FOLATE AND IRON INTAKE AND SELECTED NUTRITIONAL PARAMETERS OF WIC AND FOOD STAMP PROGRAM PARTICIPANTS

By

TARYN LARAE HEHL

Bachelor of Science

Oklahoma State University

Stillwater, Oklahoma

1997

Submitted to the Faculty of the
Graduate College of the
Oklahoma State University
in partial fulfillment of
the requirements for
the Degree of
MASTER OF SCIENCE
May, 2002

FOLATE AND IRON INTAKE AND SELECTED NUTRITIONAL PARAMETERS OF WIC AND FOOD STAMP PROGRAM PARTICIPANTS

Thesis Approved:

Kathryn S. Keim
Thesis Advisor

Gail Gates

Estell A. Darke

Timothy J. Pettibone
Dean of the Graduate College

ACKNOWLEDGEMENTS

I would like to thank my thesis advisor, Dr. Kathryn S. Keim, for all of her patience, hard work, and encouragement throughout the research and writing process. I would also like to express my gratitude to my committee members, Dr. Gail E. Gates and Dr. Elizabeth Droke for their ability to stick with me throughout the last few years.

Thank you to my co-workers and family for your support and encouragment. This thesis is dedicated to my parents, Marilyn and Burl Bruce and Jack and Mary Pryor, my sister Misti, and of course, my husband Brett and unborn son.

Lastly, Thank you God for giving me the strength and faith to not give up.

TABLE OF CONTENTS

LIST OF TABLES

CHAPTER I

INTRODUCTION

The percentage of Americans with incomes below the poverty threshold increased during the 1980's and domestic hunger and food-insufficiency re-emerged as a social and political problem (Frongillo et al., 1997) and continued to develop well into the nineties (Alaimo et al., 1998). In 1994, approximately 38 million Americans lived at or below the poverty line. An additional 14 million had incomes at or below 130% of the poverty threshold, which is the income eligibility criterion for the Food Stamp Program (Alaimo et al., 1998).

As the rate of poverty has increased in individual families and in our society, the problem of obtaining an adequate diet has also increased (Emmons, 1986). Although families that are poor spend a larger proportion of their income on food than those with higher incomes, low-income families often have diets that are nutritionally inadequate (Emmons, 1986). This held true for some families even when they were receiving government assistance such as Food Stamps (Emmons, 1986).

Nutrition and Health Issues of Low-Income Women

The relation between low-income status and poor health is well established. Low-income groups are exposed to social and psychological conditions that may have negative effects on nutrient intake, and possess fewer economic resources to manage these unfortunate circumstances (Lynch et al., 1997). Lynch et al. (1997) reported that adults living in poverty are more likely to experience poor nutritional patterns. According to the American College of Obstetricians and Gynecologists Educational Bulletin (ACOG, 1996), a woman's food consumption practices may influence her risk of cardiovascular disease, several types of cancer, diabetes mellitus, and osteoporosis (ACOG, 1996). In general, women eat much less than the recommended amounts of fruits and vegetables, especially if their income is low, therefore limiting their intake of key nutrients such as folate and fiber. The ACOG Educational Bulletin indicated that undernutrition is more prevalent in low-income women of childbearing age whose diets may be low in protein, vitamin A, vitamin C, folate, calcium, and iron. Diets low in iron and folate bring about health concerns of anemia, cardiovascular disease, and neural tube defects.

Significance of Studying Food-Insufficiency Issues

Domestic hunger affects nutrition and health outcomes in part, through decreases in food and nutrient intake. Therefore, documenting the relation among food-insufficiency, nutrient intake, and nutritional status of those affected is an important step in assessing public health risks.

According to the third National Health and Nutrition Examination Survey (NHANES III), conducted between 1988-1994, approximately 9 to 12 million Americans lived in families that reported sometimes or often not getting enough food to eat (Alaimo et al., 1998). This was defined as being food-insufficient. The prevalence of food-insufficiency was higher in those with incomes at or below

130% (PIR=1.30) of the poverty threshold; however, reported food-insufficiency existed even among middle and high-income groups.

Significance of Studying Food Assistance Program Participation

Hunger and malnutrition are directly related to poverty (Physician's Task Force on Hunger in America, 1985) and many people in our society do not have access to food on a regular basis. Families in poverty have too little income to support nutritionally adequate diets (Emmons, 1986; Peterkin et al., 1982).

