die, and a previous attempted suicide. Therefore, this suggests that alleviation of food insecurity and hunger in the United States would provide a tremendous benefit to youth in terms of possible health outcomes, psychosocial functioning, and academic performance.

Food Security/Food Sufficiency and Nutritional Consequences

Many studies to date have addressed food security/ food sufficiency and its nutritional consequences in terms of adequacy, but few have addressed the quality issues of "few kinds of foods to feed child(ren)" or "variety" in the diet. Studies have focused mostly on dietary adequacy, specifically adequacy in terms of nutrient recommendations and nutrient intake. Only a few studies have addressed how food security/sufficiency affects food group intake.

Food Security/Sufficiency and Household Nutrient Intakes. Food security/ sufficiency status has an impact on nutrient adequacy and intake in the studies performed

at the household level to date (7,38). Using CSFII data from 1989-1991, Rose et al (7) measured the overall household diet using the household nutrient adequacy ratio and two levels of food sufficiency (food sufficient and food insufficient). The household nutrient adequacy score is computed by first dividing each household member's nutrient intake by the age-sex specific Recommended Dietary Allowance for that nutrient, expressing it as a percentage, and then averaging within the household. These researchers found that food insufficient households with children had significantly lower household nutrient adequacy ratios for 13 of 15 nutrients tested, including food energy, compared to food sufficient households (7).

The 1996-1997 United States Department of Agriculture (USDA) study on food security among Food Stamp Participants is the only other study to date to address food security status on household intake or food supplies (38). This study used the new 18-item Food Security Module to determine food security status among Food Stamp Participants and a seven-day food use inventory to determine the average household nutrient intake, expressed as a percentage of the RDA. In this study, as food security worsened, household nutrient availability, expressed as a proportion of the RDA, improved significantly for energy and three of the seven nutrients tested; specifically calcium, zinc and vitamin B6 (38). This is contrary to the belief that household nutrient intake decreases as household food security worsens and contrary to the study conducted by Rose et al (7). One possible explanation is the difference in income levels studied. Rose et al (7) studied households with various incomes levels while the Food Stamp Participants Study used only those individuals who participated in the Food Stamp Program (income at or less than 130% of the federal poverty guidelines). Therefore the

Food Stamp study may be measuring Program effects or how low-income food insecure populations manage their household food supply.

Food Security/Sufficiency and Individual Nutrient Intakes in Women. Food insecurity/insufficiency status impacts nutrient adequacy in women of childbearing age (19-50 years of age) as well (3,5,13,14). Four studies to date address this issue. In a study using CSFII 1985-1986 data, Cristofar et al (3) described the nutrient composition of the diets of women, ages 19-50 years, by three levels of food sufficiency: Always enough, always have enough but not always the kind I want, and sometimes/often not enough to eat. These researchers found that as food insufficiency worsened, nutrient intake for 18 out of 28 nutrients plus total energy decreased significantly, including total fat intake expressed in grams (3).

Rose et al (5) found similar results when testing for differences among 14 nutrients plus energy between food sufficient and food insufficient women ages 19-50 years using 1989-1991 CSFII data. In this study, food insufficient women had significantly lower intakes for 10 of the 14 nutrients tested plus energy (5).

In the third study, Kendall et al (12) used the Radimir/Cornell hunger and food security questionnaire with a group of randomly selected women (n=193), ages 15-40 years, living in households with children under the age of 16 in a rural county in New York. Although not statistically significant, these researchers found that nutrient intakes among the food insecure group were less than those of the food secure group except for vitamin A and fat, which were higher (12).

The last study that addressed the impact of food security/sufficiency status on nutrient intakes in women of childbearing age is that of Tarasuk et al (14). These

researchers used the new 18-item Food Security Module to assess food security status among women (n=153) ages 19-49 years old who lived in households with children under 16 years of age in Toronto, Canada and had received emergency food relief at least once in the year prior to the survey. The women were separated into three groups based on food security status: No hunger evident, food insecure with moderate hunger, and food insecure with severe hunger. As food security decreased, the intakes of five of the ten nutrients (protein, vitamin A, iron, magnesium, and zinc) examined plus energy significantly decreased as well. This study is the only one to date that has attempted to understand the relationship between food security status, energy intake and nutrient intake (14). These researchers found that when controlling for energy intake, by dividing the nutrient intake by total energy (nutrient density), only vitamin A was significantly different between the food security status categories. Therefore, this result suggests that the differences seen for protein, magnesium, iron, and zinc were due to decreases in energy intake overall (quantity), while the decrease in vitamin A intake may be due to other factors above and beyond just caloric changes; possibly factors relating back to the quality components of hunger (14).

In summary, of the four studies described, three showed significant differences in nutrient intakes between levels of either food sufficiency status or food security status. Nutrients with significant differences between food security/sufficiency status common to all three studies were energy plus protein, iron, and magnesium. However, there are some limitations to this body of research. First, the studies compared different nutrients. These studies also were completed within different time frames and in different countries, and used different measures of food security/sufficiency status. Thus, comparability

between the studies is limited. Lastly, many of these studies did not compare actual nutrient intakes to that of a standard, making it difficult to determine if the impact that food security/sufficiency status has on a specific nutrient is a public health concern.

Food Security/Sufficiency and Individual Nutrient Intakes in Children. Food security/sufficiency status also impacts nutrient adequacy of children's diets (3,5.6). Using 1985-1986 CSFII data, Cristofar et al (3) found that among the 28 nutrients examined for differences among the three levels of food sufficiency status, the mean intakes of five nutrients plus energy were significantly reduced as food insufficiency increased in children ages 1-5 years. These five nutrients included carbohydrates, dietary fiber, Vitamin C, carotenes, and folacin (3). Using 1989-1991 CSFII data, Rose et al (5) found that household food insufficiency was not significantly associated with low intakes among preschoolers (ages 1-5 years).

Casey et al (6) conducted the latest study on the impact of food sufficiency status on nutrient intakes among children (0-17 years of age) using 1994-1996 CSFII data stratified on two levels of income (low and high). They found that children in low-income families regardless of food sufficiency status had similar nutrient intakes. However, when comparing the food insufficient low-income group to that of the food sufficient high-income group, the low-income food insufficient children had lower intakes of energy and carbohydrates and higher intakes of cholesterol. In this study children and older teens were grouped together. Caloric intake and need increases dramatically between early childhood and adolescence. Therefore the significant nutrient differences found may be due to changes in energy intake associated with age rather than

food sufficiency status. Further research that separates the children by age categories associated with nutrient requirements is needed.

In summary, two studies (3,5) to date have adequately addressed how food sufficiency status impacts the diets of children, specifically preschoolers (ages 1-5 years). No similarities between the study results could be identified. Some of the same problems associated with the food security/sufficiency status studies in women apply to those in children as well. Therefore, conclusions regarding the impact of food sufficiency status on the nutrient intakes of children can only be applied to preschoolers.

Food Security and Household Food Group Intakes. Food security/sufficiency status also impacts food group intake at the household level (12,13). Kendall et al (12,13) examined the household food supply using a 51-item household food inventory with 193 women in a rural county in New York. The 51 items from the household food inventory were grouped into five main food groups and scored by frequency. The higher the household food inventory score, the greater the household food stores. The researchers found a progressive and significant decline in the household food inventory score for each of the five food groups and overall food stores as food insecurity worsened (12,13). This study confirmed that as a households' food resources dwindle, the risk for food insecurity and hunger increases.

Food Security and Women's Food Group Intakes. Food security/sufficiency status also impacts food group intake among women of childbearing age. Using the CSFII 1989-1991 data, Cristofar et al (3) tested 59 a priori food groups, of which 13 showed significant declines in consumption as food sufficiency status worsened. Total vegetables and fruits, total fruits, total other fruits and juices, and other fruits and

mixtures mainly fruit were 4 of the 13 food groups that decreased significantly. One food group, total cereal and pastas, increased significantly in consumption as food insufficiency worsened (3).

In a smaller study of rural New York women, Kendall et al (12,13) used the questions assessing fruit and vegetable consumption from the adult Behavioral Risk Factor Surveillance System (BRFSS) (43) to determine consumption patterns of fruits and vegetables for comparison between food security status categories. Key findings were: a) weekly consumption of fruit, salad, carrots, total vegetables, and total fruits and vegetables decreased progressively as food insecurity rose; b) intake of fruit juice decreased progressively but not significantly, as food insecurity increased; and c) servings of potatoes did not change as food insecurity increased.

In the latest adult study in Toronto, Canada, Tarasuk et al (44) used the five broad food groups that correspond with Canada's Food Guide to Healthy Eating (45) to assess the impact of food security status on food group intake among women. The women in households with no hunger had higher intakes of all foods consumed except the "other foods" category compared to those in households with moderate or severe hunger. Significant and progressive declines were seen for the vegetables and fruit group, the vegetables and fruit group excluding potatoes, and the meat and meat alternatives group (44). No significant differences were detected for the grain products group, although there was a slight decrease in consumption as food insecurity increased, which is contrary to the results of Cristofar et al (3). From these studies, it appears as if food security/sufficiency status affects the consumption of fruits and vegetables in adults.

Food Security and Children's Food Group Intakes. Although food security/sufficiency status affects the food group intakes of children, the effect on children's food group intake may not be as dramatic as that of adult women (3,6). Of the 59 food groups tested, using the 1989-1991 CSFII data, Cristofar et al (3) demonstrated a significant decrease in consumption among five of the groups as food sufficiency status worsened among preschoolers. These groups included: Cream and milk desserts, total vegetables and fruits, other baked goods, total fruits, and total other fruits, mixtures, and juices. The same significant rise in consumption of total cereals and pasta seen in adult women as food sufficiency status worsened was duplicated in the preschoolers (3). This is perplexing since carbohydrate intake decreased significantly as food insufficiency worsened within the same sample of preschoolers.

Using the 1994-1996 CSFII data and corresponding Food Guide Pyramid Database, Casey et al (6) found that children ages 2-17 years living in low-income food insufficient households consumed significantly less dark green leafy vegetables, other vegetables, nuts and seeds, and added sugars and significantly more eggs than those in low-income food sufficient households. No differences in the consumption of fruit, vegetables, fruits and vegetables, non-whole grains, dry beans and peas, and yogurt was detected between low-income food sufficient and insufficient children. They also found that children in high-income food sufficient households ate significantly more fruits, non-whole grains, dark green leafy vegetables, other vegetables, yogurt, nuts and seeds, and added sugars and significantly less dry peas and beans, and eggs than low-income food insufficient children. There was no significant difference in the consumption of total vegetables and total fruits and vegetables between these two groups (6). Although mean

servings from the fruit and vegetable group differed by food sufficiency status and income, the mean group intakes from total fruit and total vegetables did not meet the recommended number of servings from the Food Guide Pyramid regardless of income and food sufficiency status.

In summary, more information is needed on how food security/sufficiency status impacts food group intake among children and specifically how it impacts the ability to meet dietary recommendations expressed as servings from the Food Guide Pyramid food groups. No attempt has been made to explain the impact of food security/sufficiency status on differences in food group intake while controlling for the effect of caloric intake. In other words, what is the effect of food security/sufficiency status on food group intake above and beyond the effect it has on energy intake?

Food Security Status and Dietary Variety. To date no studies have investigated the impact of food security status on dietary variety or overall food patterns. Although some food group and nutrient intake data differ by food security/sufficiency status, this does not explain the quality components of hunger described in the qualitative literature.

Food Security Status and Self-Report of Children's Intakes from the Food Security Module. Children are at high risk for food insecurity with and without hunger, especially in low-income populations. There are eight items from the 18-item Food Security Module (FSM) that address components of hunger at the child level (Table 2). Six of these items address inadequate intake or the quantity component of hunger at the individual level. The other two items address the quality components of hunger: Relied on few kinds of low-cost food to feed child(ren) and couldn't feed child(ren) balanced meals. From the Food Security Module, Current Population Survey, 1995-1999, the three

most prevalent child hunger items were the two quality items ("relied on few kinds of low-cost food to feed children" [12.1% to 14.4% of households responded affirmatively] and "couldn't feed child(ren) balanced meals [7.3% to 8.7% of US households responded affirmatively]), and one quantity item ("child(ren) were not eating enough" [4.2-4.7% of US households responded affirmatively]). These items are the three most prevalent items outside of those items that measure the psychological component at the household level, or anxiety over food resources. The response rates for the other five child quantity items ranged from 0.1% to 2.0% (19). Therefore, the three most common components of child hunger are: The gatekeeper's perception of child(ren) not eating enough, relying on a few low cost foods (variety in the diet), and obtaining a balanced diet. The study described in this dissertation was designed to quantify two components of children's diets (adequacy and variety) and then to examine differences in these components by food sufficiency status using a nationally representative sample of children.

Limitations of the Current Research on Food Sufficiency Status. Overall, the impact of food security/sufficiency status on adequacy of the diet has been explained to some degree, especially for adult women. However, the impact food security/sufficiency status has on adequacy of food group intake has not been assessed in a way that allows researchers to understand whether food group intake meets the current recommendations for a healthy diet. If fruit and vegetable intakes differ by food security/sufficiency status, but both the food sufficient and food insufficient groups do not consume the minimum number of servings, then public health interventions need to be planned for both groups. The literature really does not describe the characteristics of food insufficient

Table 2: Food Security Scale, Child Items[1]

Child Items
Relied on few kinds of low-cost food to feed child(ren)
Couldn't feed child(ren) balanced meals
Child(ren) were not eating enough
Cut size of child(ren)'s meals
Child(ren) were hungry
Child(ren) skipped meals
Child(ren) skipped meals in 3 or more months
Child(ren) did not eat for whole day

[1] The actual wording of each item includes a reference to resource limitations.
Source: Andrews, M., Nord, M, Bickel, G., Carlson, S. *Household Food Security in the United States, 1999.* Food and Rural Economics Division, Economic Research Service, US Department of Agriculture. Food Assistance and Nutrition Research Report No.8.

individuals who meet dietary guidelines for an adequate diet. Are they more likely to participate in food assistance programs? Do their diets consist of foods that are more nutrient dense? And what about young school age children? Up until this point studies on food security/sufficiency status only address health and behavioral outcomes in this age group. Little is known about the impact on dietary patterns in this vulnerable group of children. Lastly, one of the quality components of hunger, variety, has yet to be explored. Therefore, this dissertation study was aimed to address these issues. The next few sections of this chapter will review the literature on the variables of interest.

Food Guide Pyramid and the Pyramid Servings Database

The Dietary Guidelines for Americans (20,46) suggests that Americans "let the Pyramid guide your food choices." The reference pyramid is the USDA food guidance system for Americans or the Food Guide Pyramid. The Food Guide Pyramid provides a framework for a diet that meets the dietary needs of almost all healthy Americans that are

2 years old or greater. It features commonly eaten foods and classifies these foods into food groups (17,18). It emphasizes the need to moderate fat, saturated fat, cholesterol, and excessive calories by adjusting discretionary fat and added sugars (17,18,20-23). The Pyramid classifies foods, including mixed dish foods, into food groups, with typical household measures as serving sizes. The Pyramid (Figure 3) and its accompanying educational materials provide the user with information to plan a nutritionally adequate diet that is moderate in food substances known to promote chronic disease. It also has been used as a tool to educate the public on an adequate and moderate diet since 1992. Cleveland et al (21) developed a methodology that allows dietary intake data to be transposed into Food Guide Pyramid food groups, discretionary fat, and added sugars (22,23). This methodology is used within the CSFII 1994-96, 1998 data set to create the Pyramid servings database for each of the 5 major food groups and their respective sub-groups, discretionary fat, and added sugars. For example, the vegetable group can be sub-divided into dark green leafy vegetables, deep-yellow vegetables, white potatoes, other starchy vegetables, tomatoes, and other vegetables (22,23). The study described here used these sub-groups to understand variety of food choices within each of the Pyramid food groups for the three levels of food sufficiency.

The Pyramid database has been used in only one previous study (6) on food sufficiency status to date. The limitations of this study, using a sample of children 2-17 years of age from CSFII 1994-1996 data, were discussed in detail previously. The United States Department of Agriculture used the Pyramid database, created from CSFII 1994-1996, 1998 data, to describe the percentage of the population meeting the recommended

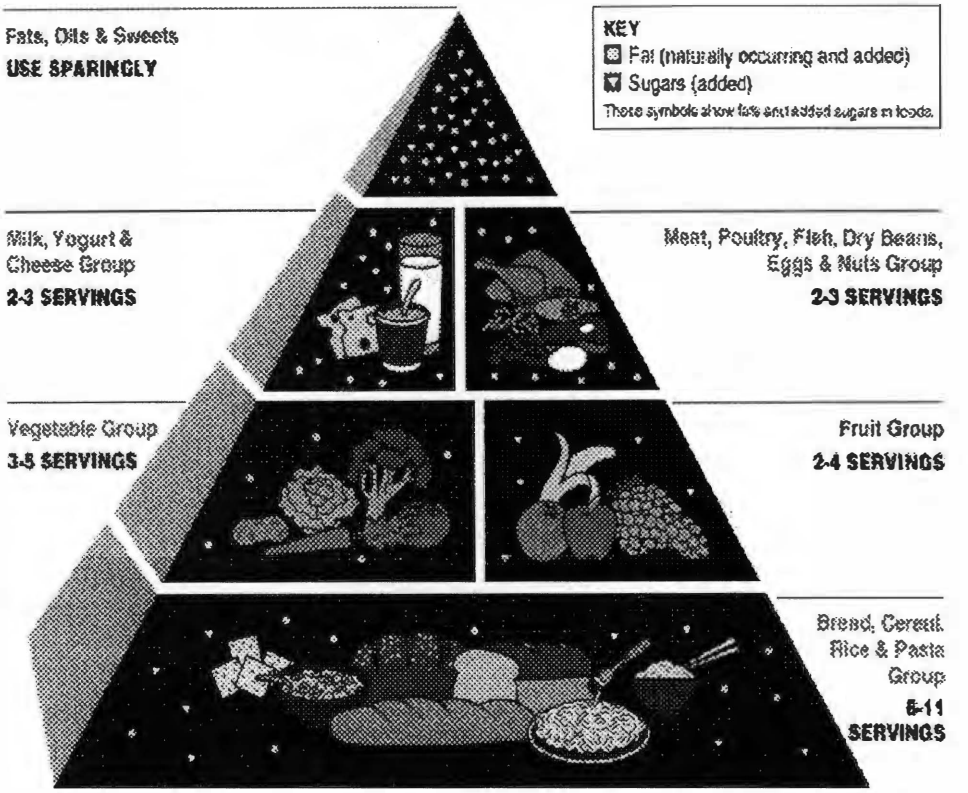

Figure 3: The Food Guide Pyramid (1992). U.S. Department of Agriculture and the U.S. Department of Health and Human Services. Home and Garden Bulletin 252.

number of servings from the Food Guide Pyramid based on age recommendations (23). These recommendations appear in Table 3. Findings from the USDA study revealed that a large proportion of children, ages 2-9 years, did not reach the minimum serving recommendations for the five main Pyramid food groups, but over-consumed added sugars and discretionary fat (the tip of the Pyramid). The children were more likely to meet the minimum serving recommendations for the grains (47%) and dairy groups (42%). However, a smaller percentage of children met the recommendations for fruit and vegetable consumption (20% and 37%, respectively). Lastly, children were least likely to meet the minimum recommendations for the meat and meat alternatives group (18%) (23).

The USDA study also measured the mean number of servings per day from each of the main food groups and their sub-groups. Children ages 2-9 years of age ate an average of 6.3 servings per day from the grains group with most of those servings coming from the non-whole grains sub-group. These same children ate an average of 2.1 and 2.0 servings of vegetables and fruits per day, respectively, with the white potatoes and the other fruits sub-groups providing the majority of the servings on average. The milk sub-group of the dairy group provided 1.6 servings per day, which comprised the better part of the dairy group servings (average of 2.0 servings per day). Lastly, children ate an average of 3.1 servings from the meat and meat alternatives group with the red meat, poultry, and hot dogs and luncheon meats subgroups providing 1.1, 0.7, and 0.7 servings per day, respectively (23).

Table 3. Recommended Number of Servings (SV) From the Food Guide Pyramid by Age

Age (years)	Kilocalories	Grains (SV)	Fruits (SV)	Vegetables (SV)	Dairy (SV)	Meat (Ounces)
2-3	About 1,300	6[a]	2[a]	3[a]	2	3.3 ounces or equivalent
4-6	About 1,600	6	2	3	2	5 ounces total or equivalent
7-8[b]	Kcals consumed<2,200	6	2	3	2	5 ounces or equivalent
	2200≤Kcal consumed<2800	9	3	4	2	6 ounces or equivalent
	Kcals consumed≥ 2800	11	4	5	2	7 ounces or equivalent

[a]Portion Sizes reduced for children age 2-3 years by 1/3.
[b]Serving number will be based on actual kilocalories consumed by the 7-8 year old subjects consistent with Cook and Friday, 2000 (31). Pyramid Servings Intakes by U.S. Children and Adults 1994-1996,1998, CNRG Table Set no. 1.
Source: *Dietary Guidelines for Americans* (38); *Tips for Using the Food Guide Pyramid for Children 2 to 6 Years Old* (6).

The Pyramid database measures the tip of the pyramid as discretionary fat and added sugars. Cook et al define both measures as follows:

> "Discretionary fat includes fats added to foods in preparation and at the table (that is cream, butter, margarine, cream cheese, oil, lard, meat drippings, cocoa, and chocolate) and fat from grain products, vegetable, fruits, dairy products, and meats and meat alternatives beyond amounts people would consume if they selected only the lowest-fat foods in each food group." (23, p.14).
>
> Added sugars "include white sugar, brown sugar, raw sugar, corn syrup, honey, molasses, and artificial sweeteners containing carbohydrates that were eaten separately or used as ingredients in processed or prepared food such as breads,

cakes, soft drinks, jams, and ice cream. Does not include sugars such s fructose and lactose that occur naturally in foods such as fruit and milk."(23, p.14).

Among children 2-9 years of age in the nationally representative sample, discretionary fat and added sugars provided 25.4% and 16.8% of the overall calories in the diet (23).

In summary, many US children consume diets that are inadequate as measured by the minimum serving recommendations from the Food Guide Pyramid yet are high in fats and sugars. Therefore, the diets of a large proportion of young children in the US do not conform to the Pyramid in terms of adequacy or proportionality. *Nutrition and Your Health: Dietary Guidelines for Americans, 5th edition* (46) recommends that Americans choose a variety of foods within the grains, vegetables and fruits groups. The USDA study (23) suggests that both adequacy of food group intake and possibly variety within these food groups may be an issue within this population. Also stated previously, food insufficiency may impact the consumption of fruits and vegetables. If children in the general population are not getting enough servings from these food groups or variety within these food groups, then food insufficient groups could be at even greater risk.

Dietary Variety

Within the first four editions of *Nutrition and Your Health: Dietary Guidelines for Americans*, variety within the overall diet, among food groups, and within food groups was encouraged, by the statement "eat a variety of foods," for optimal health (20,46). In the 2000 Dietary Guidelines this statement was replaced with "Let the Pyramid guide your food choices." The 2000 Dietary Guidelines no longer recommend overall variety in the diet, but instead recommend the consumption of foods from each of the major food groups of the Food Guide Pyramid (20,46). This change in the Dietary

Guidelines was made based on research suggesting that variety among food groups contributed to nutrient adequacy (20,46). No consensus exists on how to quantify dietary variety at present (30). Therefore, variety scores using food group intake data from previous national studies will be utilized in this study (30,31,47,48).

Dietary variety can be measured as overall variety, variety among food groups, and variety within food groups. Overall variety has been measured by simply counting the number of different foods eaten over a given period of time (47). Variety among food groups represents the number of different major food groups eaten on an average daily basis (47). Lastly, variety within major food groups has been defined as either the number of separate foods mentioned within food groups or the number of minor food groups within the major groups (47). The current study measured dietary variety in three ways: Healthy Eating Index Variety Score (overall variety), the Dietary Diversity Score (variety among food groups), and Sub-Group Contribution Score (variety within food groups). The remainder of this section describes these measures.

Healthy Eating Index Variety Score (Overall Variety). The Healthy Eating Index (HEI) was designed by the United States Department of Agriculture to assess the overall quality of the diet (30). It is based on 10 components, including conformity to the five major food groups of the Food Guide Pyramid, moderation in fat, saturated fat, cholesterol and sodium, and a variety score. For the overall HEI, a maximum score of 10 is assigned to each component for a total of 100 points. To construct the Variety Score, the number of different foods eaten in a day in sufficient amounts to contribute to at least one-half of a serving, based on Pyramid serving sizes, is totaled. Foods eaten more than once a day are counted only once. Foods that differ only by preparation method, such as

fried and boiled potatoes, are grouped together and counted as one. Different foods are counted separately, even if foods may be closely related, such as tuna and trout. When a person consumes at least eight different foods in a day, then that person receives the maximum number of points (10 points) for the HEI variety score. If a person consumes three or fewer foods per day, then that person receives the minimum score (0 points). Intermediate intakes are scored proportionally. For example, the consumption of four foods, would receive a score of 2, the consumption of five foods would receive a score of 4, and so on.

Bowman et al (30) used the 1994-1996 CSFII data to calculate the overall Healthy Eating Index mean score for children ages 2-3, 4-6, and 7-10 years. The findings were scores of 73.9, 67.7, and 66.6, respectively (34). To validate the HEI as a whole, the overall HEI was compared to 16 nutrients as a percent of the RDA and total energy intake. As the HEI rose, so did the percentage of the population meeting the RDA for each nutrient. Only a modest correlation was found between energy intake and the HEI, suggesting that increases in calories may not dramatically increase the overall HEI (48).

Little information is provided on component parts of the HEI, including the variety score (30,48). In the same study using the CSFII 1994-1996 data, the percentage of the overall population that received all 10 points from the variety score was only 52.4%, suggesting a large proportion of the population consumes a diet that lacks variety (48).

Krebs-Smith et al (47) used a measure of overall variety, the number of different foods eaten in a 3-day period, to understand the effect this type of variety has on the Mean Adequacy Ratio (MAR) of 11 nutrients. In a regression model predicting MAR,

while controlling for age and sex, overall variety was a significant predictor of MAR accounting for 8% of the variation in the MAR (47). Krebs-Smith (47) also analyzed the effect overall variety had on the following five dependent variables: energy intake in calories, fat and sugar as percent of calories consumed, and cholesterol and sodium as milligrams consumed. Overall variety did not account for any sizable proportion of the variation within any of these five models (47).

The Dietary Diversity Score (Variety Among Food Groups). The "Dietary Diversity Score (DDS) counts the number of major food groups consumed daily" (31, p. 435) or variety among food groups. One would assume that if individuals chose foods from all five food groups, overall dietary adequacy would improve. The Dietary Diversity Score can range from 0 (no food from any of the major food groups eaten) to 5 (at least one food eaten from each of the major food groups) possible points (31).

The DDS was used to assess variety among food groups in adults using data from the First National Health and Nutrition Examination Survey Epidemiologic Follow-up Study (NHEFS) (31). The DDS was found to be significantly and inversely related to age-adjusted risk for mortality in a cohort of adult men and women who had originally participated in NHANES I. Researchers concluded that when dietary patterns omitted food groups, there was an increase in all cause mortality rates. Frequencies for the DDS were 5.3%, 20.3%, 39.3%, and 35.2% for the scores 0-2, 3, 4,and 5, respectively. Among those who ate two or fewer food groups per day, more than 90% reported no consumption of fruit, while more than 80% reported no consumption from the vegetable and dairy groups (31). Thus when food groups are omitted in total, it is likely to observe no intake

of fruit, vegetables and/or dairy products in adults. To date, the DDS has not been used to measure among food group variety in a national sample of children.

Krebs-Smith et al (47) used a measure of among food group variety to understand how it effects the Mean Adequacy Ratio (MAR) for 11 nutrients. They measured among food group variety using the same formula as the DDS. In regression models predicting MAR while controlling for age and sex, among food group variety was a significant predictor of MAR accounting for 10% of the variation in the MAR (47). However, among food group variety was not a significant predictor of overall calories, percent of calories from fat or sugar, or cholesterol and sodium intake. Therefore, among food group variety may have its greatest effect on overall adequacy of the diet. Among food group variety seems to have a greater effect on adequacy of the diet than the overall measure of variety (number of different foods eaten in a time period).

These two national studies suggest that variety among food groups has an overall effect on the nutrient adequacy of the diet and overall mortality risk. The effect food sufficiency has on dietary variety was examined for the first time in this dissertation study.

Sub-Group Contribution Score (Variety Within Food Groups). Krebs-Smith et al (47) also measured variety within food groups in two ways: The total number of different foods within the major food groups over 3 days, and the number of different minor groups represented in 3 days. In each case the number of foods from the major food groups was used as a control variable (47). When predicting the MAR, both variety scores accounted for 7% of the variation within the MAR, respectively. Among food group variety explained as much of the variation in MAR scores as within food group

variety (10% and 7%, respectively). This led researchers to conclude that variety among food groups contributes to dietary adequacy and that the better interpretation of "eat a variety of foods" is to eat foods from each of the major food groups.

However, variety within certain food groups may contribute to obesity and increased caloric intake (32). In a study of 71 healthy men and women, McCrory et al (32) examined whether variety within food groups affected energy intake and body fatness, measured by Body Mass Index (BMI). Using food frequency data, within food group variety was measured as "the percentage of different food types consumed within each food group, regardless of the frequency with which they were consumed"(32, p.441). Foods were categorized into the following groups: breakfast foods; lunch and dinner entrees; sweets, snacks, and carbohydrates; condiments; fruit; vegetables; energy containing beverages; and dairy products. The researchers used multivariate techniques to control for factors associated with BMI and found that variety within the sweets, snacks, and carbohydrates group; entrees group; and condiments group was significantly and positively related to BMI. Variety within the vegetables group was significantly and negatively related to BMI. Variety within all eight of the food groups tested was significantly and positively related to energy intake. However, the limitations of this study included a small sample size and use of an unconventional food grouping system due to the use of food frequency data.

With the addition of the Pyramid database and methodology to place foods within Pyramid food groups and sub-groups, the contribution that each sub-food group has to the overall food group can now be determined. These variables of variety then can be assessed and their relationship to food security/sufficiency status determined.

In the current study the quality component of hunger, or relying on a few kinds of low-cost foods, was measured using all three-variety scores: Overall, among food group and within food group.

Study Purpose

This study was conducted to understand the effects of household food sufficiency status on the diets of children ages 2-3 and 4-8 years. Specifically, this study measured two aspects of children's diets that may be affected by food sufficiency status based on self-report of dietary habits. These two measures were: adequacy and variety. The study used the Continuing Survey of Food Intakes by Individuals 1994-1996, 1998 (CSFII) data to examine how household food sufficiency status is related to diet quality for children ages 2-3, and 4-8 years living in households who are eligible by income to participate in United States Department of Agriculture (USDA) food assistance programs. It was designed to address how household food sufficiency status affects these two aspects of children's diets: adherence to the Food Guide Pyramid serving recommendations (measuring adequacy of the diet) (17,18) and dietary variety (measured as overall variety [HEI variety score], variety among food groups [DDS] and variety within food groups of the Food Guide Pyramid).

Research Questions

The research questions revolved around two major themes: adequacy as described by Food Guide Pyramid serving recommendations and the tip of the Pyramid; and variety described as overall variety ((Healthy Eating Index (HEI) variety score)), among food group variety ((Dietary Diversity Score (DDS)) and within food groups

(sub-group contribution). These research questions examined how the quality of young children's diets differs by household food sufficiency status. The young children were 2-8 years of age living in households that were eligible by income and age to participate in USDA food assistance programs (WIC, National School Breakfast and Lunch Programs, and Food Stamps). Each of the research questions utilized the same basic framework for analysis with changes in the dependent variable and statistical methods only.

Adequacy. Adequacy was described by the degree to which intakes meet the serving recommendations of the 5 major Food Guide Pyramid groups, discretionary fat, and added sugars (2-3). The research question was:

1. Are there significant differences in diet adequacy between the three levels of household food sufficiency? Diet adequacy was measured by degree of adherence to age-specific daily serving recommendations for the 5 Food Guide Pyramid food groups and by intake of discretionary fat (grams) and added sugars (teaspoons).

Variety. Diet quality was described by three measures of variety: overall, among food groups and within food groups using the 5 major Food Guide Pyramid groups and their 19 sub-groups (2-3). The research questions were:

2. Are there significant differences in overall variety between the three levels of food sufficiency status? Overall variety was measured using the Healthy Eating Index (HEI) variety score.

3. Are there significant differences in variety among food groups between the levels of food sufficiency status? Among food group variety was measured using the Dietary Diversity Score (DDS).

4. For each major Food Guide Pyramid group, are there significant differences in the contribution of each of its food sub-groups (within food group variety) to overall Pyramid group intake between the three levels of household food sufficiency? Each sub-group's contribution was measured by the degree to which the number of servings from the respective sub-group contributes to the total number of servings for the

Pyramid food group. Contribution of food sub-group choices will serve as a proxy for diversity within a food group.

Appendix A discusses in detail the methods employed by this study to understand the quality component of hunger within children. Parts II, III, and of this dissertation include three manuscripts that present the findings for the respective research questions.

References

1. Anderson, S.A., ed. Life Sciences Research Office, Federation of American Societies for Experimental Biology (1990) Core Indictors of Nutritional Status for Difficult to Sample Populations. JNE 120:1559-1600.

2. Andrews, M., Nord, M., Bickel, G., Carlson, S. (2000) Household food security in the United States, 1999. Food and Rural Economic Division, Economic Research Service, US Department of Agriculture. Food Assistance and Nutrition Research Report No. 8.

3. Cristofar, S.P., Basiotis, P.P. (1992) Dietary intakes and selected characteristics of women ages 15-50 years and their children ages 1-5 years by reported perception of food sufficiency. JNE 24:53-58.

4. Bickel, G.W., Andrews, M.S., Klein, B.W. (1996) "Measuring Food Security in the United States: A Supplement to the CPS." In Nutrition and Food Security in the Food Stamp Program (D Hall and M Stravrianos, eds). Alexandria, VA: US Department of Agriculture, Food and Consumer Service.

5. Rose, D., Oliveira, V. (1997) Nutrient intakes of individuals from food-insufficient households in the United States. Amer J Public Health 87:1956-1961.

6. Casey, P.H., Szeto, K., Lensing, S., Boyle, M., Weber, J. (2001) Children in food-insufficient, low-income families: Prevalence, health, and nutrition status. Arch Pediatr Adolesc Med 155:501-514.

7. Rose, D., Oliviera, V. (1997) Validation of a self-reported measure of household food insufficiency with nutrient intake data. US Department of Agriculture, Economic Research Service, Food and Consumer Economics Division. Washington DC. Technical Bulletin 1863.

8. Briefel, R.R., Woteki, C.E. (1992) Development of the food sufficiency questions for the third National Health and Nutrition Examination Survey. JNE 24(supple):24S-28S.

9. Alaimo, K., Briefel, R.R., Frongillo Jr., E.A., Olson, C.M. (1998) Food insufficiency exists in the United States: Results from the Third National Health and Examination Survey (NHANES III) Amer J Public Health 88:419-426.

10. Alaimo, K., Olson, C.M., Frongillo Jr., E.A., Briefel, R.R. (2001) Food insufficiency, family income, and health in US preschool and school-aged children. Am J Public Health 91:781-786.

11. Alaimo, K., Olson, C.M., Frongillo Jr., E.A. (2001) Food insufficiency and American school-aged children's cognitive, academic, and psychosocial development. Pediatrics 108:44-53.

12. Kendall, A., Olson, C.M., Frongillo, E.A. (1995) Validation of the Radimir/Cornell measures of hunger and food insecurity. J Nutr 125:2793-2801.

13. Kendall, A., Olson, C.M., Frongillo, E.A. (1996) Relationship of hunger and food insecurity to food availability and consumption. J Amer Diet Assoc 96:1019-1024.

14. Tarasuk, V.S., Beaton, G.H. (1999) Women's dietary intakes in the context of household food insecurity. J Nutr 129:672-679.

15. Radimir, K.L., Olson, C.M., Campbell, C.C. (1990) Development of Indicators to Assess Hunger J Nutr 120:1544-1548.

16. Radimir, K.L., Olson, C.M., Greene, J.C., Campbell, C.C., Habicht, J.P. (1992) Understanding Hunger and Developing Indicators to assess it in women and children. JNE 24:36S-45S.

17. *Tips for Using the Food Guide Pyramid for Children 2 to 6 Years Old* (1999) United States Department of Agriculture, Center for Nutrition Policy and Promotion, Program Aid 1647.

18. *The Food Guide Pyramid* (1992). United States Department of Agriculture. Home and Garden Bulletin 252.

19. Cronin, F.J., Shaw, A.M., Krebs-Smith, S.M., Marsland, P.M., Light, L. (1987) Developing a food guidance system to implement the dietary guidelines. JNE 19:281-302.

20. Dixon, L.B., Cronin, F.J., Krebs-Smith, S.M. (2001) Let the Pyramid guide your food choices: Capturing the total diet concept. J Nutr. 131:461S-472S.

21. Cleveland, L.E., Cook, D.A., Krebs-Smith, S.M., Friday, J. (1997) Method for assessing food intakes in terms of servings based on food guidance. Am J Clin Nutr. 65:1254S-1263S.

22. Cook, A., Friday, J.E. Documentation: Pyramid servings database for USDA survey food codes. http://www.barc.usda.gov/bhnrc/cnrg (Accessed October 2000).

23. Cook, A., Friday, J.E. Pyramid Servings Intakes by U.S. children and Adults 1994-96, 1998. CNRG Table Set No. 1. http://www.barc.usda.gov/bhnrc/cnrg (Accessed October 2000).

24. Knol, L.L., Haughton, B. (1998) Fruit and juice intake associated with higher Dietary Status Index in rural east Tennessee women living in public housing. J Am Diet Assoc. 98:576-579.

25. Miller, M.L.(1997) *Relationships Among Food Insufficiency, Dietary Status Index, and Food Group Intake in Healthy Women of Childbearing Age: Secondary Data Analysis of NHANES III.* Knoxville, TN: The University of Tennessee; Thesis.

26. Miller, M.L., Haughton, B, Fitzhugh, E.C. *Relationships Among Food Insufficiency, Dietary Status Index , and Food Group Intake in Women of Childbearing Age in the U.S.*. Abstract, Session 2029, p. 145. Annual Meeting of the American Public Health Association, Washington, DC. November 15-18, 1998.

27. Subar, A.F., Ziegler, R.G., Patterson, B.H., Ursin, G, Braubard, B. (1994) US dietary patterns associated with fat intake: The 1987 National Health Interview Survey. Am J Public Health 84:359-366.

28. Krebs-Smith, S.M., Cook, A, Subar, A.F., Cleveland, L.E., Friday, J. (1995) US adults' fruit and vegetables intakes, 1989 to 1991: A revised baseline for the Healthy People 2000 objective. Am J Public Health 85:1623-1629.

29. Willet, W.C. (1990) Challenges for public health nutrition in the 1990s. Am J Public Health. 80:1295-1298.

30. Bowman, S.A., Lino, M., Gerrior, S.A., Basiotis, P.P. (1998) The Healthy Eating Index, 1994-1996. *Fam Econ and Nutr Review* 11:2-14.

31. Kant, A.K., Schatzkin, A., Harris, T.B., Ziegler, R.G., Block, G. (1993) Dietary diversity and subsequent mortality in the First National Health and Nutrition Examination Survey Epidemiologic Follow-up Study. Am J Clin Nutr 57:434-440.

32. McCrory, M.A., Fuss, P.J., McCallum, J.E., Manjiang, Y., Vinken, A.G., Hays, N.P, Roberts, S.B. (1999) Dietary variety within food groups: Association with energy intake and body fatness in men and women. Am J Clin Nutr 69:440-447.

33. Food Research and Action Center (1991) Community Childhood Hunger Identification Project: A Survey of Childhood Hunger in the United States. Washington DC.

34. Wehler, C.A., Scott, R.I, Anderson, J.J. (1992) The Community Childhood Hunger Identification Project: A model of domestic hunger-Demonstration Project in Seattle, Washington. JNE 24:29S-35S.

35. Hamilton, W.L., Cook, J.T., Thompson, W.W., Buron, L.F., Frongillo Jr., E.A., Olson, C.M., Wehler, C.A. (1997) *Household Food Security in the United States in 1995. Technical Report of the Food Security Measurement Project*. Alexandria, VA: United States Department of Agriculture, Food and Consumer Service, Office of analysis and Evaluation.

36. Hamilton, W.L., Cook, J.T., Thompson, W.W., Buron, L.F., Frongillo Jr., E.A., Olson, C.M., Wehler, C.A. (1997) *Household Food Security in the United States in 1995. Summary Report of the Food Security Measurement Project*. Alexandria, VA: United States Department of Agriculture, Food and Consumer Service, Office of Analysis and Evaluation.

37. Nord, M., Jemison, K., Bickel, G. (1999) Measuring food security in the United States: Prevalence of food insecurity and hunger, by state, 1996-1998. Food and Rural Economic Division, Economic Research Service, US Department of Agriculture. Food Assistance and Nutrition Research Report No. 2.

38. Cohen, B., Ohls, J., Andrews, M., Ponza, M., Moreno, L., Zambrowski, A., Cohen, R. US Department of Agriculture, Food and Nutrition Service, Office of Analysis. (1999) Food Stamp Participants' food security and nutrient availability. Final Report. Alexandria, VA.

39. Townsend, M.S., Peerson, J., Love, B., Achterberg, C., Murphy, S.P. (2001) Food insecurity is positively related to overweight in women. J Nutr 131:1738-1745.

40. Murphy, J.M., Wehler, C.A., Pagano, M.E., Little, M., Kleinman, R.E., Jellinek, M.S. (1998) Relationship between hunger and psychosocial functioning in low-income American children. J Amer Acad Child Adolesc Psychiatry 37:163-170.

41. Kleinman, R.E., Murphy, J.M., Little, M., Pagano, M., Wehler, C.A., Regal, M.S., Jellinek, M.S. (1998) Hunger in children in the United States: Potential behavioral and emotional correlates. Pediatrics 101:1:e3. www.pediatrics.org/content/vol101/issue1.

42. Alaimo, K., Olson, C.M., Frongillo, E.A. (2002) Family food insufficiency, but not low family income, is positively associated with dysthymia and suicide symptoms in adolescnents. J Nutr 132:719-725.

43. Serdula, M., Coates, R., Byers, T., Mokdad, A., Jewell, S., Chavez, N., Mares-Perlman, J., Newcomb, P., Rittenbaugh, C., Treiber, P., Block, G. (1993) Evaluation of a brief telephone questionnaire to estimate fruit and vegetable consumption in diverse study populations. Epidemology 4:455-463.

44. Tarasuk, V.S. (2001) Household food insecurity with hunger is associated with women's food intakes, health and household circumstances. J Nutr 131:2670-2676.

45. Health Canada (1997) Canada's Food Guide to Healthy Eating. H39-252/1992E. Minister of Supply and Services Canada. Ottawa, Canada.

46. *Nutrition and Your Health: Dietary Guidelines for Americans* (2000). United States Department of Agriculture and United States Department of Health and Human Services. Home and Garden Bulletin No. 232.

47. Krebs-Smith, S.M., Smiciklas-Wright, H., Guthrie, H.A., Krebs-Smith, J. (1987) The effects of variety in food choices on dietary quality. J Amer Diet Assoc. 87:897-903.

48. United States Department of Agriculture. Center for Nutrition Policy and Promotion. (1995). *The Healthy Eating Index.*

PART II:
Household Food Sufficiency Status is Related to Added Sugars Intake Among 4-8 Year Old Children

Introduction

The term food insufficiency is defined as "an inadequate amount of food intake due to a lack of money or resources" (1, p. 24S). Food sufficiency status has been used as a proxy measure for food insecurity and hunger in many studies (1-9). Those at highest risk for food insufficiency are low-income households, especially those with children (7). Food insufficiency has a detrimental effect on the general health, well-being, and academic performance of children (8-10). Given that dietary intake may be a mediating factor between health outcomes and food insufficiency, it is important to study the effect food sufficiency status has on diet quality among low-income children (10).