Food assistance programs are an important approach in assuring that all Americans have access to an adequate, safe, nutritious, and reliable food supply that is obtainable by all individuals at a moderate cost. Food assistance programs are intended to improve food security and dietary quality of their participants by providing access to food (Wilde et al., 2000). In 1999, 18.18 million individuals participated in the Food Stamp Program while 7.31 million participated in the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) (United States Department Agriculture, 2000). These two programs work by increasing the food buying power of their participants. By reducing food-insufficiency and assuring access to food of sufficient quantity and quality, food assistance programs should be able to assist families in meeting their nutritional needs.

Objectives of the Study

The overall objectives of this study were (1) to determine the differences in nutrient intake among low-income women participating and not participating in

WIC and Food Stamp Programs, (2) to determine the differences in nutritional status among low-income women participating and not participating in WIC and Food Stamp Programs, and (3) to identify the prevalence of food-insufficiency among low-income women participating and not participating in WIC and Food Stamp Programs.

Specific questions were identified as being relevant to the purpose. These questions were used to develop the specific hypotheses of the study. The research questions were as follows:

1. What is the difference in folate intake and status among low-income women participating in WIC, Food Stamps, both programs, or neither program?
2. What is the difference in folate intake and status due to women's demographic and socioeconomic characteristics (age, ethnicity, education, and poverty status)?
3. What is the relation between folate intake and folate status?
4. What is the relation between reported food-insufficiency and folate intake and status?
5. What is the difference in iron intake and status among low-income women participating in WIC, Food Stamps, both programs, or neither program?
6. What is the difference in iron intake and status due to women's demographic and socioeconomic characteristics (age, ethnicity, education, and poverty status)?
7. What is the relation between iron intake and iron status?

8. What is the relation between reported food-insufficiency and iron intake and status?
9. What is the relation between reported food-insufficiency status and program participation?
10. What is the relation among food assistance program participation, demographics, food-insufficiency, folate intake and status?

a maximum score of five. One point was counted for each food group consumed. The Serving Score evaluated the subject's intake compared to the desired number of servings from each food group—two servings each from the dairy, meat, fruit, and vegetable groups and four servings from the grain group. Four points were assigned for each food group, with a maximum Serving Score of 20 for the day. An increase in each score indicated an increase in dietary diversity and thus, may lead to a "better" diet. Both the Food Group and Serving Scores increased with increasing income and educational background. Approximately a fourth of individuals with incomes below 146% of the poverty index had a Food Group Score of 5, as compared to 40.9% of individuals with incomes between 356% and 880% of the poverty index. Only 2.2% of the sample with income below 146% of the poverty line received a Serving Score of 20, whereas 3.1% of individuals with income between 356% and 880% of the poverty line received a serving score of 20. The same trend in the Serving Score was observed for increased education.

Jeffery and French (1996) examined the relation between socioeconomic status and weight control practices among women age 20 to 45 years. Socioeconomic status, defined by family income, in relation to dieting practices was examined in an economically diverse sample of 998 women. Income information was obtained from a question requesting total family income. From the subject's responses, five yearly income classes were defined. Other demographic information (race/ethnicity and educational attainment) was incorporated into the analysis along with weight loss history, health behaviors, a maximum score of five. One point was counted for each food group consumed. The Serving Score evaluated the subject's intake compared to the desired number of servings from each food group—two servings each from the dairy, meat, fruit, and vegetable groups and four servings from the grain group. Four points were assigned for each food group, with a maximum Serving Score of 20 for the day. An increase in each score indicated an increase in dietary diversity and thus, may lead to a "better" diet. Both the Food Group and Serving Scores increased with increasing income and educational background. Approximately a fourth of individuals with incomes below 146% of the poverty index had a Food Group Score of 5, as compared to 40.9% of individuals with incomes between 356% and 880% of the poverty index. Only 2.2% of the sample with income below 146% of the poverty line received a Serving Score of 20, whereas 3.1% of individuals with income between 356% and 880% of the poverty line received a serving score of 20. The same trend in the Serving Score was observed for increased education.