From qualitative research, low-income women described hunger as an inability on their part to provide adequate amounts of food for their children due to constrained resources (11). Researchers have attempted to quantify the effect food insufficiency has on the diets of children, specifically in terms of nutrient and food group intake. Three studies, all using data from the Continuing Survey of Food Intakes by Individuals (CSFII), demonstrated that as food insufficiency worsened, energy intake decreased (2,4,5). For nutrients, results varied between these studies (2,4,5). Two of these studies also found that food insufficiency affected food group intake negatively (2,5). However, strategies for grouping the foods varied and neither study measured whether food group intake was adequate across the various levels of food sufficiency status.

One tool for measuring adequacy of food group intake and describing food group patterns in a population is the Food Guide Pyramid. The Pyramid features commonly eaten foods, including mixed dish foods, and classifies them into five major food groups, with typical household measures as serving suggestions. It also provides a framework for

a diet that meets the dietary needs of almost all healthy Americans 2 years of age or older, yet emphasizes the need to moderate dietary fat and excessive calories by adjusting discretionary fat and added sugars (12-18).

The purpose of this study was to extend previous research by investigating the effect food sufficiency status has on the adequacy of food group intake among children 2-8 years of age. The Food Guide Pyramid food group recommendations provided the basis for assessing adequacy of food group intake. Intake of added sugars and discretionary fat also were assessed.

Methods

Data Source: 1994-1996, 1998 CSFII

This study selected a sample of children 2-8 years of age from the 1994-1996, 1998 CSFII (19). The CSFII is a nationally representative sample of non-institutionalized persons living in households across the United States with over-sampling of low-income households. Prior versions of the CSFII have been used in previous studies of diet and food sufficiency status (2,5-7). The sampling frame was organized using estimates from the 1990 US population and took into account socioeconomic characteristics, geographic region, and urbanization. The CSFII provides estimates of food and nutrient intakes for 20,607 individuals of all ages from 2 nonconsecutive days of 24-hour dietary recall obtained through in person interviews. The overall 1998 CSFII 2-day response rate was 81.7%, while the overall 1994-96 2-day response rate was 76.1% (19). Proxy interviews were conducted for children less than 6 years of age. Children ages 6-11 years old provided data about their own dietary intake with the assistance of an adult household member. The preferred proxy for children was the person who prepared

the sample person's meals. However, it was permissible for any caregiver, including baby sitters or school cafeteria personnel, to provide dietary intake data, if needed (19).

Sample

The sample included 3122 children 2-8 years of age who provided 2 days of completed dietary recall data and whose households could be staged into one of four categories of food sufficiency. Selected children were those who lived in households whose income was 185% of the federal poverty level or less. This income level was chosen as a proxy for food assistance program eligibility.

To limit the confounding effect of age, the children were divided into two age categories, 2-3 year olds (n=1308) and 4-8 year olds (n=1814), with similar eating patterns and nutritional needs (20). The selected age categories, with one exception, were consistent with those of the Standing Committee on the Scientific Evaluation of the Dietary Reference Intakes (DRI) of the Food and Nutrition Board, Institute of Medicine (20). The DRI age group of 1-3 years was limited to those 2-3 years old, because serving recommendations from the Food Guide Pyramid (12,13) are applicable to those ages 2 years and older. Breastfeeding children were excluded from the study because breast milk consumption was not quantified (19). Lastly, only one child fitting the eligibility requirements for each age group was chosen at random per household. Therefore, the final sample included: 1242 and 1506 children ages 2-3 and 4-8 years, respectively.

Food Guide Pyramid and the Pyramid Servings Database

Dietary intake data were transposed into the 5 major food groups of the Food Guide Pyramid, discretionary fat, and added sugars through a method developed by Cleveland et al (16-18). Serving sizes were reduced for children ages 2-3 years, which is

consistent with the Food Guide Pyramid for Children 2-6 years of age (12). Dry beans and peas were placed into the meat group.

The recommended number of servings from each food group by age category is depicted in Table 1. These recommendations were used to create the measures of food group adherence. Adequacy of food group intake was described as the degree to which intakes met the serving recommendations for each of the 5 major food groups as follows:

Degree of Adherence=
(number of servings {2-day average}/recommended number of servings)*100

Mean number of servings from each food group and the percentage of children who met the Pyramid recommendations also were computed for comparison purposes.

Intakes of added sugars and discretionary fat were measured in teaspoons and grams, respectively. Discretionary fat were defined as all fats added to foods in preparation or at the table. This measure also included fats consumed from the five major food groups beyond what would be consumed if only the lowest fat foods in each food group were chosen. Added sugars were defined as carbohydrate sources that were eaten separately or added to the food during processing. However, this definition did not include naturally occurring sugars found in fruits and milk, or fructose and lactose. All procedures used to derive the measures of discretionary fat and added sugars were consistent with those of Cleveland et al (16-18).

Table 1. Recommended Number of Servings (SV) From the Food Guide Pyramid by Age

Age (years)	Energy (kcals)	Grain (SV)	Fruit (SV)	Vegetable (SV)	Dairy (SV)	Meat (Ounces)
2-3	About 1,300	6[a]	2[a]	3[a]	2	3.3 ounces or equivalent
4-6	About 1,600	6	2	3	2	5 ounces total or equivalent
7-8[b]	<2,200	6	2	3	2	5 ounces or equivalent
	2200-2799	9	3	4	2	6 ounces or equivalent
	≥ 2800	11	4	5	2	7 ounces or equivalent

[a]Portion Sizes reduced for children age 2-3 years by 1/3.
[b]Serving number were based on actual energy consumed by the 7-8 year old subjects consistent with Cook and Friday, 2000 (17). Documentation: Pyramid servings database for USDA survey food codes.
Source: *Tips for Using the Food Guide Pyramid for Children 2 to 6 Years Old* (12).

Food Sufficiency Status

Food sufficiency status was measured by the following question:

Which one of the following statements best describes the food eaten in your household in the last three months....?

1) Enough of the kinds of food we want to eat
2) Enough but not always the kinds of food we want to eat
3) Sometimes not enough to eat
4) Often not enough to eat

Due to the low number of responses to "often not enough to eat" (n=6 and n=14 for 2-3 year olds and 4-8 year olds, respectively), categories 3 and 4 were collapsed into "sometimes/often not enough to eat" and labeled "food insufficient." This was consistent with previous research using the food sufficiency question from the CSFII (2,4-6). Study participants then were placed into one of three categories: food sufficient (enough of the

kinds of food wanted), food sufficient with limitations (enough but not always the kinds of food wanted), and food insufficient.

Control Variables

Dietary practices can vary by race/ethnicity, geographic region, level of urbanization, and household income. They also can vary by household level descriptors, such as educational status of the household head, whether the head of the household is a female, and the number of household members (4). These variables were controlled for in all analyses. Many children in the sample were participating in food assistance programs at the time the survey was completed. Therefore, household participation in the Food Stamp and WIC programs, and sample child participation in the National School Breakfast and/or the National School Lunch Programs were recoded into dichotomous responses and used as control measures. Lastly, the year the respondent entered the sample also was controlled for due to differences in nutrient intakes for the 1994-96 and 1998 CSFII sample of children, particularly, for 3- to 5-year old children (19).

Data Analysis

Data analysis used a combination of statistical software packages. SAS 8.2 was used for all data management and re-coding activities (21), while data analysis was completed using SUDAAN version 8.0.1 (22). The CROSSTAB and DESCRIPT procedures in SUDAAN were used to compute descriptive statistics. Using the REGRESS procedure in SUDAAN, ten linear regression models (energy intake, adherence scores of the five major food groups, grams of discretionary fat, teaspoons of added sugars, and percentage of energy from discretionary fat and added sugars) were tested for differences among the three levels of food sufficiency status (α=0.01) while

controlling for food assistance participation and other factors affecting dietary intake. A conservative significance level of α=0.01 was used due to the large number of tests completed.

A detailed description of the methodology used in this study can be found in Appendix A.

Results

Sample Characteristics

The prevalence of food sufficiency, food sufficiency with limitations, and food insufficiency was 58.1%, 35.4%, and 6.5% among 2-3 year old children and 55.3%, 37.5%, and 7.2% among 4-8 year old children. Table 2 depicts selected characteristics of the two samples of children by food sufficiency status. The food insufficient children tended to be Hispanic, to live in a household that was headed by an individual with slightly more than nine years of education on average and to live in a household with an average of five household members. In both age groups the percentage of the sample at or below 130% of the poverty level increased as food sufficiency status decreased. Participation in food assistance programs also tended to increase as food sufficiency status decreased.

Energy Intake

Mean energy intake differed significantly between the two samples of children (α=0.01). The 4-8 year old children had a significantly higher mean energy intake than the 2-3 year children (1760 kcals versus 1472 kcals, respectively).

Table 2: Prevalence of Selected Household and Demographic Characteristics by Age and Food Sufficiency Status

	2-3 years of age (n=1242)			4-8 years of age (n=1506)		
	Food Sufficient (n=714)	**Food Sufficient with Limitations** (n=450)	**Food Insufficient** (n=76)	**Food Sufficient** (n=867)	**Food Sufficient with Limitations** (n=541)	**Food Insufficient** (n=97)
Household Economic Resources						
Income Category, % (SE)						
0-130% FPL	62.72 (2.77)	71.63 (2.95)	93.76 (2.76)	58.94 (2.53)	71.04 (2.96)	92.07 (3.88)
131-185% FPL	37.28 (2.77)	28.37 (2.95)	6.24 (2.76)	41.06 (2.53)	28.96 (2.96)	7.93 (3.88)
Participating in Food Assistance Programs, %, (SE)						
Anyone in Household on WIC	41.05 (2.52)	52.09 (3.22)	51.12 (7.11)	20.04 (1.60)	24.30 (2.96)	37.40 (5.84)
Food Stamps	34.37 (2.68)	50.27 (3.16)	54.87 (7.24)	31.78 (2.52)	42.97 (3.74)	64.69 (5.43)
School Breakfast	--	--	--	25.74 (2.63)	33.02 (3.49)	50.31 (7.14)
School Lunch	--	--	--	51.74 (2.47)	60.00 (3.76)	64.26 (6.22)
Household Characteristics						
Household Size, Mean (SE)	4.60 (0.08)	4.59 (0.09)	5.59 (0.31)	4.76 (0.06)	4.77 (0.11)	5.37 (0.24)
Highest Grade Completed for Household Head, Mean (SE)	12.41 (0.27)	11.71 (0.20)	9.25 (0.61)	12.91 (0.48)	12.11 (0.62)	9.66 (0.52)
Female Headed Household, % (SE)	31.55 (3.17)	38.73 (3.52)	35.64 (5.38)	30.31 (2.37)	36.43 (3.45)	44.86 (6.32)
Sample Person Characteristics						
Race/Ethnicity, % (SE)						
Non-Hispanic White	40.43 (2.93)	45.56 (3.32)	30.74 (5.89)	49.35 (3.17)	44.42 (4.48)	35.83 (6.46)
Non-Hispanic Black	26.61 (3.29)	24.84 (2.76)	12.99 (3.21)	24.10 (3.00)	28.95 (4.03)	11.32 (3.62)
Hispanic	26.96 (2.89)	23.12 (3.24)	45.76 (7.58)	22.03 (2.72)	21.27 (3.79)	43.52 (7.26)

Adherence to the Food Guide Pyramid Serving Recommendations

Children in the 2-3 year old group had mean adherence scores greater than 100 for the grain and fruit groups and scores less than 100 for the vegetable, dairy, and meat groups (Table 3).

Mean adherence scores for all five of the Pyramid food groups fell below 100 for the 4-8 year old group, although scores for the grain and dairy groups were close to 100; 94.4 and 98.3, respectively. The older group of children had significantly lower ($p=0.00$) mean adherence scores for the grain, vegetable, fruit, and meat groups and a significantly higher score for the dairy group ($p=0.00$) compared to the younger children.

Added Sugars and Discretionary Fat

Children ages 4-8 years consumed on average 18.3 teaspoons of added sugars and 51.6 grams of discretionary fat, while the children 2-3 years of age consumed significantly ($p=0.00$) less added sugars and discretionary fat, or 13.6 teaspoons and 42.4 grams, respectively. Children ages 4-8 years also consumed on average 16.5% and 26.1% of their total energy from added sugars and discretionary fat. For the 2-3 year old children, the percentage of total energy from added sugars (14.7%, $p=0.00$) and discretionary fat (25.5%, $p=0.01$) were significantly less than that of the 4-8 year old children.

Table 3: Mean Degree of Adherence Score for the Food Guide Pyramid Food Groups, Mean Intake of Added Sugars and Discretionary Fat by Age Group

	Age Category		
	2-3 Years (n=1242) Mean (SE)	**4-8 Years (n=1506) Mean (SE)**	**p-value[2]**
Degree of Adherence Scores for the Food Guide Pyramid Food Groups[1]			
Grain	114.97 (2.15)	94.44 (1.36)	0.00
Vegetable	83.45 (1.65)	63.61 (1.89)	0.00
Fruit	131.25 (4.42)	75.68 (2.52)	0.00
Dairy	90.24 (1.82)	98.33 (1.89)	0.00
Meat	90.12 (1.38)	71.78 (1.30)	0.00
Intake of Added Sugars[3]			
Added Sugars (teaspoons)	13.64 (0.35)	18.33 (0.42)	0.00
Added Sugars (% of Energy)	14.72 (0.31)	16.51 (0.28)	0.00
Intake of Discretionary Fat[3]			
Discretionary Fat (grams)	42.37 (0.68)	51.58 (0.86)	0.00
Discretionary Fat (% of Energy)	25.53 (0.24)	26.05 (0.21)	0.01

[1]All degree of adherence scores measured as (number of servings {2-day average}/ recommended number of servings)*100 differed significantly (p=0.00).

[2]Tests of statistical significance are based on t-test.

[3]Intake of added sugars and discretionary fat differed significantly between the two age groups of children.

Total Energy Intake by Food Sufficiency Status

After controlling for other factors affecting diet, mean energy intake did not vary significantly between the three categories of food sufficiency status for either age group (Table 4). However, the 4-8 year old food insufficient group consumed less energy on average than the 4-8 year old food sufficient with limitations and food sufficient groups.

Adherence to the Food Guide Pyramid Serving Recommendations by Food Sufficiency Status

Among children, ages 2-3 years, mean adherence scores across all three levels of food sufficiency status were greater than 100 for the grain and fruit groups and less than 100 for the vegetable and meat groups (Table 4). The mean adherence score for the dairy group was below 100 for those 2-3 year old children who fell within the food sufficient and food sufficient with limitations groups and above 100 for the food insufficient group.

For the 4-8 year old children, mean adherence scores fell below 100 for all food groups regardless of food sufficiency status except the dairy group. The mean adherence score for the dairy group was greater than 100 for the food sufficient with limitations and food insufficient groups and less than 100 for the food sufficient group.

When tested for differences while controlling for factors affecting the diet and participation in food assistance programs ($p \leq 0.01$), mean adherence scores for the five major food groups of the Food Guide Pyramid did not differ by food sufficiency status in children 2-8 years of age (Table 4). However, the meat group approached significance ($p=0.04$) in 4-8 year old children, with the food insufficient group eating less from the meat group than the food sufficient and food sufficient with limitations groups.

Table 4: Total Energy Intake, Degree of Adherence Scores for the Food Guide Pyramid Food Groups[1], and Average Intake of Added Sugars and Discretionary Fat by Age and Food Sufficiency Status

	Children Ages 2-3 Years (n=1242)							Children Ages 4-8 Years (n=1506)						
	Food Sufficient N=714		Food Sufficient With Limitations N=450		Food Insufficient N=76			Food Sufficient N=867		Food Sufficient With Limitations N=541		Food Insufficient N=97		
	Mean	SE	Mean	SE	Mean	SE	p-value[2]	Mean	SE	Mean	SE	Mean	SE	p-value[2]
Total Energy	1473.63	25.42	1473.65	28.33	1448.68	68.25	0.81	1751.88	21.03	1797.39	31.88	1635.66	80.23	0.08
Degree of Adherence Scores for the Food Guide Pyramid Food Groups[1]														
Grains	115.17	3.01	115.01	2.81	113.19	5.86	0.77	94.10	1.94	95.27	1.83	92.93	4.00	0.76
Vegetables	84.60	2.73	83.03	2.83	75.38	8.40	0.73	64.77	2.06	64.46	2.77	50.52	5.94	0.07
Fruits	134.21	5.73	128.38	6.17	120.70	7.42	0.50	79.72	3.19	69.83	4.00	75.09	7.23	0.10
Milk	89.84	2.63	88.33	3.07	103.86	8.26	0.21	96.06	2.43	100.26	2.98	105.75	8.05	0.53
Meat	89.95	2.07	90.26	2.42	91.11	6.70	0.89	70.50	1.66	74.95	2.09	65.19	4.41	0.04
Intake of Added Sugars														
Teaspoons	13.61	0.46	14.09	0.43	11.57	1.19	0.31	18.25	0.50	19.36[3]	0.73	13.64[3]	1.22	0.00
% of Energy	14.63	0.38	15.38	0.43	11.96	0.77	0.03	16.74	0.45	16.85[3]	0.43	13.01[3]	0.80	0.01
Intake of Discretionary Fat														
Grams	41.96	0.91	43.08	1.24	42.21	3.10	0.72	51.29	0.98	52.88	1.23	47.16	2.89	0.15
% of Energy	25.31	0.27	25.83	0.36	25.81	1.14	0.43	26.11	0.34	26.08	0.31	25.42	0.56	0.58

[1] All degree of adherence scores measured as (number of servings {2-day average}/ recommended number of servings)*100.

[2]Tests for statistical significance are based on multiple linear regression while controlling for socio-demographic factors and food assistance participation.

[3]Among the 4-8 year olds, added sugars differed significantly between the food sufficient with limitations and food insufficient groups.

Discretionary Fat, Added Sugars, and Food Sufficiency Status

Average intake (grams) of discretionary fat and percentage of energy from discretionary fat remained unchanged over the three categories of food sufficiency status among 2-3 year old children, while these measures decreased slightly in the 4-8 year old food insufficient group, but not significantly ($p=0.15$ and $p=0.58$, respectively).

The average consumption of added sugars (teaspoons) also remained unchanged over the three categories of food sufficiency status among children 2-3 years old. However, the percentage of energy from added sugars decreased, but not significantly ($p=0.03$), in the food insufficient group. This result differed for the 4-8 year old children. The food insufficient 4-8 year old children consumed significantly less added sugars (teaspoons) than their food sufficient with limitations counterparts ($p=0.00$). There were no statistically significant differences in consumption of added sugars (teaspoons) between the food sufficient and food sufficient with limitations groups ($p=0.24$) and the food insufficient and food sufficient groups ($p=0.02$). The percentage of energy from added sugars also differed by food sufficiency category in the 4-8 year old children ($p=0.01$), with food insufficient children consuming less of their calories from added sugars than the food sufficient with limitations group ($p=0.00$). There was no statistically significant difference in consumption of energy from added sugars between the food sufficient and food sufficient with limitations groups ($p=0.65$) and the food insufficient and food sufficient groups ($p=0.02$).

Discussion

Food Sufficiency Status

Using a sample of children from the Third National Health and Nutrition Examination Survey (NHANES III) (1988-1994), Alaimo et al (7) reported the national prevalence of food insufficiency for children 2 months-5 years and 6-11 years as 16.5% and 15.0% in the low-income population (≤130% of the FPL) and 3.4% and 4.9% for the low-middle income population (131-185% of the FPL). When the sample from this study is divided into the same income categories as Alaimo et al used, the prevalence of food insufficiency for children 2-3 years and 4-8 years becomes 9.0% and 10.1% for the low-income group (≤ 130% of the FPL) and 1.3% and 1.7% for the low-middle-income group (131-185% of the FPL). These rates are slightly lower than those described from the NHANES III data. The observed difference may reflect changes in the prevalence of food insufficiency between the two time intervals of the studies, 1988-1994 for NHANES III and 1994-1996, 1998 for CSFII. Differences also may exist due to differences in the response categories for the food sufficiency question between the surveys. Respondents within NHANES III categorized themselves as either food sufficient or food insufficient, but could not categorize themselves as food sufficient with limitations (1). Other demographic and household variables described by food sufficiency status are similar to previous studies (5,7,9).

Energy Intake

In this study energy intake between food sufficiency status categories for both groups of children did not differ significantly. This finding is consistent with all except

one study examining food sufficiency status and children's energy intake (2,4,5). Using the 1985-1986 CSFII, Cristofar and Basiotis (2) found significant differences in total energy intake between the three categories of food sufficiency status among low-income children 1-5 years of age. This finding was not repeated in later studies using 1989-1991 CSFII data (4) and 1994-1996 CSFII data (5). One possible explanation for the differences seen by Cristofar and Basiotis (2) in energy intake between groups could be the larger sample size of food insufficient children in their study (n=322).

Degree of Adherence Scores for Pyramid Food Groups

A mean degree of adherence score for a food group is similar in construction to that of the group mean percentage of the RDA for a nutrient (20). As the score decreased for the food group in question, the average number of servings consumed from that food group also decreased. For example, the mean intakes from the vegetable group for the 2-3 year old and 4-8 year old children were 2.50 and 1.97 servings, respectively. Within these two age groups of children, degree of adherence scores for the vegetable group were 83.45 and 63.61. Between the two age groups of children, both the mean number of servings and the degree of adherence scores decreased with age. Also, when the group mean adherence score decreased, the percentage of the population meeting the serving recommendation from the Food Guide Pyramid food group also decreased. For example, the prevalence of meeting the Food Guide Pyramid recommendation for the vegetable group for children ages 2-3 and 4-8 were 33.7% and 17.8%, respectively. Between the two age groups of children, both the prevalence of meeting the recommendation and the adherence scores decreased with age. Therefore, the degree of adherence score provides a quick reference for how closely a group's mean intake adheres to a reference point or

recommendation, in this case, while incorporating energy intake and age requirements in its calculation.

Using these scores, this study found that 2-3 year old, low-income children from a nationally representative sample consumed on average less than the recommended number of servings from the vegetable, dairy, and meat groups and more than the recommended number from the grain and fruit groups. The older low-income children consumed less than the recommended number for all five of the Food Guide Pyramid food groups. This pattern is similar to that of Lino et al (23), who used the Healthy Eating Index (HEI) to describe children's conformity to the Food Guide Pyramid serving recommendations for the five major food groups. Within the HEI, conformity to the Food Guide Pyramid serving recommendations was described with a score between 0 and 10, where 10 represented an intake at the recommended amounts. They found that 2-3 year children had higher scores for the grain, vegetable, fruit, and meat groups, while 4-6 year old children had a lower score for the dairy group.

The current study found differences in adherence to Food Guide Pyramid food group recommendations and intakes of added sugars and discretionary fat between the 2-3 year old and 4-8 year old children, suggesting that diet quality diminishes with age, as evidenced by decreased adherence to food group intake and increased intakes of added sugars and discretionary fat. Bowman et al (24) also noted differences between these two age groups in terms of overall dietary quality. Using the 1994-1996 CSFII and the overall Healthy Eating Index, which assesses an individual's adherence to the Dietary Guidelines for Americans, they found that younger children (2-3 years old) had better overall diets than older children (4-6 and 7-10 years old).

When food sufficiency status is considered, adherence to the Pyramid food group recommendations was similar to that of the overall sample. Across the three levels of food sufficiency status, children, ages 2-3 years, had lower than recommended intakes of the vegetable, dairy (except for the food insufficient group), and meat groups. The older 4-8 year old children had lower than recommended intakes for all groups, except dairy, across food sufficiency levels. Dairy intake was less than recommended for the food sufficient older children, but above the recommendation for the food sufficient with limitations and food insufficient groups. However, this was not significant.

The results of this study suggest that food sufficiency status does not affect adherence to serving recommendations for the five major food groups of the Food Guide Pyramid. This is similar to the findings of Casey et al (5), but contrary to the findings of Christofar and Basiotis (2). Using the 1994-1996 CSFII data and the corresponding Food Guide Pyramid Database, Casey et al (5) found that children ages 2-17 years living in low-income (≤ 130% of the FPL) food insufficient households consumed significantly less dark green leafy vegetables, other vegetables, nuts and seeds, and added sugars and significantly more eggs than those in low-income food sufficient households. No differences in the consumption of fruits, vegetables, or total fruits and vegetables were detected between low-income food sufficient and insufficient children. Similarly, the current study found that mean adherence scores declined, although not significantly, as food insufficiency worsened for the fruit and vegetable food groups. Adherence scores from the current study for the other major food groups could not be compared to Casey et al results.

Using data from the 1985-86 CSFII, Christofar and Basiotis (2) found that as food insufficiency worsened in low-income preschoolers, there were significant declines in the intake of 5 of 59 food groups tested; specifically cream and milk desserts, total vegetables and fruits, other baked goods, total fruits, and total other fruits, mixtures, and juices. This is contrary to the findings of this study in regards to fruits and vegetables. However, it is difficult to compare the two studies due to differences in food intake measurements (grams versus servings) and food grouping protocols.

Added Sugars and Discretionary Fat

Across the three categories of food sufficiency status, added sugars did differ significantly for the older 4-8 year old children. The added sugars intake of the food insufficient group was significantly less than that of the food sufficient with limitations group. However, this was not the case for the younger children. Casey et al (5) also found significant differences in the consumption of added sugars between food sufficient and food insufficient children age 2-17 years. Therefore, the current study refines the conclusions of Casey et al; intake of added sugars does not vary by food sufficiency status among 2-3 year old children.

Among the 4-8 year old children, the pattern of intake for added sugars and adherence to food group recommendations may be consistent with the "displacement theory," which is highly debated (25). The displacement theory suggests that consumption of excessive foods that are high in added sugars and discretionary fat decreases consumption of foods from the food groups of the Pyramid. Using CSFII 1994-1996, Forshee and Storey (26) found that added sugars were negatively correlated with the dairy group and positively correlated with the grain group among 6-11 year old

children. However, they suggested that the amount of added sugars needed to displace an entire serving from a food group is substantial. In the current study, food insufficient children, 4-8 years old, had significantly lower intakes of added sugars than the food sufficient with limitations group. Although not significantly different, the children classified as food insufficient also had a lower average intake of the grain group and a higher intake of the dairy group than their food sufficient with limitations counterparts. This pattern is consistent with the predictive pattern Forshee and Storey propose. In terms of the displacement theory, this finding suggests that food sufficiency status may confound results regarding added sugars intake and its relationship to the major food groups. Further investigation is needed.

Implications

The current study found that children from low-income households regardless of household food sufficiency status have poor diets as evidenced by low degree of adherence scores for the vegetable, fruit (only 4-8 year olds), and meat groups and high intakes of added sugars and discretionary fat. The current study also suggests that diet quality diminishes significantly with age. Therefore, nutrition education is imperative for all low-income households with children ages 2-8 years regardless of food sufficiency status. Education messages need to focus on the importance of choosing a diet that is moderate in sugar and discretionary fat and adequate servings from the Food Guide Pyramid food groups, especially those food groups where mean degree of adherence scores were lower than 100.

According to findings from qualitative research (11) and the Food Security Module (3,30,31), children in food insufficient/insecure homes should have reduced

intakes of foods and therefore have adherence scores that are less than that of their food sufficient counterparts. This study suggests that children in food insufficient homes are able to adhere to the Food Guide Pyramid recommendations just as well as those living in food sufficient and food sufficient with limitations households. This raises a new question. How is that so? Do food insufficient children adhere to the overall recommendations in the same way as the food sufficient children but obtain the result in a different manner? For example, could food insufficient children be receiving the same adherence score for the meat group by consuming beans, eggs and peanut butter while their food sufficient counterparts receive the same score by eating meats, poultry, and fish? Part IV of this dissertation addressed this question.

Mean intakes of added sugars (as teaspoons or percentage of energy from added sugars) for the food insufficient 4-8 year old children were significantly less than that for the food sufficient with limitations group and approached significance for the food sufficient group. This finding suggests that the older food insufficient children compared to their food sufficient with limitations counterparts have better adherence to the Dietary Guideline to "Choose beverages and foods to moderate your intake of sugars." One explanation for this finding may be the episodic nature of food insufficiency/insecurity in this country. Episodes of insufficiency may lead to episodes of over-consumption or to consumption of different types of foods when resources for food become available, resulting in the differences in added sugars seen in this current study. Further research is needed on food sufficiency status, sources of added sugars, and displacement of foods from the major food groups by increased intakes of added sugars.

Another possible reason that children's mean food group adherence scores did not differ significantly by food sufficiency status may be participation in food assistance programs, which increased as food sufficiency decreased. In fact, over 50% of the food sufficient with limitations and food insufficient households with children between the ages of 2-3 years participated in the WIC and Food Stamp Programs, while over 60% of the food sufficient with limitation and food insufficient households with children 4-8 years participated in the National School Lunch Program. Food assistance programs are designed to address domestic hunger and have been found to improve dietary intake in those at risk (27-29). Findings from this study suggest that those at greatest risk for hunger or food insufficiency are participating in one or more food assistance programs. This study did control for food assistance program participation, which may offset the effect that food insufficiency has on the dietary intakes of children. Although it would have been interesting to examine the interaction of food sufficiency status and program participation on food group intake in children, interactions could not be tested due to small sample sizes in the food insufficient groups. Further research along this line is needed.

Limitations

The nature of secondary data limits the type and kinds of variables that can be utilized. Although food insufficiency is used as a proxy for food insecurity and hunger, consistent with other research based on CSFII data (4-7), the new food security measurement instrument (30-32) is a more sophisticated measure. Data from its incorporation in any food surveys research will not be available for some time.

Therefore, the 1994-1996, 1998 CSFII was the best available data set to study the variables of interest.

Self-reports of dietary intake can introduce bias, which may be especially true where a proxy for a child is involved. Intake data for children participating in the CSFII can originate from a number of sources including day care teachers or school food service personnel, therefore increasing bias. CSFII included a large sample size and extensive training and re-training of personnel to help address these issues. This study also used only children for whom data were available from 2-day dietary recalls to overcome limitations of a single 24-hour dietary recall.

By focusing on children from households at 185% of the poverty level, this study included a large population of children who were income-eligible for food assistance programs. Eligibility, however, does not equate with participation. Nevertheless, analysis procedures within all models controlled for participation in WIC, Food Stamps, and the National School Breakfast and Lunch Programs, where appropriate.

Conclusions

In conclusion, household food sufficiency status does not affect the ability to adhere to the serving recommendations for the major food groups of the Food Guide Pyramid and does not influence discretionary fat intake among low-income children ages 2-8 years. It does, however, effect consumption of added sugars in children 4-8 years of age. Furthermore, although the younger 2-3 year old low-income children seemed to eat a better diet than their 4-8 year old counterparts, both groups of children on average consumed diets that do not conform to the Food Guide Pyramid recommendations.

References

1. Briefel, R.R., Woteki, C.E. (1992) Development of the food sufficiency questions for the third National Health and Nutrition Examination Survey. JNE 24(supple):24S-28S.

2. Cristofar, S.P., Basiotis, P.P. (1992) Dietary intakes and selected characteristics of women ages 15-50 years and their children ages 1-5 years by reported perception of food sufficiency. JNE 24:53-58.

3. Bickel, G.W., Andrews, M.S., Klein, B.W. (1996) "Measuring Food Security in the United States: A Supplement to the CPS." In Nutrition and Food Security in the Food Stamp Program (D Hall and M Stravrianos, eds). Alexandria, VA: US Department of Agriculture, Food and Consumer Service.

4. Rose, D., Oliveira, V. (1997) Nutrient intakes of individuals from food-insufficient households in the United States. Amer J Public Health 87;1956-1961.

5. Casey, P.H., Szeto, K., Lensing, S., Boyle, M., Weber, J. (2001) Children in food-insufficient, low-income families: Prevalence, health, and nutrition status. Arch Pediatr Adolesc Med 155;501-514.

6. Rose, D., Oliviera, V. (1997) Validation of a self-reported measure of household food insufficiency with nutrient intake data. US Department of Agriculture, Economic Research Service, Food and Consumer Economics Division. Washington DC. Technical Bulletin 1863.

7. Alaimo, K., Briefel, R.R., Frongillo Jr., E.A., Olson, C.M. (1998) Food insufficiency exists in the United States: Results from the Third National Health and Examination Survey (NHANES III) Amer J Public Health 88:419-426.

8. Alaimo, K., Olson, C.M., Frongillo Jr., E.A., Briefel, R.R. (2001) Food insufficiency, family income, and health in US preschool and school-aged children. Am J Public Health 91:781-786.

9. Alaimo, K., Olson, C.M., Frongillo Jr., E.A. (2001) Food insufficiency and American school-aged children's cognitive, academic, and psychosocial development. Pediatrics 108:44-53.

10. Wehler, C.A., Scott, R.I., Anderson, J.J. (1992) The Community Childhood Hunger Identification Project: A model of domestic hunger-Demonstration project in Seattle, Washington. JNE 24:29S-35S.

11. Radimir, K.L., Olson, C.M., Campbell, C.C. (1990) Development of Indicators to Assess Hunger J Nutr 120:1544-1548.

12. *Tips for Using the Food Guide Pyramid for Children 2 to 6 Years Old* (1999). United States Department of Agriculture, Center for Nutrition Policy and Promotion, Program Aid 1647.

13. *The Food Guide Pyramid* (1992). United States Department of Agriculture. Home and Garden Bulletin 252.

14. Cronin, F.J., Shaw, A.M., Krebs-Smith, S.M., Marsland, P.M., Light, L. (1987) Developing a food guidance system to implement the dietary guidelines. JNE 19:281-302.

15. Dixon, L.B., Cronin, F.J., Krebs-Smith, S.M. (2001) Let the Pyramid guide your food choices: Capturing the total diet concept. J Nutr. 131:461S-472S.

16. Cleveland, L.E., Cook, D.A., Krebs-Smith, S.M., Friday, J. (1997) Method for assessing food intakes in terms of servings based on food guidance. Am J Clin Nutr. 65:1254S-1263S.

17. Cook, A., Friday, J.E. Documentation: Pyramid servings database for USDA survey food codes. http://www.barc.usda.gov/bhnrc/cnrg (Accessed October 2000).

18. Cook, A., Friday, J.E. Pyramid Servings Intakes by U.S. children and Adults 1994-96, 1998. CNRG Table Set No. 1. http://www.barc.usda.gov/bhnrc/cnrg (Accessed October 2000).

19. United States Department of Agriculture, Agriculture Research Service. (2000) Continuing Survey of Food Intakes by Individuals 1994-96, 1998. CD-ROM.

20. Standing Committee on the Scientific Evaluation of the Dietary Reference Intakes of the Food and Nutrition Board, Institute of Medicine. (2001). *Dietary reference intakes. Applications in dietary assessment.* Food and Nutrition Board, Institutes of Medicine.

21. *SAS System* under Microsoft Windows, version 8.2 (1999-2001) SAS Institute Inc., Cary NC.

22. Shah, B.V., Barnwell, B.G., Biegler, G.S. (1997) *SUDAAN User's Manual, Release 7.5.* Research Triangle Park, NC: Research Triangle Institute.

23. Lino, M., Gerrior, S.A., Basiotis, P.P., Anand, R.J. (1998) Report card on the diet quality of children. Family Ecomonics and Nutrition Review 12: 78-80.

24. Bowman, S.A., Lino, M., Gerrior, S.A., Basiotis, P.P. (1998) The Healthy Eating Index, 1994-1996. Family Ecomonics and Nutrition Review 11:2-14.

25. Krebs-Smith, S.M. (2001) Choose beverages and foods to moderate your intake of sugars: Measurement requires quantification. J Nutr 131:527S-535S.

26. Forshee, R.A., Storey, M.L. (2001) The role of added sugars in the diet quality of children and adolescents. J Amer Coll Nutr 20:32-43.

27. Oliviera, V., Gunderson, C. (2000) WIC and the Nutrient Intake of Children. Washington, DC: Economic Research Service, U.S. Department of Agriculture. Food Assistance and Nutrition Research Report No. 5.

28. Wilde, P.E., McNamara, P.E., Ranney, C.K. (2000) The effect on dietary quality of participation in the Food Stamp and WIC programs. Washington DC: Food and Rural Economics Division, Economic Research Service, U.S. Department of Agriculture. Food Assistance and Nutrition Research Report No. 9.

29. Rose, D., Habicht, J.P., Devaney, B. (1998) Household participation in the Food Stamp and WIC programs increases nutrient intakes of preschool children. J Nutr 128:548-555.

30. Hamilton WL, Cook JT, Thompson WW, Buron LF, Brongillo EA Jr, Olson CM, Wehler CA. (1997) *Household Food Security in the United States in 1995. Technical Report of the Food Security Measurement Project.* Alexandria, VA: United States Department of Agriculture, Food and Consumer Service, Office of Analysis and Evaluation.

31. Hamilton WL, Cook JT, Thompson WW, Buron LF, Brongillo EA Jr, Olson CM, Wehler CA. (1997) *Household Food Security in the United States in 1995. Summary Report of the Food Security Measurement Project.* Alexandria, VA: United States Department of Agriculture, Food and Consumer Service, Office of analysis and Evaluation.

PART III: Household Participation in the WIC Program, But Not Food Insufficiency, is Related to Dietary Variety Among 2-8 Year Old Low-Income Children

Introduction

The term food security is used to describe a household's or an individual's access to safe and nutritious food and/or resources to purchase said food. Hunger is currently seen as a potential but not necessary consequence of household food insecurity (1). The prevalence of domestic hunger is measured through the Food Security Module within the Current Population Survey. In 2000, 10.5% of U.S. households were food insecure. Approximately 1/3 of those households (3.3%) were food insecure with hunger, meaning one or more individuals within the household experienced hunger at some point within the past year. The prevalence of food insecurity and hunger varied by household type. Households with children and households with incomes at or below the poverty level were at highest risk for food insecurity and hunger (2).

In a qualitative study completed in Upstate New York, low-income women described their experience with hunger as one in which there was a limited number of foods available within the household and household members were eating a small number of low-cost foods repetitively (3,4). The Food Security Module captures this concept with the following question: "Relied on few kinds of low-cost foods to feed child(ren) because there was not enough money for food" (2). In 2000, 16.3% of U.S. households with children reported that they had relied on a few kinds of food to feed their children within the past year due to limited resources to purchase food (2). Studies confirmed that changes in the household food supply did occur as food insecurity worsened (5-7). However, the effect on the diets of children living in food insecure households was less clear (7-10).

Food sufficiency status has been used as a proxy measure for hunger and food security in many studies (7-16). To quantify the effect food sufficiency status has on the redundancy (reliance on a few low-cost foods) of low-income children's diets, two measures of dietary variety were used in this study: overall variety and variety among food groups. Overall variety has been measured by simply counting the number of different foods eaten over a given period of time (17-22). Variety among food groups denotes the number of different major food groups eaten on a daily basis (17,18,23,24). The purpose of this study was to understand for 2-8 year old low-income children the relationships between dietary variety, measured as overall variety and variety among food groups, and several socio-demographic characteristics, including household food sufficiency status.

Methods

Data Source Used: 1994-1996, 1998 CSFII

A sample of 2-3 year old and 4-8 year old children was drawn from the 1994-1996, 1998 Continuing Survey of Food Intakes by Individuals (CSFII) (25). The CSFII, a nationally representative sample of non-institutionalized persons (n=20,607) living in households across the United States with over-sampling of low-income households, provides estimates of food and nutrient intakes of individuals of all ages from two nonconsecutive days of 24-hour dietary recall obtained through in person interviews.

Sample

The sample included two categories of 2-8 year-old children: those 2-3 years of age (n=1,242) and those 4-8 years of age (n=1,506). Selected children were those who provided 2 days of completed dietary recall data, whose households could be staged into

one of four categories of food sufficiency, and who lived in households where income was 185% of the federal poverty level or less. This income was chosen as a proxy for food assistance program eligibility. Lastly, one child fitting the eligibility requirements was randomly chosen from each household.

Measures of Variety

Variety was described using two measures: Healthy Eating Index Variety Score (overall variety) (19-22) and Dietary Diversity Score (among food group variety) (18, 23). A discussion of how each of these dependent variables was calculated follows.

Healthy Eating Index Variety Score. Overall variety was measured using the Variety Score from the Healthy Eating Index (HEI). This score is one component of the overall index and ranges from 0 to 10 points. To construct the HEI Variety Score, the number of different foods eaten in a day in sufficient amounts to contribute to at least one-half of a serving, based on Food Guide Pyramid (26,27) serving sizes, is totaled. Foods eaten more than once a day are counted only once. Foods that differ only by preparation method are grouped together and counted as one. When an individual consumes at least 8 different foods in a day, then that person receives the maximum number of points (10 points) for the HEI Variety Score. If an individual consumes 3 or fewer different foods per day, then that person receives the minimum score (0 points). Intermediate intakes are scored proportionally (19-22).

In this study the HEI Variety Scores were calculated based on dietary recall data for both Day 1 and Day 2. Since the variety scores were computed on two nonconsecutive days, the two scores were averaged and used as a dependent variable describing overall variety.

Dietary Diversity Score. The Dietary Diversity Score (DDS) was used to describe among food group variety based on the major food groups of the Food Guide Pyramid; or the grain, vegetable, fruit, dairy, and meat groups (23,26,27). The score "counts the number of major food groups consumed daily" (23, p.435). Therefore, the possible points for the DDS can range from 0 (less than one serving from each of the major food groups) to 5 (at least one serving from each of the major food groups) possible points. To compute the DDS, one point was awarded each time the two-day average intake was 1 serving or greater for any of the five food groups. For example, if a child consumed on average 0.75 servings from the meat and vegetable groups, 1.5 servings from the fruit group, 4.5 servings from the grain group and 2 servings from the dairy group, then the DDS was scored as 0 points for the meat and vegetable groups, and 1 point each for the fruit, grain and dairy groups, for a total of 3 points out of the 5 points possible. The number of servings from each of the 5 major food groups of the Pyramid was calculated using the Pyramid servings database for USDA survey food codes (28-31).

Socio-Demographic Variables

Dietary practices have been shown to vary by race/ethnicity, geographic region, level of urbanization, household income, educational status of the household head, whether the head of the household is a female, and the number of household members (9). Many children in this sample were participating in food assistance programs at the time the survey was completed. Therefore, household participation in the Food Stamp and WIC programs, and child participation in the National School Breakfast and/or the National School Lunch Programs were recoded into dichotomous responses. These

variables, along with food sufficiency status, were tested as possible predictors of overall and among food group variety. One additional variable of particular interest was food sufficiency status. This variable was measured using the following question:

> Which one of the following statements best describes the food eaten in your household in the last three months....?
>
> 1) Enough of the kinds of food we want to eat
> 2) Enough but not always the kinds of food we want to eat
> 3) Sometimes not enough to eat
> 4) Often not enough to eat

Categories 3 and 4 were collapsed into "sometimes/often not enough to eat" and labeled "food insufficient" due to a limited number of responses to "often not enough to eat" (n=6 and n=14 for 2-3 year olds and 4-8 year olds, respectively). This is consistent with previous research using the food sufficiency question from the CSFII (7-10). Study participants were placed into one of three categories: food sufficient (enough of the kinds of food wanted), food sufficient with limitations (enough but not always the kinds of food wanted), and food insufficient.

Data Analysis

Data analysis used a combination of statistical software packages. SAS 8.2 was used for data management (32) while data analysis was completed using SUDAAN version 8.0.1 (33). The CROSSTAB and DESCRIPT procedures in SUDAAN were used to compute descriptive statistics. Using the DESCRIPT procedure in SUDAAN, a t-test was used to test for differences in the HEI Variety Score between the two age groups of children (α=0.01). A linear regression model was used to test for significant predictors (α=0.01) of overall variety (Variety Score from the HEI) for each sample of children.