Jeffery and French (1996) examined the relation between socioeconomic status and weight control practices among women age 20 to 45 years. Socioeconomic status, defined by family income, in relation to dieting practices was examined in an economically diverse sample of 998 women. Income information was obtained from a question requesting total family income. From the subject's responses, five yearly income classes were defined. Other demographic information (race/ethnicity and educational attainment) was incorporated into the analysis along with weight loss history, health behaviors, and weight control practices. The researchers found that meal skipping was nearly twice as high in the income group that made less than $10,000 per year than it was in the higher income groups. Data also revealed that the individual's mean energy intake and percentage of calories from fat, estimated by the 60-item Block Food Frequency Questionnaire, decreased with increasing income. Mean energy intake (calories per day) for the group with income less than $10,000 was 1915 calories per day, while the group making $40,000 or more had a mean energy intake of 1493 calories per day ($p = 0.0004$). Fat intake for individuals at the low end of the income distribution (< $10,000) was 37% of calories, compared to 33% of calories for individuals at the high end of the income distribution (≥ $40,000). With these results, the authors concluded that economic constraints restrict behavioral options such as access to healthy foods.

Rose and Oliveira (1997A) used 24-hour food recall data from the 1989-1991 Continuing Survey of Food Intakes by Individuals (CSFII) to assess the diets of adult women (19 to 45 years of age). The final analytic sample of adult women included 3774 individuals. The researchers studied intake of energy and 14 other nutrients. The authors also incorporated food-insufficiency data into their analysis. All individuals were placed into the food-sufficient group or the food-insufficient group based on their household respondent's answer to the food-insufficiency questions (Appendix A). Mean nutrient intake among women from food-insufficient households was below two-thirds of the RDA for six nutrients: energy, calcium, iron, vitamin E, magnesium, and zinc.

Emmons (1986) interviewed 76 white and black low-income families weekly for one month. After the participants had received their public assistance and Food Stamp allotments for the month, a 24-hour food recall was obtained each week from each family member so that food intake could be monitored as food-buying resources were depleted. The author calculated an Index of Nutritional Quality (INQ) to relate the density of nutrients to recommended standards. An INQ of 1.0 indicated an adequate supply of that nutrient, whereas, an INQ less than 1.0 indicated an inadequate supply of a given nutrient within the diet of the individual. Calorie consumption per day, measured as a percent of the RDA, was significantly lower in the fourth week as compared to the first week of the month (83.30 ± 54.10 and 90.43 ± 56.55, respectively; $p<.05$). The researcher also found that there were several nutrients (vitamin B-6, vitamin D, vitamin E, iron, calcium, magnesium, zinc, and pantothenic acid) that were below 82% of the RDA for each nutrient both at the first and fourth weeks of the month. Females over the age of 19 had INQs of less than 1.0 for 14 nutrients including iron (0.95), calcium (0.69), and folate (0.53)

Increased Risk of Poor Health as Income Decreases

According to Haggerty and Johnson (1996) adults living in poverty were more likely to experience poor nutritional patterns, receive less adequate medical care, live in overcrowded and unhealthy circumstances, and were more likely to be exposed to environmental risk, infection, and illness. The following section discusses the risk of poor health in relation to low-income.

Pappas et al. (1993) used records from the 1986 National Mortality Followback Survey (n = 13,491) and the 1986 National Health Interview Survey (n = 30,725) to calculate direct mortality rates and indirect mortality ratios for individuals 25 to 64 years of age according to race, sex, income, and family status. Rates were reported per 1,000 deaths. Direct mortality rates were higher for the groups with annual income less than $9,000 as compared to higher income groups. For example, white females with an income under $9,000 had a death rate of 6.5, which was more than 5 times higher than the rate of 1.6 experienced by white females with an income of $25,000 or more. Black women with an income less than $9,000 had a mortality rate of 7.6 as opposed to the rate of 2.3 sustained by black women with an income greater than $25,000. A similar relation was noted for the various educational levels in that as level of education increased, mortality rate decreased.

Lynch et al. (1997) utilized income data collected in 1965, 1974, and 1983 from a representative sample of adults in California to examine the cumulative effect of economic hardship on subjects who were alive in 1994. Incidences of economic hardship were defined as the number of times between 1965 and 1983 that participants reported that total household income was less than 200% of the federal poverty level for the respective year. Associations in this study were evident even though subjects with income below 200% of the poverty level were more likely to have died during the study and therefore not to have been included in the analysis. Selective analysis, which allowed economic hardship to vary with length of survival, demonstrated that subjects whose income was below 200% of the poverty threshold were at increased risk for death over the 29-year study period.