The Dietary Diversity Score was recoded further into a dichotomous variable. A

score of 0 to 4 was recoded as "lacking among food group variety" and a score of 5 was recoded as "among food group variety." The Pearson χ^2 test was used to test for differences in the prevalence of "adequate variety" between the two age groups of children using the CROSSTAB procedure in SUDAAN (α=0.01). A logistic regression model was used to test whether the independent variables and food sufficiency status predicted "among food group variety" using the LOGISTIC procedure in SUDAAN. The odds ratio and 99% confidence interval generated from this procedure described the relationship between predictor variables and adequacy of food group variety.

Results

Sample Characteristics

Sample characteristics for each age group of children are depicted in Table 1. The prevalence of food sufficiency, food sufficiency with limitations, and food insufficiency was 58.1%, 35.4%, and 6.5% among 2-3 year old children and 55.3%, 37.5%, and 7.2% among 4-8 year old children. Each sample of children could be characterized as racially/ethnically diverse with the majority of each group at or below 130% of the federal poverty level.

Healthy Eating Index Variety Score

Healthy Eating Index Variety Scores by selected demographic and household characteristics are depicted in Table 2. Children, 2-3 years old, had a slightly higher mean HEI Variety Score than the children, 4-8 years old(p=0.00). Among 2-3 year old children, the only significant predictor of overall variety was participation in the WIC Program (p=0.01). HEI Variety Scores for those children who participated in the

Table 1: Prevalence of Selected Household and Demographic Characteristics by Age

	Age Category	
	2-3 Years (n=1242)	**4-8 Years (n=1506)**
Economic Resources		
Food Sufficiency Status, % (SE)		
Food Sufficient	58.07 (2.06)	55.27 (2.06)
Food Sufficient with Limitations	35.40 (2.03)	37.49 (2.22)
Food Insufficient	6.52 (0.71)	7.24 (0.84)
Income Category, %, (SE)		
0-130% FPL	67.94 (1.82)	65.86 (2.06)
131-185% FPL	32.06 (1.82)	34.14 (2.06)
Participation in Food Assistance Programs, %, (SE)		
Anyone in Household on WIC	45.65 (2.09)	22.90 (1.46)
Household Receiving Food Stamps	41.37 (2.37)	38.36 (2.46)
Child Participates in School Breakfast	----	30.24 (2.36)
Child Participates in School Lunch	----	55.73 (2.17)
Household Characteristics		
Region, % (SE)		
Northwest	16.82 (1.85)	17.40 (1.74)
Midwest	22.19 (2.12)	23.83 (2.30)
South	33.65 (2.76)	31.70 (2.99)
West	27.34 (2.59)	27.07 (3.45)
Urbanization, % (SE)		
MSA, central city	40.33 (2.72)	36.58 (2.72)
MSA, outside central city	35.46 (2.64)	37.40 (2.93)
Non-MSA	24.21 (2.46)	26.02 (2.37)
Female Head of Household, % (SE)	34.34 (2.50)	33.66 (2.16)
Household Size, Mean (SE)	4.66 (0.06)	4.80 (0.06)
Highest Grade Completed for Household Head, Mean (SE)	11.95 (0.20)	12.38 (0.37)
Sample Person Characteristics		
Race/Ethnicity, % (SE)		
Non-Hispanic White	41.56 (2.51)	46.51 (3.16)
Non-Hispanic Black	25.19 (2.53)	24.99 (2.76)
Hispanic	26.80 (2.68)	23.32 (2.27)
Other	6.45 (0.76)	5.19 (0.97)

Table 2: HEI Variety Scores by Selected Household and Demographic Characteristics

	Age Category	
	2-3 Years (n=1242) Mean (SE)	4-8 Years (n=1506) Mean (SE)
HEI Variety Score (Overall Variety)	7.99 (0.05)[1]	7.54 (0.08)[2]
Food Sufficiency Status		
Food Sufficient	8.16 (0.07)	7.58 (0.12)
Food Sufficient with Limitations	7.79 (0.13)	7.49 (0.11)
Food Insufficient	7.71 (0.27)	7.54 (0.33)
Income Category		
0-130% FPL	7.95 (0.07)	7.58 (0.08)
131-185% FPL	8.08 (0.13)	7.47 (0.17)
Food Assistance Programs		
Anyone in Household on WIC		
Yes	8.17 (0.11)[3]	7.78 (0.16)
No	7.84 (0.08)[4]	7.47 (0.10)
Household Receiving Food Stamps		
Yes	7.89 (0.12)	7.67 (0.16)
No	8.06 (0.09)	7.46 (0.10)
Child Participates in School Breakfast		
Yes	--	7.60 (0.14)
No	--	7.51 (0.10)
Child Participates in School Lunch		
Yes	--	7.63 (0.11)
No	--	7.43 (0.12)
Region		
Northwest	8.03 (0.12)	7.96 (0.15)[5]
Midwest	8.03 (0.13)	7.58 (0.23)
South	7.93 (0.10)	7.04 (0.12)[6]
West	8.02 (0.09)	7.83 (0.11)[5]
Urbanization		
MSA, central city	8.12 (0.11)	7.80 (0.11)
MSA, outside central city	7.99 (0.10)	7.51 (0.14)
Non-MSA	7.79 (0.13)	7.22 (0.21)
Household Head is Female		
Yes	7.97 (0.11)	7.61 (0.14)
No	8.00 (0.07)	7.50 (0.09)
Race/Ethnicity		
Non-Hispanic White	7.84 (0.11)	7.38 (0.16)
Non-Hispanic Black	7.97 (0.13)	7.44 (0.15)
Hispanic	8.33 (0.15)	7.98 (0.14)
Other	7.66 (0.40)	7.46 (0.38)

Note: Neither household size nor educational status of household head were significant predictors of the HEI Variety Scores among children 2-8 years of age (p=0.00).

[1,2]The 2-3 year old children had a significantly higher mean HEI Variety Score than the 4-8 year old children.

[3,4]Among 2-3 year children, HEI Variety Score differed significantly (p=0.01) between those participating in the WIC Program and those not participating in the WIC Program.

[5,6]Among 4-8 year old children, HEI Variety Scores differed significantly (p=0.00) by region of the country.

program were higher than those who did not participate in the program. When comparing HEI Variety Scores across the three categories of food sufficiency status, the HEI Variety Scores did not change significantly (p=0.11), although the scores declined slightly as food sufficiency status decreased in the 2-3 year old children.

Among the 4-8 year old children, region of the country was the only significant predictor of overall variety (p=0.00). Children in this age group living in the South had lower scores than those living in the West (p=0.00) or Northwest (p=0.00). When comparing HEI Variety Scores across the three categories of food sufficiency status, the HEI Variety Scores did not differ significantly for children 4-8 years old (p=0.33).

Dietary Diversity Scores

Among food group variety, defined as consumption of at least one serving on average over two days from each of the 5 major food groups of the Food Guide Pyramid, was observed in only 42.7% and 37.8% of the 2-3 year old and 4-8 year old children, respectively (Table 3). The prevalence of among food group variety did not differ significantly between the two groups (p=0.03). An estimated 18.8% of 2-3 year old children and 19.5% of 4-8 year old children received scores of 3 or less. The food groups usually omitted from the diet or not eaten in quantities large enough to equal one serving were the vegetable, fruit and/or dairy groups. Almost all of the children in this study consumed at least one serving on average over the two days from the grain group and most consumed at least one serving on average from the meat group.

Table 3: Among Food Group Variety, Dietary Diversity Scores, and Consumption of at Least One Serving from the 5 Major Food Groups by Age Group

	Age Category	
	2-3 Years of Age (n=1242)	**4-8 Years of Age (n=1506)**
Among Food Group Variety, %, (SE)[1]	42.72 (1.38)	37.81 (1.82)
Dietary Diversity Scores, % (SE)		
0	0.12 (0.12)	---
1	0.11 (0.11)	0.48 (0.32)
2	3.27 (0.48)	2.57 (0.60)
3	15.29 (1.11)	16.44 (1.59)
4	38.49 (1.65)	42.70 (2.10)
5	42.72 (1.38)	37.81 (1.82)
% (SE) of children consuming at least one serving from the following food groups:		
Grain	99.65 (0.20)	99.78 (0.21)
Vegetable	78.45 (1.57)	76.94 (1.90)
Fruit	74.54 (1.22)	58.54 (2.16)
Dairy	76.38 (1.28)	83.97 (1.34)
Meat	91.09 (1.00)	95.55 (0.78)

[1]The prevalence of among food group variety, defined as consumption of at least one serving on average over two days from each of the 5 major food groups of the Food Guide Pyramid, did not differ by age (p=0.03).

The prevalence of among food group variety and its relationship to food sufficiency status, participation in food assistance programs and other socio-demographic variables is depicted in Tables 4 and 5. Among 2-3 year old children, participation in the WIC Program was a significant predictor of among food group variety in this model. Those children participating in the WIC Program were 66% more likely to obtain a diet that had at least one serving from each of the major foods groups than those who did not participate in the program. Those 2-3 year old children living in cities or suburban areas were also more likely to have diets that contained at least one serving from each of the major food groups than those 2-3 year old children who lived in rural areas. Among 2-3 year old children, no other variables tested in this model were significant predictors of among food group variety.

Among the 4-8 year old children, only household participation in the WIC Program was a predictor of among food group variety. Those 4-8 year old children who had at least one member of the household participating in the WIC Program were 71% more likely to obtain a diet that contained at least one serving from each of the food groups of the Food Guide Pyramid than those children who lived in households that did not participate in the WIC Program.

When compared across the three food sufficiency categories, the percentage of food insufficient children receiving among food group variety decreased as food insufficiency worsened. This finding occurred for both the 2-3 year old and 4-8 year old children. However, when confounding factors were taken into consideration, the percentage of children receiving among food group variety did not differ significantly by food sufficiency status.

Table 4: Prevalence of Among Food Group Variety[1] by Food Sufficiency Status and Other Demographic Variables

Demographic Variables	Prevalence of Among Food Group Variety[1]	
	2-3 Year Olds	4-8 Year Olds
	% (SE)	% (SE)
Food Sufficiency Status		
Food Sufficient	42.87 (1.81)	39.00 (2.27)
Food Sufficient with Limitations	42.99 (2.54)	36.92 (3.19)
Food Insufficient	39.98 (7.16)	33.31 (5.48)
Income Category		
0-130% FPL	41.71 (1.91)	40.35 (1.96)
131-185% FPL	44.89 (2.29)	32.88 (3.93)
Participating in Food Assistance Programs		
Anyone in Household on WIC		
Yes	48.63 (2.06)	46.07 (3.44)
No	37.68 (1.84)	35.53 (2.25)
Food Stamps		
Yes	42.04 (2.68)	40.59 (2.50)
No	43.12 (1.91)	36.04 (2.45)
School Breakfast		
Yes	--	40.68 (4.09)
No	--	36.55 (2.32)
School Lunch		
Yes	--	37.74 (2.97)
No	--	37.87 (2.70)
Region		
Northwest	40.17 (4.99)	43.89 (4.11)
Midwest	46.14 (2.48)	35.83 (2.21)
South	38.76 (2.50)	33.64 (2.78)
West	46.42 (2.33)	40.49 (4.90)
Urbanization		
MSA, central city	43.51 (2.57)	35.87 (2.66)
MSA, outside central city	46.34 (2.53)	41.74 (3.36)
Non-MSA	36.14 (2.15)	34.85 (2.98)
Household Head		
Female Head	40.48 (2.70)	43.47 (2.72)
Not Headed by Female	43.81 (1.51)	35.01 (2.13)
Race/Ethnicity		
Non-Hispanic White	44.44 (2.29)	34.37 (2.68)
Non-Hispanic Black	35.95 (2.95)	40.00 (2.75)
Hispanic	49.23 (3.34)	41.20 (4.26)
Other	31.19 (5.20)	42.70 (10.77)

[1]Among food group variety defined as consumption of at least one serving on average over two days from each of the 5 major food groups of the Food Guide Pyramid.

Table 5: Selected Odds Risk Ratios for Among Food Group Variety[1] Among Children 2-3 and 4-8 Years of Age

	2-3 Year Old Children			4-8 Year Old Children		
		99% Confidence Interval			99% Confidence Interval	
	OR	Lower	Upper	OR	Lower	Upper
Food Sufficiency Status						
Food Sufficient	--	--	--	--	--	--
Food Sufficient with Limitations	0.95	0.65	1.39	0.82	0.51	1.30
Food Insufficient	0.85	0.37	1.96	0.59	0.27	1.30
Income Category						
0-130% FPL	0.90	0.64	1.27	1.26	0.70	2.25
131-185% FPL	--	--	--	--	--	--
Participation in Food Assistance Programs						
Anyone in Household on WIC[2]	1.66	1.18	2.33	1.71	1.04	2.82
	--	--	--	--	--	--
Food Stamps[2]	1.00	0.60	1.64	0.90	0.55	1.47
	--	--	--	--	--	--
School Breakfast[2]				1.31	0.67	2.53
				--	--	--
School Lunch[2]				1.04	0.60	1.80
				--	--	--
Region						
Northwest	0.78	0.39	1.54	1.03	0.52	2.03
Midwest	1.18	0.69	2.02	0.82	0.47	1.44
South	0.81	0.47	1.38	0.63	0.31	1.27
West	--	--	--	--	--	--
Urbanization						
MSA, central city	1.77	1.07	2.92	0.89	0.54	1.48
MSA, outside central city	1.74	1.19	2.54	1.39	0.87	2.22
Non-MSA	--	--	--	--	--	--
Household Size[3]	0.97	0.86	1.09	0.92	0.81	1.03
Household Head Education (yrs)[3]	1.00	0.98	1.03	1.01	0.98	1.04
Household Head						
Female Head	0.92	0.58	1.45	1.26	0.75	2.11
Not Headed by Female	--	--	--	--	--	--
Race/Ethnicity						
Non-Hispanic White	0.91	0.47	1.77	0.83	0.46	1.51
Non-Hispanic Black	0.56	0.29	1.08	1.04	0.48	2.24
Hispanic	--	--	--	--	--	--
Other	0.48	0.22	1.06	1.21	0.43	3.42

-- Denotes the Reference Group.

[1] Among food group variety defined as consumption of at least one serving on average over two days from each of the 5 major food groups of the Food Guide Pyramid.

[2] Reference group is not participating in the program.

[3] Continous variable.

Discussion

Overall Variety

In this study, the HEI Variety Score for the 2-3 year old children was significantly higher (7.99) than that for the 4-8 year old children (7.54). However, this difference represents one-eighth of a typical Food Guide Pyramid food group serving. The HEI Variety Scores reported in this study were slightly lower than those reported by Lino et al (34). They reported HEI Variety Scores from the overall population regardless of income for children 2-3 year olds, 4-6 year olds, and 7-10 year old as 8.4, 7.9 and 8.1, respectively (35). The finding of this study is consistent with the lower overall HEI scores found in persons living in households below the poverty level (20).

Overall Variety, Energy Intake and Food Sufficiency Status

Krebs-Smith et al (18) found that overall variety was significantly and positively related to energy intake in a sub-sample of individuals over 1 year of age drawn from the 1977-1978 Nationwide Food Consumption Survey. However, overall variety accounted for only an additional 1% of the variation in energy intake after accounting for other control variables. Since the HEI variety score counts the number of different foods eaten within a day, one could propose that as energy intake increases, the number of different foods also would increase slightly. However, this was not the case with this sample of children. The older children in this sample had significantly higher energy intakes than younger children, 1760 kcals versus 1472 kcals, respectively (36). However, in the current study, the older children had slightly lower HEI scores than the younger children. In other words, higher caloric intake seen in the older children was based on greater reliance on fewer different foods. When addressing adherence to the servings from the

food groups of the Food Guide Pyramid, 4-8 year old children consumed significantly more servings on average from the dairy and meat groups, but significantly less servings on average from the fruit, vegetable, and grain groups than the 2-3 year old children (36). Moreover, the 4-8 year old children also consumed more added sugars and discretionary fat. This suggests that 4-8 year old low-income children may rely on fewer different kinds of foods than their 2-3 year old counterparts, but the foods they rely on are higher in calories, added sugars, and discretionary fat.

The Healthy Eating Index Variety Score counts the number of different foods consumed in a day. Therefore, it was anticipated that this score would substantiate the qualitative statement about food insufficiency, or "relied on few kinds of low-cost foods to feed child(ren) because there was not enough money for food (2-4)." However this was not the case. HEI Variety Scores did not vary by food sufficiency status for either age group of children. These scores also did not seem to vary by food sufficiency status in the same way as energy intake varied (36). Among the 4-8 year old children, HEI Variety Scores remained the same while mean energy intake varied slightly, approaching significance ($p=0.08$), between the three categories of food sufficiency status: food sufficient (1751 kcals), food sufficient with limitations (1797 kcals), and food insufficient (1635 kcals). One possible explanation is that the gatekeeper or household head that reported reliance on a "few kinds of low-cost foods" may be responding in relation to only the household food supply. For example, many of the 4-8 year old children ate school breakfast and/or school lunch, or away from home foods. As food insufficiency increased, these programs were relied on more heavily (36). These children also may rely more heavily on the variety of foods available outside the home. For the 2-3 year old

children, small insignificant differences in the HEI Variety Scores were noted across the three levels of food sufficiency status. These children may rely more heavily on the variety of foods available within the household food supply. Further research is needed regarding children's consumption of at home and away from home foods and food sufficiency status.

Among Food Group Variety

"Let the Pyramid Guide Your Food Choices" (17,35). This Dietary Guideline targets nutrient adequacy by encouraging Americans to eat foods from each of the major food groups of the Food Guide Pyramid. In this study the Dietary Diversity Score was used to measure the extent to which low-income children conform to this guideline. Results revealed a large proportion of children did not consume at least one serving from each of the major food groups daily and that many children were actually only consuming three or less food groups per day. The food groups most often missing from the diets of low-income children were vegetable, fruit, and dairy. This is disconcerting because the Dietary Diversity Score is simply a measure of the number of different major food groups eaten in a day and does not reflect the minimum number of recommended servings from each major food group.

Among Food Group Variety and Food Sufficiency Status

The prevalence of among food group variety decreased as food insufficiency increased for both age groups of children. Even so, food sufficiency status was not found to be a predictor of among food group variety for either age group of children. This non-significant finding is consistent with previous research regarding adherence scores to the major food groups of the Food Guide Pyramid (36).

Variety and Household Participation in the WIC Program

Results from this study suggest that household participation in the WIC Program improves the number of different foods consumed, as assessed with the HEI Variety Score. Using 1989-1991 CSFII data, Basiotis et al (37) also found that participation in the WIC Program had a strong positive effect on diet quality, measured by the overall HEI, in low-income households. They estimated that participation in the WIC Program contributed approximately 23 points to the overall household HEI score. They also found that all the components of the HEI, except the vegetable and saturated fat components, contributed to the overall increase in the HEI score associated with participation in the WIC Program. The WIC Program provides a food package, nutrition education, and referrals. The food package provided by the WIC Program may allow families to stretch their food budgets and therefore purchase a wider array of foods, which would increase their HEI Variety Score. It is unclear from this research which component of WIC may be affecting the number of different foods eaten.

Participation in the WIC Program was found to be a significant predictor of among food group variety, as well. Almost half of the children who participated in the WIC Program were able to consume at least one serving from each of the major food groups. The food package of the WIC Program was designed to improve nutrient adequacy by providing specific foods needed at various stages of the life cycle. Again, it is unclear which components of the WIC Program are working to improve among food group variety.

Implications

This study suggests that among low-income children, 2-3 year olds have slightly better overall variety, as measured by the HEI Variety Score, than 4-8 year old children. However, both groups have HEI Variety Scores that indicate they are getting most of their energy and nutrient intake from 6 or fewer different foods on average. There is no recommendation for how many different foods in a day children should consume, although it would appear that low-income children, regardless of food sufficiency status, relied on a few different kinds of foods.

The new Dietary Guidelines address among food group variety by emphasizing, "Let the Pyramid Guide Your Food Choices (17)." This guideline suggests that all Americans choose a diet that provides the recommended number of servings from each of the five major food groups of the Food Guide Pyramid. Using a score similar to that of the Dietary Diversity Score, Krebs-Smith et al (18) found that overall nutrient intake improved when foods from each of the 5 major food groups were consumed. This finding emphasizes the importance of among food group variety to the overall diet. The current study's findings suggest that a large proportion of low-income children ages 2-8 years, regardless of food sufficiency status, fail to receive at least one serving let alone meet the recommended number of servings from each of the major food groups. The most problematic food groups were vegetable, fruit, and dairy.

Limitations

One limitation specific to this study is construction of the HEI Variety Score. When an individual eats 8 or more foods, his/her score is 10. A score of 0 is awarded

when an individual consumes 3 foods or less in a day. Therefore, the HEI Variety Score can only detect variations within the number of foods eaten when that number is between 3 and 8 different kinds of foods. All those individuals who consumed 8 or more different foods per day will receive the same score. This may have played a role in these findings. A perfect score of 10 was found in 37.1% of the 2-3 year children and 27.5% of the 4-8 year old children.

Secondary data analysis can be limiting in terms of the types and kinds of variables that can be used. The CSFII 1994-1996, 1998 was chosen due to the large sample size of low-income children and the quality of dietary data it could provide. The new food security measurement instrument provides the most accurate measurement of household hunger or food insecurity. However, at the time this research commenced, a data set which included both the new food security measurement instrument and dietary data on a large sample of young children was not available. Therefore, this data set provided the best opportunity to study the relationship between dietary variety and food security status using food sufficiency status as a proxy for hunger and food insecurity.

Conclusions

Overall variety, as measured by the HEI Variety Score, differed between the two age groups of children. The 4-8 year old low-income children relied on fewer kinds of foods than their 2-3 year old counterparts. However, the 4-8 year old children consumed significantly more calories. Also, a large percentage of the population did not meet the definition established for among food group variety. Lastly, participation in the WIC Program, but not food sufficiency status, was one predictor of overall variety (2-3 year olds) and among food group variety (2-8 year olds).

References

1. SA Anderson, ed. Life Sciences Research Office, Federation of American Societies for Experimental Biology (1990) "Core Indictors of Nutritional Status for Difficult to Sample Populations." JNE 20:1559-1600.