Geronimus et al. (1996) analyzed death certificates and census data to study mortality among blacks and whites 15 to 64 years of age from selected areas of the U.S. Black subjects were selected from New York City, Detroit, Los Angeles, and Alabama. White subjects were selected from New York City, Detroit, Kentucky, and Alabama. From each city, one area of persistent poverty and one higher income area was studied. Annual death rates were presented per 100,000 members of the population, after standardization for age. The death rate for both sexes in every group of poor blacks was excessive. Poor black women living in Harlem had a mortality rate of 759 whereas the higher income comparison group of black women living in Queens-Bronx experienced a death rate of 242. People living in the poor white areas generally had mortality rates exceeding the national average for whites. These poverty areas had higher death rates than the people did in the higher income comparison groups. Poor white women living in the Detroit area had an annual death rate of 428 in contrast to the rate of 121 sustained by the white women living in the higher income comparison group, in Sterling Heights.

Mirwosky and Hu (1996) studied data from the 1990 U.S. Survey of Work, Family, and Well Being (WFW), and the 1979-80 national Survey of Personal Health Practices and Consequences (HP) to evaluate the effect of income on physical impairment. These data sets were chosen because each contained adequate and comparable measures of impairment, income, economic hardship, and exercise, as well as measures of education, sex, race, marriage, and age. Data indicated that physical impairment and its rate of increase rose sharply as household income dropped below the 20^{th} percentile ($p < 0.001$). There was a significant interaction between income and education. Income became less of a factor in physical impairment as level of education increased ($p < 0.001$), illustrating that the combination of low education with low-income sharpens the association between low-income and physical impairment.

Food Insecurity vs. Food-insufficiency

By definition, food insecurity exists "whenever the availability of nutritionally adequate, safe foods, or the ability to acquire personally acceptable foods in socially acceptable ways is limited or uncertain" (FASEB, 1990). Food-insufficiency is defined as an inadequate amount of food intake due to lack of resources (Briefel and Woteki, 1992). In current literature, the term "food insecurity" is being used interchangeably with "food-insufficiency". For years, researchers have been attempting to develop questionnaire-based, self-reported measures to quantify food-insufficiency/food insecurity. Appendices A, B, C, D and E show various sets of questions that have been validated to measure self-reported food-insufficiency/food insecurity. Appendix A describes the food-insufficiency question used in the Continuing Survey of Food Intakes by Individuals (CSFII). NHANES III included a series of questions (Appendix B) in their survey to evaluate resources available to obtain food, however one specific question was used to quantify actual food-insufficiency (Alaimo et al., 1998;

Frongillo et al., 1997). The Community Childhood Hunger Identification Project (CCHIP) food-insufficiency items (Appendix C) focused primarily on the measurement of food-insufficiency in children (Frongillo et al., 1997). The Radimer/Cornell measure of food insecurity (Appendix D) consists of a 10-item questionnaire addressing qualitative and quantitative components of food insecurity at the household and individual level (Frongillo et al., 1997; Radimer et al., 1992; Kendall et al., 1996). A 6-item short form questionnaire (Appendix E) was created from a much longer 18-item questionnaire and analyzed for effectiveness in the research by Blumberg et al. (1999). According to the Blumberg et al. (1999) research, this short form household food security scale accurately identified the level of food security for 97.7% of all households compared to the validated 18-item Core Food Security Module. Even though research in this area has come a long way, there are still conflicting thoughts on the most adequate means of evaluating food-insufficiency/food insecurity, along with differing opinions about the correct usage of the terms. Although great effort has been given to clarify the proper usage of the two terms, for the purpose of the current research, food-insufficiency was used throughout the text.

Increased Food-Insufficiency as Income Decreases

Current research indicates that food-insufficiency is more prevalent in the low-income population as compared to the higher income population (Cristofar and Basiotis, 1992; Alaimo et al., 1998; Rose and Oliviera, 1997A). The following section illustrates the increase in the prevalence of food-insufficiency relative to a decline in income.