2. Nord, M., Nader, K., Tichen, L., Andrews, M., Bickel, G., Carlson, S. (2002) Household food security in the United States, 2000. Food and Rural Economic Division, Economic Research Service, US Department of Agriculture. Food Assistance and Nutrition Research Report No. 21.

3. Radimir, K.L., Olson, C.M., Campbell, C.C. (1990) Development of Indicators to Assess Hunger J Nutr 20:1544-1548.

4. Radimir, K.L., Olson, C.M., Greene, J.C., Campbell, C.C., Habicht, J.P. (1992) Understanding Hunger and Developing Indicators to assess it in women and children. Jne 24:36S-45S.

5. Kendall, A., Olson, C.M., Frongillo, E.A. (1995) Validation of the Radimir/Cornell measures of hunger and food insecurity. J Nutr 125:2793-2801.

6. Kendall, A., Olson, C.M., Frongillo, E.A. (1996) Relationship of hunger and food insecurity to food availability and consumption. J Amer Diet Assoc 96:1019-1024.

7. Rose, D., Oliviera, V. (1997) Validation of a self-reported measure of household food insufficiency with nutrient intake data. US Department of Agriculture, Economic Research Service, Food and Consumer Economics Division. Washington DC. Technical Bulletin 1863.

8. Cristofar, S.P., Basiotis, P.P. (1992) Dietary intakes and selected characteristics of women ages 15-50 years and their children ages 1-5 years by reported perception of food sufficiency. JNE 24:53-58.

9. Rose, D., Oliveira, V. (1997) Nutrient intakes of individuals from food-insufficient households in the United States. Amer J Public Health 87:1956-1961.

10. Casey, P.H., Szeto, K., Lensing, S., Boyle, M., Weber, J. (2001) Children in food-insufficient, low-income families: Prevalence, health, and nutrition status. Arch Pediatr Adolesc Med 155;501-514.

11. Bickel, G.W., Andrews, M.S., Klein, B.W. (1996) "Measuring Food Security in the United States: A Supplement to the CPS." In Nutrition and Food Security in the Food Stamp Program (D Hall and M Stravrianos, eds). Alexandria, VA: US Department of Agriculture, Food and Consumer Service.

12. Briefel, R.R., Woteki, C.E. (1992) Development of the food sufficiency questions for the third National Health and Nutrition Examination Survey. JNE 24(supple):24S-28S.

13. Alaimo, K., Briefel, R.R., Frongillo Jr., E.A., Olson, C.M. (1998) Food insufficiency exists in the United States: Results from the Third National Health and Examination Survey (NHANES III) Amer J Public Health 88:419-426.

14. Alaimo, K., Olson, C.M., Frongillo Jr., E.A., Briefel, R.R. (2001) Food insufficiency, family income, and health in US preschool and school-aged children. Am J Public Health 91:781-786.

15. Alaimo, K., Olson, C.M., Frongillo Jr., E.A. (2001) Food insufficiency and American school-aged children's cognitive, academic, and psychosocial development. Pediatrics 108:44-53.

16. Townsend, M.S., Peerson, J., Love, B., Achterberg, C., Murphy, S.P. (2001) Food insecurity is positively related to overweight in women. J Nutr. 131:1738-1745.

17. Dixon, L.B., Cronin, F.J., Krebs-Smith, S.M. (2001) Let the Pyramid guide your food choices: Capturing the total diet concept. J Nutr. 131:461S-472S.

18. Krebs-Smith, S.M., Smiciklas-Wright, H., Guthrie, H.A., Krebs-Smith, J. (1987) The effects of variety in food choices on dietary quality. J Amer Diet Assoc. 87:897-903.

19. United States Department of Agriculture. Center for Nutrition Policy and Promotion. (1995) *The Healthy Eating Index.*

20. Bowman, S.A., Lino, M., Gerrior, S.A., Basiotis, P.P. (1998) The Healthy Eating Index, 1994-1996. Fam Econ and Nutr Review 11:2-14.

21. Bowman, S.A., Lino, M., Gerrior, S.A., Basiotis, P.P. (1995) The Healthy Eating Index:1994-1996. Center for Nutrition Policy and Promotion, U.S. Department of Agriculture. CNPP-5.

22. Kennedy, E.T., Ohls, J., Carlson, S., Fleming, K. (1995) The Healthy Eating Index: Design and Applications. J Amer Diet Assoc 95:1103-1108.

23. Kant, A.K., Schatzkin, A., Harris, T.B., Ziegler, R.G., Block, G. (1993) Dietary diversity and subsequent mortality in the First National Health and Nutrition Examination Survey Epidemiologic Follow-up Study. Am J Clin Nutr 57:434-440.

24. Cox, D.R., Skinner, J.D., Carruth, B.R., Moran, J., Houck, K.S. (1997) A food variety index for Toddlers (VIT): Development and application. J Amer Diet Assoc 97:1382-1386.

25. United States Department of Agriculture, Agriculture Research Service. (2000). Continuing Survey of Food Intakes by Individuals 1994-96, 1998. CD-ROM.

26. *Tips for Using the Food Guide Pyramid for Children 2 to 6 Years Old.* (1999) United States Department of Agriculture, Center for Nutrition Policy and Promotion, Program Aid 1647.

27. *The Food Guide Pyramid* (1992). United States Department of Agriculture. Home and Garden Bulletin 252.

28. Cronin, F.J., Shaw, A.M., Krebs-Smith, S.M., Marsland, P.M., Light, L. (1987) Developing a food guidance system to implement the dietary guidelines. JNE 19:281-302.

29. Cleveland, L.E., Cook, D.A., Krebs-Smith, S.M., Friday, J. (1997) Method for assessing food intakes in terms of servings based on food guidance. Am J Clin Nutr. 65:1254S-1263S.

30. Cook, A., Friday, J.E. Documentation: Pyramid servings database for USDA survey food codes. http://www.barc.usda.gov/bhnrc/cnrg (Accessed October 2000).

31. Cook, A., Friday, J.E. Pyramid Servings Intakes by U.S. children and Adults 1994-96, 1998. CNRG Table Set No. 1. http://www.barc.usda.gov/bhnrc/cnrg (Accessed October 2000).

32. *SAS System* under Microsoft Windows, version 8.2. (1999-2001) SAS Institute Inc., Cary NC.

33. Shah BV, Barnwell BG, Biegler GS. (1997) *SUDAAN User's Manual, Release 7.5.* Research Triangle Park, NC: Research Triangle Institute.

34. Lino, M., Gerrior, S.A., Basiotis, P.P., Anand, R.J. (1998) Report card on the diet quality of children. Family Economics and Nutrition Review 12: 78-80.

35. *Nutrition and Your Health. Dietary Guidelines for Americans.* (200) United States Department of Agriculture and United States Department of Health and Human Services. Fifth Edition. Home and Garden Bulletin No. 232.

36. Knol, L.L. (2002) Household food sufficiency status and the quality of children's diets: An analysis from the Continuing Survey of Food Intakes by Individuals 1994-1996, 1998. PhD dissertation. University of Tennessee, Knoxville, TN.

37. Basiotis, P.P., Kramer-LeBlanc, C.S., Kennedy, E.T. (1998) Maintaining nutrition security and diet quality: The role of the Food Stamp Program and WIC. Family Economics and Nutrition Review 11:4-17.

PART IV:
Household Food Sufficiency Status and Its Relationship to Variety Within Food Groups Among Low-Income Children

Introduction

The term food security is used to describe a household's or an individual's access to safe and nutritious food and/or resources to purchase said food. Hunger is currently seen as a potential but not necessary consequence of household food insecurity (1). Food sufficiency status has been used as a proxy measure for hunger and food security in many studies (2-11). Qualitative research suggests that hunger or food insufficiency affects the quality of children's diets by limiting the amount and types of foods consumed (12-15). Studies have confirmed that changes in the household food supply do occur as food insecurity worsens (2,15). However, the effect on the diets of children living in food insufficient households is less clear (2-5).

Food group analysis or food pattern analysis has been used to understand the relationship between household food insufficiency and children's dietary patterns (3,5). National nutrition policy suggests that Americans "Let the Pyramid guide your food choices" (16, 17). The reference pyramid is the USDA food guidance system or the Food Guide Pyramid (18,19). The Food Guide Pyramid provides a framework for a diet that meets the dietary needs of almost all healthy Americans 2 years of age or greater. It features commonly eaten foods and classifies these foods into food groups. This classification system provides a means of assessing food group intake among populations in a meaningful manner and therefore can be used in studies of dietary quality. To date, only one study has addressed dietary quality and food sufficiency status using a food group analysis approach based on the food grouping system from the Food Guide Pyramid (5). Using data from the Continuing Survey of Food Intakes by Individuals (CSFII 1994-1996) and the Food Guide Pyramid Database (20-23), Casey et al (5) found

that among low-income children age 2-17 years food sufficiency status affected the intake of several smaller food groups that comprised the 5 major food groups of the Food Guide Pyramid. However, Knol (24) demonstrated that food sufficiency status was not related to adherence to the serving recommendations of the 5 major food groups of the Food Guide Pyramid. This raised a new question. If food insufficient children adhered to the overall Food Guide Pyramid recommendations to the same extent as food sufficient children, did they consume different foods within food groups to achieve the desired outcome? For example, did food insufficient children consume a similar number of servings from the overall vegetable group as their food sufficient counterparts, but do so by consuming a limited number of low costs foods within this food group?

The purpose of this study was to understand the relationship between household food sufficiency status and eating patterns within the 5 major food groups of the Food Guide Pyramid among low-income children ages 2-8 years. A within food group variety score was used to provide the basis for this food pattern analysis.

Methods

Data Source: 1994-1996, 1998 CSFII

A sample of 2-8 year old children was selected from the 1994-1996, 1998 CSFII (25), which provides a nationally representative sample of non-institutionalized persons living in households across the United States with over-sampling among low-income households. The CSFII provides estimates of food and nutrient intakes for individuals of all ages (n=20,607) from 2 nonconsecutive days of 24-hour dietary recall. For children less than 6 years of age, proxy interviews were conducted. The preferred proxy for children was the person who prepared the child's meals. However, any caregiver could

provide dietary intake data, if needed (25). Children ages 6-11 years old provided data about their own dietary intake with the assistance of an adult household member.

Sample

A sample of 2-8 year old children was drawn from the 1994-1996, 1998 CSFII (25). The sample included 2748 low-income children (185% of the federal poverty level of less). To limit the confounding effect of age, the children were divided into two age categories, 2-3 year olds (n=1242) and 4-8 year olds (n=1506), with similar nutritional needs (26). These age categories, with one exception, were consistent with those of the Standing Committee on the Scientific Evaluation of the Dietary Reference Intakes (DRI) of the Food and Nutrition Board, Institute of Medicine (26). Serving recommendations from the Food Guide Pyramid (18,19) are applicable to those age 2 years and older, therefore the DRI age group of 1-3 years was limited to those 2-3 years old only. Selected children were those who provided 2 days of completed dietary recall data and lived within households that could be staged into one of four categories of food sufficiency. Lastly, only one child fitting the eligibility requirements was chosen at random from each household.

Food Guide Pyramid and the Pyramid Servings Database

Dietary intake data were transposed into the food groups using the Food Guide Pyramid Database (20-23). To be consistent with the serving sizes recommended by the *Food Guide Pyramid for Children 2 to 6 Years Old* (18), portion sizes were reduced by 1/3 for children ages 2-3 years (18). Legumes, such as dry beans and peas, were placed into the meat group.

Sub-Group Contribution Scores

The major food groups of the Food Guide Pyramid were sub-divided further into sub-groups (Table 1). Servings from each sub-group and servings from the corresponding major food group were used to derive Sub-Group Contribution Scores. Sub-group contribution is defined here as the number of servings from a sub-group divided by the overall intake from its corresponding major food group expressed as a percentage. The following equation was used to calculate sub-group contribution:

$$\text{Sub-group Contribution Score} = \frac{\text{number of sub-group servings (2 Day average)}}{\text{number of corresponding Pyramid group servings total (2 Day average)}} \times 100$$

For example, if potatoes contributed 1.0 serving on average over the two days to the 4.0 total servings from the vegetable group, then its score would be 25, or the potatoes sub-group comprised 25% of the total servings of vegetables for the two days.

Food Sufficiency Status

Food sufficiency status was assessed with the following question:

> Which one of the following statements best describes the food eaten in your household in the last three months....?
>
> 1) Enough of the kinds of food we want to eat
> 2) Enough but not always the kinds of food we want to eat
> 3) Sometimes not enough to eat
> 4) Often not enough to eat

Consistent with previous research, categories 3 and 4 were collapsed into "sometimes/often not enough to eat" and labeled "food insufficient" due to limited responses to "often not enough to eat" (2-5). Based on answers to the food sufficiency question, study participants were placed into three categories of food sufficiency: food

Table 1. Pyramid Food Group and Sub-Groups

Pyramid Food Group	Food Sub-groups
Grain	Whole Grain Non-whole grain
Vegetable	Dark-green vegetables Deep-yellow vegetables White potatoes Other Starchy Vegetables Tomatoes Other vegetables
Fruit	Citrus fruits, melons, and berries Other fruits
Dairy	Milk Yogurt Cheese
Meat	Meat (beef, pork, lamb, veal, game) Organ meats (meat, poultry) Frankfurters, sausage, luncheon meats Poultry (chicken, turkey, other) Fish (fish, shellfish, other) Eggs Cooked dry beans and peas Soybean products (tofu, meat analogs) Nuts and seeds

Source: Cook and Friday, 2000. Documentation: Pyramid Servings Database for USDA Survey Food Codes, Community Nutrition Research Group, Agricultural Research Service, US Department of Agriculture October 2000.

sufficient (enough of the kinds of foods wanted), food sufficient with limitations (enough but not always the kinds of food we want to eat), and food insufficient (sometimes/often not enough to eat).

Control Variables

Dietary practices have been reported to vary by race/ethnicity, geographic region, level of urbanization, household income, educational status of the household head, whether the head of the household is a female, and the number of household members

(4). Another potential variable among participants was participation in food assistance programs (4), which described many children in this sample. Therefore, household participation in the WIC and Food Stamp Programs and individual participation among school age children in the National School Breakfast and National School Lunch Program were used as control variables in this analysis.

A more complete discussion of these variables can be found in Appendix A of this dissertation.

Data Analysis

Data analysis used a combination of statistical software packages. SAS 8.2 was used for data management (27) while data analysis was completed using SUDAAN version 8.0.1 (28). The CROSSTAB and DESCRIPT procedures in SUDAAN were used to compute descriptive statistics. Using the REGRESS procedure in SUDAAN, 22 linear regression models (one for each sub-group contribution score) were tested for differences among the three levels of food sufficiency status (α=0.01) while controlling for food assistance participation and other factors affecting dietary intake. A conservative significance level of α=0.01 was used due to the large number of tests completed.

Results

Sample characteristics and prevalence of food sufficiency, food sufficiency with limitations and food insufficiency were described previously (24). In brief, the prevalence of food sufficiency, food sufficiency with limitations and food insufficiency was 58.1%, 35.4%, and 6.5% among 2-3 year old children and 55.3%, 37.5%, and 7.2% among 4-8 year old children. This study focuses on sub-group contribution scores,

differences in sub-group contribution scores by age, and the relationship between food sufficiency status and these scores.

Mean Intake from the 5 Food Groups of the Food Guide Pyramid by Age

Because total servings from the major food groups were used in calculation of the Sub-Group Contribution Scores, mean intakes by age group are depicted in Table 2 for comparison purposes. The older group of children, 4-8 years, had significantly lower ($p=0.00$) mean intakes from the grain, vegetable, and fruit groups and significantly higher intakes of the meat and dairy group ($p=0.00$) compared to the younger children, 2-3 years.

Sub-Group Contribution Scores by Age

The mean Sub-Group Contribution Score for each of the 22 sub-groups by its corresponding major food group is depicted in Table 3. Within each major food group a pattern of sub-group consumption was observed for each sample of children. Because the denominator was the total number of servings from the major food group, the Sub-Group Contribution Scores within a major food group were dependent upon one another. As consumption from one sub-group within a major food group increased, at least one of the other Sub-Group Contribution Scores within that major food group decreased. A short description of the patterns within each of the five major food groups follows.

Grain Group. Mean number of grain servings differed significantly between the two age groups of children with 2-3 year old children consuming more servings on average from the grain group than the 4-8 year children. Both age groups of children consumed most of the grain servings from the non-whole grains sub-group. The pattern of consumption for whole grains and non-whole grains significantly differed with age.

Table 2: Intake of Major Food Groups of the Food Guide Pyramid by Age

Food Guide Pyramid Food Groups	Age Category				
	2-3 Years (n=1242)		4-8 Years (n=1506)		p-value[2]
	N[1]	Mean (SE)	N[1]	Mean (SE)	
Grain	1242	6.90 (0.13)	1506	5.92 (0.11)	0.00
Vegetable	1221	2.50 (0.05)	1492	1.97 (0.06)	0.00
Fruit	1181	2.63 (0.09)	1437	1.56 (0.05)	0.00
Dairy	1234	1.80 (0.04)	1497	1.97 (0.04)	0.00
Meat	1237	2.97 (0.05)	1503	3.67 (0.07)	0.00

[1]Number of children whose intake exceeded zero servings from the designated food group.

[2] Tests for statistical significance were based on t-test with a significance level of α=0.01.

Table 3: Sub-Group Contribution Scores[1] Arranged By Major Food Group By Age Group

Food Groups	Age Category		
	2-3 Years (n=1242) Mean (SE)	4-8 Years (n=1506) Mean (SE)	p-value[2]
Grain			
Whole grains	14.84 (0.50)	13.13 (0.48)	0.01
Non-whole grains	85.17 (0.50)	86.87 (0.48)	0.01
Vegetable			
Dark Green Vegetables	3.42 (0.44)	3.36 (0.39)	0.91
Deep Yellow Vegetables	5.02 (0.39)	4.67 (0.37)	0.52
White Potatoes	40.25 (0.94)	40.21 (1.31)	0.98
Other Starchy Vegetables	9.94 (0.64)	8.98 (0.60)	0.18
Tomatoes	21.65 (0.91)	20.81 (0.76)	0.47
Other Vegetables	19.76 (0.63)	22.00 (0.78)	0.02
Fruit			
Citrus, melons, and berries	37.88 (1.19)	39.67 (1.48)	0.34
Other fruits	62.39 (1.12)	60.36 (1.48)	0.27
Dairy			
Milk	80.22 (0.76)	78.60 (0.72)	0.14
Yogurt	1.42 (0.23)	0.83 (0.17)	0.02
Cheese	17.91 (0.71)	20.22 (0.72)	0.03
Meat			
Meat (beef, pork, lamb, etc)	31.09 (0.75)	34.48 (1.05)	0.01
Organ Meats	0.16 (0.06)	0.25 (0.07)	0.41
Frankfurters, sausage, luncheon meats	19.89 (0.81)	21.48 (0.88)	0.13
Poultry (chicken, turkey, etc)	21.34 (0.73)	20.56 (0.70)	0.45
Fish (fish, shellfish, other)	5.00 (0.44)	4.62 (0.54)	0.58
Eggs	11.93 (0.55)	8.86 (0.41)	0.00
Cooked Dry Beans and Peas	5.08 (0.56)	4.33 (0.52)	0.14
Nuts and Seeds	5.17 (0.39)	5.19 (0.35)	0.94
Soybean Products	0.35 (0.16)	0.26 (0.06)	0.56

[1]Sub-group Contribution Scores = (number of sub-group servings{2-day average}/ number of corresponding Pyramid group servings total {2-day average}) *100.
[2]Tests for statistical significance were based on t-tests with a significance level of α=0.01.

The 2-3 year old children had a significantly higher Sub-Group Contribution Score for whole grains and significantly lower score for non-whole grains than the 4-8 year old children.

Vegetable Group. The mean number of vegetable servings also differed significantly between the two age groups of children, with 2-3 year old children consuming more servings on average from the vegetable group than the 4-8 year old children. Both age groups of children consumed most of their vegetable servings from the white potatoes, tomatoes and other vegetables (such as lettuce, green beans, cabbage, celery, mushrooms, onions, etc) sub-groups. No significant differences in sub-group contribution scores were found between the two age groups of children for any of the six sub-groups of vegetables.

Fruit Group. Average number of fruit servings for the 2-3 year children was significantly higher than that for the 4-8 year old children. The other fruits sub-group contributed slightly more servings to the overall fruit group than the citrus, melons, and berries sub-group for both age groups. However, no significant differences in Sub-Group Contribution Scores were found between the two age groups.

Dairy Group. The average number of servings from the dairy group for the 4-8 year children was significantly higher than that for the 2-3 year old children. The milk sub-group provided the largest contribution to the overall dairy group for both age groups.

Meat Group. The mean number of servings from the meat group also differed significantly between the two age groups of children, with 4-8 year old children consuming more servings on average from the meat group than the 2-3 year children.

Both age groups of children consumed most of the meat group servings from the following three sub-groups: meat (beef, pork, and lamb); frankfurters, sausage, and luncheon meats; and poultry. The pattern of consumption for the meat (beef, pork, and lamb) and eggs sub-groups significantly changed with age. The 2-3 year old children had a significantly higher Sub-Group Contribution Score for eggs and significantly lower score for meat (beef, pork, and lamb) than the 4-8 year old children.

Sub-Group Contribution Scores by Food Sufficiency Status

Because total servings from the major food groups were used in the calculation of the Sub-Group Contribution Scores, mean intakes by food sufficiency status for each age group are depicted in Table 4 for comparison purposes. No significant differences in mean intake of the 5 major food groups of the Food Guide Pyramid were detected across the three levels of food sufficiency status for either age group of children (Table 4). When comparing across food sufficiency status categories while controlling for confounding factors, no significant differences in Sub-Group Contribution Scores for the 22 sub-groups were found regardless of age (Table 5). However, because this study used a conservative significance level and is exploratory, trends in Sub-Group Contribution Scores that differed at a significance level of $\alpha>0.01$ to $\alpha=0.05$ are discussed.
Food insufficient compared to food insufficient 2-3 year old children consumed proportionally more from the citrus, melons, and berries sub-group and proportionately less from the other fruits and frankfurters, sausage and luncheon meats sub-groups. Among the 2-3 year old children, these three sub-group contribution scores were the only scores to approach significance. Food insufficient 4-8 year old children ate proportionally less from the dark green vegetables sub-group and proportionally more

Table 4: Intake of Major Food Groups of the Food Guide Pyramid by Age and Food Sufficiency Status

	Children Ages 2-3 Years (n=1242)							Children Ages 4-8 Years (n=1506)						
Food Guide Pyramid Food Groups	Food Sufficient (n=714)		Food Sufficient with Limitations (n=450)		Food Insufficient (n=76)		p-value[2]	Food Sufficient (n=867)		Food Sufficient with Limitations (n=541)		Food Insufficient (n=97)		p-value[2]
	N[1]	Mean (SE)	N[1]	Mean (SE)	N[1]	Mean (SE)		N[1]	Mean (SE)	N[1]	Mean (SE)	N[1]	Mean (SE)	
Grain	714	6.91 (018)	450	6.90 (0.17)	76	6.79 (0.35)	0.77	867	5.88 (0.15)	541	6.00 (0.14)	97	5.84 (0.29)	0.77
Vegetable	703	2.54 (0.08)	441	2.49 (0.08)	75	2.26 (0.25)	0.73	859	2.00 (0.06)	537	2.00 (0.09)	95	1.57 (0.20)	0.17
Fruit	684	2.68 (0.11)	422	2.57 (0.12)	73	2.41 (0.15)	0.51	828	1.63 (0.07)	516	1.45 (0.08)	92	1.56 (0.15)	0.14
Dairy	710	1.80 (0.05)	446	1.77 (0.06)	76	2.08 (0.17)	0.21	861	1.92 (0.05)	538	2.01 (0.06)	97	2.11 (0.16)	0.53
Meats	711	2.97 (0.07)	448	2.98 (0.08)	76	3.01 (0.22)	0.89	867	3.61 (0.09)	539	3.84 (0.11)	96	3.33 (0.24)	0.06

[1]Number of children whose intake exceeds zero servings from the designated food group.

[2] Tests for statistical significance are based on multiple linear regression while controlling for socio-demographic factors and food assistance participation.

Table 5: Sub-Group Contribution Scores[1] Arranged By Major Food Group By Age and Food Sufficiency Status

Food Groups	Children Ages 2-3 Years (n=1242)				Children Ages 4-8 Years (n=1506)			
	Food Sufficient (n=714) Mean (SE)	Food Sufficient with Limitations (n=450) Mean (SE)	Food Insufficient (n=76) Mean (SE)	p-value[2]	Food Sufficient (n=867) Mean (SE)	Food Sufficient with Limitations (n=541) Mean (SE)	Food Insufficient (n=97) Mean (SE)	p-value[2]
Grain Group								
Whole grains	15.15 (0.68)	15.01 (0.84)	11.22 (1.64)	0.25	13.85 (0.68)	12.53 (0.70)	10.80 (1.13)	0.08
Non-whole grains	84.87 (0.68)	84.98 (0.84)	88.73 (1.64)	0.26	86.15 (0.68)	87.47 (0.70)	89.16 (1.13)	0.08
Vegetable Group								
Dark Green Vegetables	3.52 (0.53)	2.74 (0.41)	6.38 (3.48)	0.45	3.78 (0.57)	3.17 (0.57)	1.10 (0.43)	0.02
Deep Yellow Vegetables	5.47 (0.61)	4.11 (0.51)	5.95 (1.66)	0.24	4.69 (0.40)	4.76 (0.68)	4.02 (1.12)	0.76
White Potatoes	39.13 (1.41)	42.79 (1.55)	36.65 (3.29)	0.44	40.28 (1.54)	39.71 (1.92)	42.35 (4.31)	0.43
Other Starchy Vegetables	10.28 (0.73)	10.09 (1.39)	5.80 (1.78)	0.14	9.67 (1.07)	8.38 (0.65)	6.73 (1.83)	0.43
Tomatoes	22.16 (1.32)	20.83 (1.16)	21.34 (2.83)	0.96	20.15 (0.99)	20.98 (1.46)	25.05 (3.43)	0.66
Other Vegetables	19.45 (0.63)	19.43 (1.19)	24.48 (2.93)	0.50	21.44 (0.78)	23.05 (1.38)	20.90 (2.59)	0.31
Fruit Group								
Citrus, melons, and berries	37.82 (1.59)	36.05 (1.79)	47.75 (3.41)	0.04	39.87 (1.75)	38.49 (2.65)	44.47 (5.38)	0.46
Other fruits	62.63 (1.50)	63.97 (1.77)	52.28 (3.41)	0.03	60.20 (1.75)	61.49 (2.64)	55.58 (5.37)	0.46
Dairy Group								
Milk	81.20 (1.00)	77.76 (1.28)	84.61 (2.03)	0.12	78.01 (0.85)	79.03 (1.41)	80.78 (1.86)	0.89
Yogurt	1.58 (0.33)	1.27 (0.29)	0.82 (0.44)	0.73	1.00 (0.25)	0.69 (0.30)	0.32 (0.17)	0.45
Cheese	16.78 (0.91)	20.43 (1.10)	14.43 (2.02)	0.08	20.65 (0.87)	19.89 (1.35)	18.69 (1.81)	0.95
Meat Group								
Meat (beef, pork, lamb, etc)	30.73 (0.99)	30.54 (1.19)	37.88 (3.90)	0.07	34.19 (1.44)	35.29 (1.47)	32.48 (4.10)	0.62
Organ Meats	0.17 (0.08)	0.15 (0.07)	0.08 (0.08)	0.09	0.22 (0.09)	0.32 (0.15)	0.08 (0.08)	0.14
Frankfurters, sausage, luncheon meats	19.18 (1.07)	22.34 (1.31)	13.05 (2.07)	0.02	22.36 (1.17)	20.99 (1.84)	17.28 (2.03)	0.44
Poultry (chicken, etc)	21.17 (0.97)	21.44 (1.44)	21.36 (2.40)	0.92	19.72 (1.04)	21.53 (1.02)	22.00 (2.98)	0.31
Fish (fish, shellfish, other)	5.65 (0.61)	4.19 (0.63)	3.73 (1.15)	0.26	4.54 (0.69)	4.60 (1.07)	5.40 (1.30)	0.88
Eggs	12.24 (0.76)	11.50 (0.80)	11.43 (2.21)	0.33	9.14 (0.61)	7.97 (0.58)	11.20 (1.68)	0.25
Cooked Dry Beans and Peas	4.61 (0.68)	5.11 (0.70)	9.24 (3.21)	0.28	3.69 (0.47)	4.60 (0.84)	7.87 (1.67)	0.05
Nuts and Seeds	5.70 (0.54)	4.65 (0.52)	3.28 (1.12)	0.47	5.80 (0.64)	4.59 (0.51)	3.70 (0.89)	0.49
Soybean Products	0.55 (0.28)	0.10 (0.05)	0.02 (0.01)	0.24	0.38 (0.11)	0.14 (0.07)	0.03 (0.01)	0.16

[1]Sub-group Contribution Scores = (number of sub-group servings{2-day average}/ number of corresponding Pyramid group servings total {2-day average}) *100

[2]Tests for statistical significance are based on multiple linear regression while controlling for socio-demographic factors and food assistance participation.

from the cooked dry beans and peas sub-group than their food sufficient counter parts. These are the only two sub-group contribution scores for the older children to approach significance.

Discussion

Sub-Group Contribution Score

The use of the Sub-Group Contribution Scores allowed for an examination of patterns of sub-group consumption within the major food groups of the Food Guide Pyramid. When these scores were compared between the two age groups of children or across the three categories of food sufficiency status, substitution patterns of sub-groups within food groups could be detected.

The Sub-Group Contribution Score was utilized as a means of assessing within food group variety (29,30). This type of variety is typically assessed as the number of different foods consumed within a food group or the number of different sub-groups consumed within a major food group (29,30). The Sub-Group Contribution Score may not be the best measure of within food group variety, because it does not measure the number of different foods consumed. It does, however, assess dependence or reliance upon certain sub-groups within a food group. When the major food group had a large enough number of sub-groups, dependence upon a sub-group could be detected. For example, 60% of all the vegetables consumed by the children were white potatoes and tomatoes. This finding could be interpreted as a lack of variety among the vegetables group. If the food sub-groups could be sub-divided further, this score might provide a good measure of dependence/reliance on sub-sets of foods within the major food groups of the Food Guide Pyramid. For example, if the citrus, melons, and berries sub-group

were split into whole fruits and fruit juices, then the patterns detected within the overall Pyramid fruit group would be more interpretable.

Food Sufficiency Status and Its Relationship to the Sub-Group Contribution Scores

Because the Sub-Group Contribution Scores were calculated as the percent contribution of a sub-group to the total group, they reflect dependence/reliance. This study's findings, however, did not quantify the statement from the qualitative research "relied on a few kinds of low-cost foods to feed my children" (12-15, 31). For this statement to be true, one would expect that certain lower cost items within a major food group would contribute more heavily to the major food group and significant differences between the sub-group contribution scores across the three levels of food sufficiency status would be detected. This was not the case using a conservative measure of significance. However, general trends in the Sub-Group Contribution Scores suggested that food insufficient 2-3 year old children consumed proportionately more from the citrus, melons, and berries sub-group and proportionately less from the other fruits sub-group and frankfurters, sausage and luncheon meats sub-group than their food sufficient counterparts. The older food insufficient 4-8 year old children ate proportionately less from the dark green vegetables sub-group and proportionally more from the cooked dry beans and peas sub-group than their food sufficient counter parts. The trend for the older food insufficient children to consume proportionally more dry beans and peas supports the statement "relied on a few kinds of low-cost foods to feed my children" (12-15,31). However, caution is warranted.

The findings from this study differ from the findings of Casey et al (5). Using the 1994-1996 CSFII data, Casey et al (5) found that children ages 2-17 years living in low-

income (≤ 130% of the FPL) food insufficient households consumed significantly less dark green leafy vegetables, other vegetables, and nuts and seeds, and significantly more eggs than those in low-income food sufficient households. Their findings, however, are based on intake data as servings. While this study explored variety within the major food groups by examining the proportional contribution of sub-groups to the major food groups of the Food Guide Pyramid. Therefore, results for a specific food group may not be comparable.

Implications

The new *Dietary Guidelines for Americans* and the Food Guide Pyramid place an emphasis on eating a variety of foods from the grain group, with a special emphasis on whole grains (17-19). The Food Guide Pyramid for Young Children (18) suggests that at least 3 of the 6 daily grain group choices should be whole grains. This study and previous research (24) suggests that low-income children, 2-8 years of age, adhere to serving recommendations for the grain group, but that variety within this food group is problematic. Consumption of whole grains does not improve with age and it does not vary by food sufficiency status.

The new *Dietary Guidelines for Americans* also place a larger emphasis on fruit and vegetable intake (17). Variety is encouraged within these groups to ensure adequate intake of Vitamin A, Vitamin C, folate, carotenoids, and potassium. This study and previous research (24) suggests that 4-8 year old children do not consume adequate amounts from the fruit and vegetable groups, and, within these groups, variety may be limited. Although 2-3 year children had significantly better intakes of fruits and

vegetables than 4-8 year old children, they still consumed inadequate amounts from the vegetable group, and variety within that group was limited.

Intake from the meat group was also problematic for these low-income children. This study and previous research (24) suggest that children do not meet the serving recommendations of the Food Guide Pyramid. Some sub-groups within the meat group require a larger serving size to equal the protein equivalent of one ounce of meat. For example, a child must eat 1 ½ hot dogs to equal 1-ounce of meat. In this study, frankfurters, sausage, and luncheon meats contributed approximately 20% of the meat group consumed; these children may actually be consuming fewer servings (measured in ounces) from the meat group overall while consuming a larger volume of food from this group.

Nutrition education is imperative for all low-income children ages 2-8 years regardless of food sufficiency status. Education messages need to focus on the importance of choosing more whole grains, increasing intake of fruits and vegetables, choosing a variety of fruits and vegetables, and increasing intake from the meat group with an emphasis on high quality protein sources.

With the new focus on variety within the grain, fruit, and vegetable groups, a methodology is needed to more accurately assess variety within food groups and adherence to the latest version of *The Dietary Guidelines for Americans*. The Sub-Group Contribution Score may be a helpful way of assessing dependence/reliance on select groupings of foods within these major food groups. However, these scores could be enhanced by a larger number of sub-groups within the major food groups of the Food Guide Pyramid.

Limitations

One limitation specific to this study is the construction of the sub-group contribution score. This score uses as its denominator the number of servings eaten from the larger food group. If no servings from the larger food group are consumed, then the score cannot be calculated and that individual is dropped from the analysis. This limitation may have its greatest impact on the vegetable and fruit groups, because they are the food groups most often omitted. This limitation may not have affected results between food sufficiency status categories, because the omission of a major food group was seldom seen within the food insufficient group regardless of age.

The nature of secondary data limits the types and kinds of variables available to the researcher. The CSFII 1994-1996, 1998 provided a large sample of low-income children for which food sufficiency status and quality dietary data were available. Although the new food security measurement instrument is the current means of assessing domestic hunger, this instrument was not available within the CSFII 1994-1996, 1998 (31-33). Therefore, this study used food sufficiency status as a proxy measure for food security, which is consistent with previous research (2-5). As data from dietary studies and the new Food Security Module (30) become available the question "relied on a few kinds of low cost foods to feed my children" should be validated.

This study relied on self-report of dietary intake, which can introduce bias. This is especially true where dietary data were gathered through proxy, especially when the proxy was someone from outside the home. CSFII included a large sample size and extensive training and re-training of personnel to help address these issues. To overcome

limitations of a single 24-hour dietary recall, this study also used only children for whom data were available from 2-day dietary recalls.

In the selection of the sample for this study, every effort was made to collect the most homogeneous sample and control for factors related to food sufficiency status. This may have reduced the chances for significant findings.

Conclusions

The variety measures tested within this study lent no support to the concepts set forth in the qualitative research regarding hunger and its affect on the eating patterns of children. Some trends between age groups and food sufficiency status were noted. However, these trends were not statistically significant when tested while controlling for other variables that may affect eating patterns.

References

1. SA Anderson, ed. Life Sciences Research Office, Federation of American Societies for Experimental Biology (1992) "Core Indictors of Nutritional Status for Difficult to Sample Populations." JNE 120:1559-1600.

2. Rose, D., Oliviera, V. (1997) Validation of a self-reported measure of household food insufficiency with nutrient intake data. US Department of Agriculture, Economic Research Service, Food and Consumer Economics Division. Washington DC. Technical Bulletin 1863.

3. Cristofar, S.P., Basiotis, P.P. (1992) Dietary intakes and selected characteristics of women ages 15-50 years and their children ages 1-5 years by reported perception of food sufficiency. JNE 24:53-58.

4. Rose, D., Oliveira, V. (1997) Nutrient intakes of individuals from food-insufficient households in the United States. Amer J Public Health 87:1956-1961.

5. Casey, P.H., Szeto, K., Lensing, S., Boyle, M., Weber, J. (2001) Children in food-insufficient, low-income families: Prevalence, health, and nutrition status. Arch Pediatr Adolesc Med 155:501-514.

6. Bickel, G.W., Andrews, M.S., Klein, B.W. (1996) "Measuring Food Security in the United States: A Supplement to the CPS." In Nutrition and Food Security in the Food Stamp Program (D Hall and M Stravrianos, eds). Alexandria, VA: US Department of Agriculture, Food and Consumer Service.

7. Briefel, R.R., Woteki, C.E. (1992) Development of the food sufficiency questions for the third National Health and Nutrition Examination Survey. JNE 24(supple):24S-28S.

8. Alaimo, K., Briefel, R.R., Frongillo Jr., E.A., Olson, C.M. (1998) Food insufficiency exists in the United States: Results from the Third National Health and Examination Survey (NHANES III) Amer J Public Health 88:419-426.

9. Alaimo, K., Olson, C.M., Frongillo Jr., E.A., Briefel, R.R. (2001) Food insufficiency, family income, and health in US preschool and school-aged children. Am J Public Health 91:781-786.

10. Alaimo, K., Olson, C.M., Frongillo Jr., E.A. (2001) Food insufficiency and American school-aged children's cognitive, academic, and psychosocial development. Pediatrics 108:44-53.

11. Townsend, M.S., Peerson, J., Love, B., Achterberg, C., Murphy, S.P. (2001) Food insecurity is positively related to overweight in women. J Nutr 131:1738-1745.

12. Radimir, K.L., Olson, C.M., Campbell, C.C. (1990) Development of Indicators to Assess Hunger J Nutr 20:1544-1548.

13. Radimir, K.L., Olson, C.M., Greene, J.C., Campbell, C.C., Habicht, J.P. (1992) Understanding Hunger and Developing Indicators to assess it in women and children. JNE 24:36S-45S.

14. Kendall, A., Olson, C.M., Frongillo, E.A. (1995) Validation of the Radimir/Cornell measures of hunger and food insecurity. J Nutr 125:2793-2801.

15. Kendall, A., Olson, C.M., Frongillo, E.A. (1996) Relationship of hunger and food insecurity to food availability and consumption. J Amer Diet Assoc 96:1019-1024.

16. *Nutrition and Your Health. Dietary Guidelines for Americans.* (2000) United States Department of Agriculture and United States Department of Health and Human Services. Fifth Edition. Home and Garden Bulletin No. 232.

17. Dixon, L.B., Cronin, F.J., Krebs-Smith, S.M. (2001) Let the Pyramid guide your food choices: Capturing the total diet concept. J Nutr 131:461S-472S.

18. *Tips for Using the Food Guide Pyramid for Children 2 to 6 Years Old* (1999). United States Department of Agriculture, Center for Nutrition Policy and Promotion, Program Aid 1647.

19. *The Food Guide Pyramid* (1992). United States Department of Agriculture. Home and Garden Bulletin 252.

20. Cleveland, L.E., Cook, D.A., Krebs-Smith, S.M., Friday, J. (1997) Method for assessing food intakes in terms of servings based on food guidance. Am J Clin Nutr 65:1254S-1263S.

21. Cronin, F.J., Shaw, A.M., Krebs-Smith, S.M., Marsland, P.M., Light, L. (1987) Developing a food guidance system to implement the dietary guidelines. JNE 19:281-302.

22. Cook, A., Friday, J.E. Documentation: Pyramid servings database for USDA survey food codes. http://www.barc.usda.gov/bhnrc/cnrg (Accessed October 2000).

23. Cook, A., Friday, J.E. Pyramid Servings Intakes by U.S. children and Adults 1994-96, 1998. CNRG Table Set No. 1. http://www.barc.usda.gov/bhnrc/cnrg (Accessed October 2000).

24. Knol, L.L. (2002) Household food sufficiency status and the quality of children's diets: An analysis from the Continuing Survey of Food Intakes by Individuals 1994-1996, 1998. PhD dissertation. University of Tennessee, Knoxville, TN.

25. United States Department of Agriculture, Agriculture Research Service. (2000). Continuing Survey of Food Intakes by Individuals 1994-96, 1998. CD-ROM.

26. Standing Committee on the Scientific Evaluation of the Dietary Reference Intakes of the Food and Nutrition Board, Institute of Medicine. (2001). *Dietary reference intakes. Applications in dietary assessment.* Food and Nutrition Board, Institutes of Medicine.

27. *SAS System* under Microsoft Windows, version 8.2. (1999-2001) SAS Institute Inc., Cary NC.

28. Shah BV, Barnwell BG, Biegler GS. (1997) *SUDAAN User's Manual, Release 7.5.* Research Triangle Park, NC: Research Triangle Institute.

29. Krebs-Smith, S.M., Smiciklas-Wright, H., Guthrie, H.A., Krebs-Smith, J. (1987) The effects of variety in food choices on dietary quality. J Amer Diet Assoc 87:897-903.

30. McCrory, M.A., Fuss, P.J., McCallum, J.E., Manjiang, Y., Vinken, A.G., Hays, N.P, Roberts, S.B. (1999) Dietary variety within food groups: Association with energy intake and body fatness in men and women. Am J Clin Nutr 69:440-447.

31. Nord, M., Nader, K., Tichen, L., Andrews, M., Bickel, G., Carlson, S. (2002) Household food security in the United States, 2000. Food and Rural Economic Division, Economic Research Service, US Department of Agriculture. Food Assistance and Nutrition Research Report No. 21.

32. Hamilton WL, Cook JT, Thompson WW, Buron LF, Brongillo E A Jr, Olson CM, Wehler CA. (1997) *Household Food Security in the United States in 1995. Technical Report of the Food Security Measurement Project.* Alexandria, VA: United States Department of Agriculture, Food and Consumer Service, Office of Analysis and Evaluation.

33. Hamilton WL, Cook JT, Thompson WW, Buron LF, Brongillo EA Jr, Olson CM, Wehler CA. (1997) *Household Food Security in the United States in 1995. Summary Report of the Food Security Measurement Project.* Alexandria, VA: United States Department of Agriculture, Food and Consumer Service, Office of analysis and Evaluation.

Appendix

Appendix A:
Extensive Methodology

This appendix describes in detail the methodology used in this study, including the methods used to determine adequacy and variety/diversity using the Food Guide Pyramid food groups, sub-groups, and discretionary fat and added sugars. This study used secondary data for children 2-8 years of age from the Continuing Survey of Food Intakes by Individuals 1994-1996, 1998 (1).

Research Questions

The research questions revolved around two major themes: adequacy as described by Food Guide Pyramid serving recommendations and intake of discretionary fat and added sugars; and variety described as overall variety ((Healthy Eating Index (HEI) variety score)), among food group variety ((Dietary Diversity Score (DDS)) and within food groups (sub-group contribution). These research questions examined how the quality of young children's diets differs by household food sufficiency status. The young children were 2-8 years of age living in households that were eligible by income and age to participate in USDA food assistance programs (WIC, National School Breakfast and Lunch Programs, and Food Stamps). Each of the research questions utilized the same basic framework for analysis with changes in the dependent variable and statistical methods only.