Alaimo et al. (1998) used data from the third National Health and Nutrition Examination Survey, 1988-94 (NHANES III) to estimate the prevalence of food-insufficiency in the United States and to examine sociodemographic characteristics related to food-insufficiency. NHANES III classified total family income as a poverty income ratio (PIR). PIR is the ratio of family income to the federal poverty level times 100. For the NHANES III research the authors created income categories using PIR cutoffs. Participants were considered low-income if they had a PIR less than 130%. A PIR of 131% to 185% was classified as low-middle income, 186% to 350% was considered middle income, and above 350% was labeled as high income. A survey participant was classified as "food-insufficient" if the respondent to the family questionnaire reported that the family "sometimes" or "often" did not get enough food to eat. Because the variables included in this analysis were family-level variables, one individual per family was selected to be in the analysis (n=15,000 for total population; n=5258 for low-income population; n=2235 for low-middle-income population). Four percent of the population lived in families that reported “sometimes” or “often” not getting enough food to eat and were considered food-insufficient. Ninety-nine percent of these food-insufficient families reported that the reason for their food-insufficiency was a lack of money. Controlling for other factors, the low-income population had a higher prevalence of food-insufficiency compared to the low-middle-income population (14.0% vs.4.3%, respectively).

Cristofar and Basiotis (1992) analyzed data from the USDA Continuing Survey of Food Intakes by Individuals 1985-86 (CSFII) in order to explore dietary intakes and selected sociodemographic, economic, and health related characteristics associated with self-reported perception of food-insufficiency. The sample consisted of 3,000 households containing at least one female member between 19 and 50 years of age. The sample for this research consisted of 3,398 women because all women were included in the survey that met eligibility criteria. Survey data included information on individual and household characteristics as well as on food and nutrient intakes of age eligible women. Three food-sufficiency categories were created by using the participant's responses to the food-insufficiency questions (Appendix A). Group 1 = Always enough food, Group 2 = Not always the type of food wanted, and Group 3 = Sometimes/often not enough to eat. Weekly household income for those reporting "not enough to eat" was significantly lower ($p \leq 0.01$) than the reported income for the rest of the sample. Reported weekly household income was $178.30, $173.11, and $156.04 for groups 1, 2 and 3, respectively.

Rose and Oliveira (1997A) reported that household income was lower for individuals from food-insufficient households in all age groups studied. Women aged 19-50 from food-sufficient households reported a mean household per capita income of $14,000, while women from food-insufficient households reported an income of $4,200.

Hamilton et al. (1997) utilized the Current Population Survey (CPS) data from the U.S. Bureau of Census to report the first national prevalence estimates of food-insufficiency and hunger. The U.S. Bureau of Census conducted the first Food Sufficiency Supplement to its regular CPS in 1995. Analysis of these data measured the underlying level of severity of food-insufficiency and hunger experienced in U.S. households (Hamilton et al., 1997). According to the researchers, food-insufficiency is clearly related to income and poverty. More than 1/3 of poor households were classified as food-insufficient, while only 8% of households with incomes above the poverty lines were food-insufficient. Hamilton et al. (1997) showed that 17% of households with incomes less than 50% of the poverty level were affected by some form of food-insufficiency, whereas, the rate falls to 1.4% for those with incomes greater than 185% of the poverty level.

In order to identify factors contributing to food-insufficiency in rural upstate New York, Olson et al. (1997) conducted two personal interviews with 193 women between the ages of 20 and 40 years who had less than 16 years of education and had children living at home. During the first interview, the researchers gathered information on sociodemographic characteristics, methods of obtaining food, food program participation, household expenditures, and administered the Radimer/Cornell hunger and food insecurity items (Appendix D).

The household food inventory was repeated at the second interview approximately three weeks later. The Radimer/Cornell measure was used as one of the dependent measures of food-insufficiency in this study. Any household that had a positive response to one or more of the questions was defined as food-insufficient. The remaining households were defined as food-sufficient. The sociodemographic factor, annual income, was grouped into six categories: <$5,000, $5,000-$10,000, $10,000-$15,000, $15,000-$20,000, $20,000-$25,000, >$25,000. According to the results from Chi-square analysis, as income decreased there was an increase in the percentage of families that reported food-insufficiency.