Adequacy. Adequacy was described by the degree to which intakes meet the serving recommendations of the 5 major Food Guide Pyramid groups, discretionary fat, and added sugars (2-3). The research question was:

1. Are there significant differences in diet adequacy between the three levels of household food sufficiency? Diet adequacy was measured by degree of adherence to age-specific daily serving recommendations for the 5 Food Guide Pyramid food groups and by intake of discretionary fat (grams) and added sugars (teaspoons).

Variety. Diet quality was described by three measures of variety: overall, among food groups and within food groups using the 5 major Food Guide Pyramid groups and their 19 sub-groups (2-3). The research questions were:

2. Are there significant differences in overall variety between the three levels of food sufficiency status? Overall variety was measured using the Healthy Eating Index (HEI) variety score.

3. Are there significant differences in variety among food groups between the levels of food sufficiency status? Among food group variety was measured using the Dietary Diversity Score (DDS).

4. For each major Food Guide Pyramid group, are there significant differences in the contribution of each of its food sub-groups (within food group variety) to overall Pyramid group intake between the three levels of household food sufficiency? Each sub-group's contribution was measured by the degree to which the number of servings from the respective sub-group contributes to the total number of servings for the Pyramid food group. Contribution of food sub-group choices will serve as a proxy for diversity within a food group.

Data Source Used: 1994-1996, 1998 CSFII

The 1994-1996, 1998 CSFII (1) is a nationally representative sample of non-institutionalized persons living in households across the United States with over-sampling of low-income households. It has been used in previous studies of diet and food sufficiency status (4-7). The sampling frame was organized using estimates from the 1990 US population and took into account socioeconomic characteristics, geographic region, and urbanization. The overall 1998 CSFII 2-day response rate was 81.7%, while the overall 1994-96 2-day response rate was 76.1% (1). The CSFII provides estimates of

food and nutrient intakes of individuals of all ages from 2 nonconsecutive days of 24-hour dietary recall obtained through in person interviews. Proxy interviews were conducted for children less than 6 years of age or for any persons who could not report their own intake. Children ages 6-11 years old provided data about their own dietary intake with the assistance of an adult household member. The preferred proxy for children was the person who prepared the sample person's meals. However, it was permissible for any caregiver, including baby sitters or school cafeteria personnel, to provide dietary intake data, if needed. The 1994-1996, 1998 CSFII contains food and nutrient data for 2,943 2-3 year old children and 3,935 4-8 year old children. Survey participants were asked specific food-related information including: food name, type of meal where the food was consumed, time and location when the food was consumed, quantity of the food consumed and whether the day's intake represented a usual day's intake (1).

Sample

The sample included 3122 children 2-8 years of age who provided 2 days of completed dietary recall data and whose households could be staged into one of four categories of food sufficiency. Selected children were those who lived in households whose income was 185% of the federal poverty level or less. This income level was chosen as a proxy for food assistance program eligibility.

To limit the confounding effect of age, the children were divided into two age categories, 2-3 year olds (n=1308) and 4-8 year olds (n=1814), with similar eating patterns and nutritional needs (9). The selected age categories, with one exception, are consistent with those of the Standing Committee on the Scientific Evaluation of the

Dietary Reference Intakes (DRI) of the Food and Nutrition Board, Institute of Medicine (9). The DRI age group of 1-3 years was limited to those 2-3 years old, since serving recommendations from the Food Guide Pyramid (10-11) are applicable to those ages 2 years and older. Breastfeeding children were excluded from the study since breast milk consumption was not quantified (19). Lastly, only one child fitting the eligibility requirements for each age group was chosen at random per household. Therefore, the final sample included: 1242 and 1506 children ages 2-3 and 4-8 years, respectively.

Measures of Interest

The same main effect and control variables were used in all of the analyses. These variables are discussed first and then followed by the various dependent variables.

Main effect. Food sufficiency status, the main effect, was measured by the following question from the CSFII:

> Which one of the following statements best describes the food eaten in your household in the last three months....?
>
> 5) Enough of the kinds of food we want to eat
> 6) Enough but not always the kinds of food we want to eat
> 7) Sometimes not enough to eat
> 8) Often not enough to eat
> 8) Don't know
> 9) Not ascertained

Due to low number of responses to "often not enough to eat" (n=6 and n=13 for 2-3 year olds and 4-8 year olds, respectively), categories 3 and 4 were collapsed into "sometimes/often not enough to eat" and labeled "food insufficient." This is consistent with previous research using the food sufficiency question from the CSFII (4-7). All members of households with responses of "don't know" and "not ascertained" were excluded from this study. Those study participants with "enough of the kinds of food

wanted" were labeled as "food sufficient" while those study participants choosing category 2 were labeled as "food sufficient with limitations." Therefore, there were three categories of food sufficiency status: food sufficient, food sufficient with limitations, and food insufficient.

Control variables. Dietary practices can vary by race/ethnicity, geographic region, level of urbanization, and household income. They also can vary by household level descriptors, such as household head's education level, whether the household is headed by a single adult, and the number of household members (6). These variables were used as controls for all analyses completed in this study. Many children in the sample were participating in food assistance programs at the time the survey was completed. Therefore, program participation was recoded into a dichotomous variables with "yes" or "no" responses for the following: whether the household was participating in the Food Stamp Program at the time of the survey, whether any member of the family participates in the WIC program, and whether the sample child participates in the National School Breakfast and/or the National School Lunch Programs. These variables were used as controls in all analyses as well. Lastly, nutrient intakes for the 1994-96 and 1998 CSFII sample of children differ by year in which the participant entered the sample, particularly, for the 3- to 5-year old children. Therefore, the year the respondent entered the sample was also be used as a control measure (1).

Dependent Variables

The dependent variables differed for each research question. All were derived using the Community Nutrition Research Group's online database for the Pyramid servings for USDA survey food codes, including CSFII 1994-96, 1998 (3). The dataset

variables of interest included the food groups, discretionary fat, and added sugars. On-line SAS input files allow the foods consumed by sample persons to be converted to servings from food groups based on the Pyramid's serving size recommendations and then averaged over the 2-day period (3). The other SAS files in this release were used to adjust the 2-3 year old children's serving sizes to be consistent with those of the Pyramid for children (10) and to place the dry beans and peas into the meat group, since these foods may be used as a meat replacement in many low income households.

Dependent variables of interest are sectioned into the three areas of research categories and described in relation to each research question.

Adequacy. Adequacy was described by the degree to which intakes meet the serving recommendations of the 5 major Food Guide Pyramid groups, discretionary fat, and added sugars (2-3). The research question was:

> Question 1: Are there significant differences in diet adequacy between the three levels of household food sufficiency? Diet adequacy was measured by degree of adherence to age-specific daily serving recommendations for the 5 Food Guide Pyramid food groups and by intake of discretionary fat (grams) and added sugars (teaspoons).

To answer this research question this study used 7 continuous dependent variables: degree of adherence to servings recommendations from the 5 major Food Guide Pyramid food groups, discretionary fat measured in grams, and added sugars measured in teaspoons. Discretionary fat and added sugars represented the "tip" of the Pyramid. Degree of adherence to serving recommendations for each of the 5 Food Guide Pyramid

Table A1. Recommended Number of Servings (SV) From the Food Guide Pyramid by Age

Age (years)	Kilocalories (kcals)	Grain (SV)	Fruit (SV)	Vegetable (SV)	Dairy (SV)	Meat (Ounces)
2-3	About 1,300	6[a]	2[a]	3[a]	2	3.3 ounces or equivalent
4-6	About 1,600	6	2	3	2	5 ounces total or equivalent
7-8[b]	Kcals consumed<2,200	6	2	3	2	5 ounces or equivalent
	2200≤Kcal consumed<2800	9	3	4	2	6 ounces or equivalent
	Kcals consumed≥ 2800	11	4	5	2	7 ounces or equivalent

[a]Portion Sizes reduced for children age 2-3 years by 1/3.
[b]Serving number will be based on actual kilocalories consumed by the 7-8 year old subjects consistent with Cook and Friday, 2000 (31). Pyramid Servings Intakes by U.S. Children and Adults 1994-1996,1998, CNRG Table Set no. 1.
Source: *Dietary Guidelines for Americans* (13); *Tips for Using the Food Guide Pyramid for Children 2 to 6 Years Old* (10).

food groups (Table 1) was calculated as:

$$\text{Degree of Adherence} = \frac{\text{number of servings (2-day average)}}{\text{Recommended number of servings by age}} \times 100$$

Variety. Diet quality was described by three measures of variety: overall, among food groups and within food groups using the 5 major Food Guide Pyramid groups and their 19 sub-groups (2-3). The research questions were:

> Question 2. Are there significant differences in overall variety between the three levels of food sufficiency status? Overall variety was measured using the Healthy Eating Index (HEI) Variety Score.

The Healthy Eating Index (HEI) is a calculated set of variables available within the 1994-1996, 1998 CSFII data (14-15). The HEI Variety Score is one component of the overall

index and ranges from 0 to 10 points. To construct the HEI Variety Score, the number of different foods eaten in a day in sufficient amounts to contribute to at least one-half of a serving, based on Pyramid serving sizes, was totaled. Foods eaten more than once a day were counted only once. Foods that differed only by preparation method, such as fried and boiled potatoes, were grouped together and counted as one. Different foods were counted separately, even if foods were closely related, such as tuna and trout. When a person consumed at least 8 different foods in a day, then that person received the maximum number of points (10 points) for the HEI variety score. If a person consumed 3 or fewer foods per day, then that person received the minimum score (zero points). Intermediate intakes were scored proportionally. For example, consumption of 4 foods, would receive a score of 2, consumption of 5 foods would receive a score of 4, and so on (14-16).

In this study variety scores were calculated based on intake data for both Day 1 and Day 2. Since the variety scores were computed on two nonconsecutive days, the two scores were averaged and used as a dependent variable describing overall variety.

> Question 3. Are there significant differences in variety among food groups between the levels of food sufficiency status? Among food group variety was measured using the Dietary Diversity Score (DDS).

To answer this question, this study used the Dietary Diversity Score. The Dietary Diversity Score is the number of major food groups from the Food Guide Pyramid consumed daily (17). The Dietary Diversity Score can range from 0 (no foods eaten from each of the major food groups) to 5 (at least one food eaten from each of the major food groups) possible points. The DDS utilized the following food groups: Total number of

grain servings, total number of vegetable servings, total number of fruit servings, total number of dairy servings, and total number of meat servings. In this study, to compute the Dietary Diversity Score, one point was awarded each time the two-day average intake was one serving or greater for any one of the five food groups. For example, if a child consumed on average 0.75 servings from the meat and vegetable groups, 1.5 servings from the fruit group, 4.5 servings from the grain group and 2 servings from the dairy group, then the DDS was scored as 0 points for the meat and vegetable groups, and 1 point each for the fruit, grain and dairy groups, for a total of 3 points out of the 5 points possible.

> Question 4. For each major Food Guide Pyramid group, are there significant differences in the contribution of each of its food sub-groups (within food group variety) to overall Pyramid group intake between the three levels of household food sufficiency? Each sub-group's contribution was measured by the degree to which the number of servings from the respective sub-group contributes to the total number of servings for the Pyramid food group. Contribution of food sub-group choices served as a proxy for diversity within a food group.

To answer research question 4, this study calculated the sub-group contribution (Table 2) for each group being studied as a continuous dependent variable. For example, when testing within the Fruit group, two tests were used. In the first test the contribution of "citrus fruits, melons and berries" to the overall Fruit group was calculated and used as the dependent variable. In the second analysis the contribution of "other fruits" to the fruits group was calculated and used as the dependent variable. The procedure was repeated for each Pyramid group and its sub-groups. The following equation was used to calculate sub-group contribution:

Table A2. Pyramid Food Group and Sub-Groups

Pyramid Food Group	Food Sub-groups
Grain Group	Whole Grain Non-whole grain
Vegetable Group	Dark-green vegetables Deep-yellow vegetables White potatoes Other starchy vegetables Tomatoes Other vegetables
Fruit Group	Citrus fruits, melons, and berries Other fruits
Dairy Group	Milk Yogurt Cheese
Meat and Bean Group	Meat (beef, pork, lamb, veal, game) Organ meats (meat, poultry) Frankfurters, sausage, luncheon meats Poultry (chicken, turkey, other) Fish (fish, shellfish, other) Eggs Cooked dry beans and peas Soybean products (tofu, meat analogs) Nuts and seeds

Source: Cook and Friday, 2000 (3). Documentation: Pyramid Servings Database for USDA Survey Food Codes, Community Nutrition Research Group, Agricultural Research Service, US Department of Agriculture October 2000.

Sub-group Contribution Scores =

$$\frac{\text{number of sub-group servings (2 Day average)}}{\text{number of corresponding Pyramid group servings total (2 Day average)}} \times 100$$

Data Analysis

The 1994-1996, 1998 CSFII utilized a complex multistage probability sampling design, which rendered traditional statistical analysis and software inappropriate for use in this study (1). Therefore, this analysis used a combination of statistical software packages for data analysis. SAS 8.2, traditional statistical software based on a simple random sample, was used for all data management and re-coding activities (19). Actual data analysis used SUDAAN (20), a unique software package, that can control for cluster-correlated data and the 1994-1996, 1998 CSFII 4-year sampling weights. This was needed to estimate accurate descriptive and inferential statistics (1,20).

Data analysis occurred in three phases. Phase one focused on data management and re-coding of the measures of interest. The sample was defined and key variables identified and re-coded. At this point one respondent fitting the age profile from each household was chosen for each sample using a random selection procedure to eliminate duplicate household members.

Phase two focused on descriptive statistics, refining variable re-coding, and exploratory data analysis, including evaluation of data distribution, identification of potential outliers, examination of item non-response, and missing data analysis. SUDAAN's CROSSTAB procedure was utilized to compute frequencies and any cross tabulation statistics, such as chi-square tests. SUDAAN's DESCRIPT procedure was

used to compute means, standard errors, and measures of distribution.

Phase three produced the final results. Inferential and multivariate procedures using SUDAAN were used to examine the relationship of dependent variables in questions 1-4 with the independent measures of food sufficiency, while controlling for confounding factors. Due to the large number of tests that were performed, tests with an $\alpha \leq 0.01$ were considered significant.

Question 1. Specifically, the answer to Question 1 regarding adequacy of Pyramid food group intake was found through 7 linear regression models using the 7 dependent variables (the 5 degree of adherence measures with 1 for each of the 5 major Food Guide Pyramid food groups, grams of discretionary fat, and teaspoons of added sugars). Each linear model tested for differences by food sufficiency status (α=0.01) while controlling for food assistance participation and the other previously identified factors affecting dietary intake previously stated using SUDAAN (version 7.5), specifically the REGRESS procedure.

Question 2. The answer to question 2 regarding the HEI variety score was determined again through one linear regression model where the HEI variety score was the dependent variable in a test for differences by food sufficiency status (α=0.01) while controlling for previously mentioned confounding factors using SUDAAN, specifically the REGRESS procedure.

Question 3. To answer question 3, the Dietary Diversity Score was recoded into a dichotomous variable called DDS2, which described the among food group variety as two possible outcomes: adequate or inadequate based on the Dietary Diversity Scores. A score of 0 to 4 was recoded into one response and labeled "lacking among food group

variety" and a score of 5 was recoded as "among food group variety." A logistic regression model was used to test whether food sufficiency status predicted "among food group variety" while controlling for the previously mentioned variables. The LOGISTIC procedure of SUDAAN was used to answer this question. The odds ratio and 99% confidence interval generated from this procedure were used to describe the relationship between food sufficiency status and adequate variety.

Question 4. The answer to the fourth question regarding contribution of food choices for Pyramid food groups also used linear regression models for each dependent variable (in this case, sub-group contribution within each Pyramid food group) to test for differences by food sufficiency status while controlling for previously mentioned confounding variables and using the REGRESS procedure in SUDAAN. For example, when testing within the fruit group, two models were tested, one where the dependent variable is the contribution from the "citrus fruits, melons and berries" sub-group and the other where the contribution from the "other fruits" sub-group was tested.

Anticipated Problems and Limitations

The nature of secondary data limits the type and kinds of variables that can be utilized. Although food insufficiency was used as a proxy for food insecurity and hunger, consistent with other research based on CSFII data (4-7), the researcher recognized that the new food security measurement instrument (21-23) is a more sophisticated measure. Data from its incorporation in any food surveys research will not be available for some time. Therefore, the 1994-1996, 1998 CSFII was the best available data set to study the variables of interest.

Self-reports of dietary intake can introduce bias, which may be especially true where a proxy for a child is involved. CSFII included a large sample size and extensive training and re-training of personnel to help address this issue. This study only used children for whom data were available from 2-day dietary recalls to overcome limitations of a single 24-hour dietary recall.

By focusing on children from households at 185% of the poverty level, the researcher encountered a large population of children who were income-eligible for food assistance programs. Eligibility, however, does not equate with participation. To address this, analysis procedures within all models controlled for participation in WIC, Food Stamps, and the National School Breakfast and Lunch Programs, where appropriate. Unfortunately, the CSFII data set does not provide information about participation in the Child and Adult Care Feeding Program or the Summer Feeding Program, additional sources of food assistance for children.

Multiple children within the same household are likely to have eating patterns that are highly correlated. Up to 3 and sometimes 4 children from the same household met the selection criteria. To solve this dilemma, the researcher randomly selected one person from each household that met the age criteria for that group.

Appendix References

1. United States Department of Agriculture, Agriculture Research Service. (2000) Continuing Survey of Food Intakes by Individuals 1994-96, 1998. CD-ROM.

2. Cleveland LE, Cook DA, Krebs-Smith SM, Friday J. (1997) Method for assessing food intakes in terms of servings based on food guidance. Am J Clin Nutr. 65:1254S-1263S.

3. Cook A, Friday JE. Documentation: Pyramid servings database for USDA survey food codes. http://www.barc.usda.gov/bhnrc/cnrg. (Accessed October 2000).

4. Rose D, Oliveira V. (1997) *Validation of a self-reported measure of household food insufficiency with nutrient intake.* US. Department of Agriculture, Economic Research Service, Food and Consumer Economics Division. Technical Bulletin 1863.

5. Cristofar SP, Basiotis PP. (1992) Dietary intakes and selected characteristics of women ages 19-50 years and their children ages 1-5 years by reported perception of food sufficiency. JNE 24:53-58.

6. Rose D, Oliveira V. (1997) Nutrient intakes of individuals from food-insufficient households in the United States. Am J Public Health 87:1956-1961.

7. Casey, P.H., Szeto, K., Lensing, S., Boyle, M., Weber, J. (2001) Children in food-insufficient, low-income families: Prevalence, health, and nutrition status. Arch Pediatr Adolesc Med 155;501-514.

8. Women, Infants, and Children. Frequently Asked Questions. http://www.fns.usda.gov/wic/MENU/FAQ/FAQ.HTM#3 Updated 3/14/01. Accessed May 11, 2001.

9. Standing Committee on the Scientific Evaluation of the Dietary Reference Intakes of the Food and Nutrition Board, Institute of Medicine. (2001). *Dietary reference intakes. Applications in dietary assessment.* Food and Nutrition Board, Institutes of Medicine.

10. *Tips for Using the Food Guide Pyramid for Children 2 to 6 Years Old.* (1999) United States Department of Agriculture, Center for Nutrition Policy and Promotion, Program Aid 1647.

11. *The Food Guide Pyramid* (1992). United States Department of Agriculture. Home and Garden Bulletin 252.

12. Oliveria V, Gundersen C. (2000) WIC and the nutrient intake of children. Food and Rural Economic Division, Economic Research, United States Department of Agriculture. *Food Assistance and Nutrition Research Report No. 5.*

13. *Nutrition and Your Health: Dietary Guidelines for Americans.* (2000) United States Department of Agriculture and United States Department of Health and Human Services. Fifth Edition. Home and Garden Bulletin No. 232.

14. Center for Nutrition Policy and Promotion. Download HEI data (SAS 6.12). http://www.usda.gov/cnpp/hei9496data.htm. (Accessed October 2001).

15. Center for Nutrition Policy and Promotion. Download HEI 1998 for children 2-9 data (SAS 6.12). http://www.usda.gov/cnpp/hei9496data.htm. (Accessed October 2001).

16. Bowman, S.A., Lino, M., Gerrior, S.A., Basiotis, P.P. (1998) The Healthy Eating Index, 1994-1996. Fam Econ and Nutr Review 11:2-14.

17. Kant, A.K., Schatzkin, A., Harris, T.B., Ziegler, R.G., Block, G. (1993) Dietary diversity and subsequent mortality in the First National Health and Nutrition Examination Survey Epidemiologic Follow-up Study. Am J Clin Nutr 57:434-440.

18. Cook A, Friday JE. Pyramid Servings Intakes by U.S. children and Adults 1994-96, 1998. CNRG Table Set No. 1. http://www.barc.usda.gov/bhnrc/cnrg. (Accessed October 2000).

19. *SAS System* under Microsoft Windows, version 8.2. (1999-2001) SAS Institute Inc., Cary NC.

20. Shah BV, Barnwell BG, Biegler GS. (1997) *SUDAAN User's Manual, Release 7.5.* Research Triangle Park, NC: Research Triangle Institute.

21. Carlson S, SJ, Andrews MS, Bickel GW. (1999) Measuring food insecurity and hunger in the United States: Development of a national benchmark measure and prevalence estimates. J Nutr 129;510S-516S.

22. Hamilton WL, Cook JT, Thompson WW, Buron LF, Brongillo EA Jr, Olson CM, Wehler CA. (1997) *Household Food Security in the United States in 1995. Technical Report of the Food Security Measurement Project.* Alexandria, VA: United States Department of Agriculture, Food and Consumer Service, Office of analysis and Evaluation.

VITA

Linda Lou Knol received her Bachelors Degree in Resource Development with an emphasis in Dietetics from the University of Rhode Island. Her Masters Degree in Nutrition, with an emphasis on Public Health Nutrition, was granted by The University of Tennessee, Knoxville. She will also be receiving her PhD in Nutrition from The University of Tennessee, Knoxville.