Relation Between Demographic Factors and Food-Insufficiency

According to Alaimo et al. (1998) prevalence of food-insufficiency in the total population was highest among Mexican-Americans (15.2%), next highest among the non-Hispanic black population (7.7%), and lowest among non-Hispanic white individuals (2.5%). In the low-income population, 24.8% of Mexican-Americans, 13.5% of non-Hispanic black Americans, and 11.8% of non-Hispanic white Americans lived in families reporting food-insufficiency. Food-insufficient individuals lived in larger families than food-sufficient individuals both in the over-all population (mean 4.3 vs. 3.4 family members, respectively) and in the low-income population (4.7 vs. 4.0 family members, respectively).

Cristofar and Basiotis (1992) reported that the factors affecting the prevalence of food-insufficiency should not be considered independently, but rather treated as a group of factors that contribute to the increased probability of reported food-insufficiency. Therefore, according to the researchers, the more characteristics possessed by an individual, the higher the probability of food-insufficiency. Household size and available economic resources were the best predictors of food-insufficiency. According to results of this study, a woman most likely reported food-insufficiency if she was black or Asian, didn't own her home, and lived in a large household. A food-insufficient woman was also less likely to attend college.

Family heads of food-insufficient families were less likely than food-sufficient family heads to be high school graduates (42.7% vs. 75.7%, respectively) (Alaimo et al., 1998). Olson et al. (1997) discovered that as education increased, food-insufficiency decreased ($p < 0.01$). Forty-six percent of food-insufficient individuals were high school graduates while only 8% of food-insufficient subjects were college graduates. According to the research of Rose and Oliveira (1997A), household income and educational level of the household head were lower for individuals from food-insufficient households.

Increased Risk of Low Iron Intake and Poor Status as Income Decreases and Food-Insufficiency Becomes More Prevalent

Based on the Third Report on Nutrition Monitoring in the United States (Federation of American Societies for Experimental Biology, 1995), iron needs vary depending on age and physiological state. Iron needs are particularly high during periods of rapid growth, such as the prenatal period, infancy, adolescence, and in women during their childbearing years (National Research Council, 1989).

Iron deficiency is the most prevalent nutrient deficiency in American women (Federation of American Societies for Experimental Biology, 1995).

Although the prevalence of iron deficiency appears to have declined in recent years, it remains relatively high in vulnerable groups such as women of childbearing age. Iron deficiency occurs in three stages: (1) depletion of iron stores, (2) decreased circulation of iron measured by transferrin saturation or erythrocyte protoporphyrin, and (3) iron deficiency anemia, characterized by decreased serum ferritin, transferrin saturation, hemoglobin, and mean corpuscular volume, and increased erythrocyte protoporphyrin. According to the results of the third National Health and Nutrition Examination Survey 1988-94 (NHANES III), the prevalence of iron deficiency (possessing an abnormal value for at least 2 of 3 tests for erythrocyte protoporphyrin, serum ferritin, or transferrin saturation) was 11% for young adult women and iron deficiency anemia was reported as 5% (Looker et al., 1997). Iron deficiency anemia was defined as iron deficiency plus low hemoglobin.

The higher risk of low-income individuals for nutritional inadequacy coupled with women's increased iron needs places low-income women at an increased risk for iron deficiency. According to Rose and Oliveira (1997A), mean iron intake, as measured by a percentage of the 1989 RDA, was below the Recommended Dietary Allowance (RDA) among women from food-insufficient households. Rose and Oliveira (1997A) concluded that food-insufficiency affects nutrition and health outcomes, at least in part through decreased nutrient intake. The following section will show how iron intake and iron status diminish as the prevalence of food-insufficiency increases in the low-income population.

Rose and Oliveira (1997A) reported that intake for several nutrients was significantly lower ($p < 0.05$) in food-insufficient women than the food-sufficient group. Food-insufficient women's iron intake was 67% of the1989 RDA compared to food-sufficient women's iron intake of 79% of the 1989 RDA.

According to Emmons (1986), when nutrient intakes were compared to the RDA, diets of low-income families were found to be inadequate in eight nutrients including iron. This was not only a finding toward the end of the month, but also at the beginning. When a 24-hour recall was administered during the first and last week of the month, iron was inadequately supplied in the diet in both weeks. The diet of week one supplied 81.74% $\pm$ 55.72% of the RDA and week four supplied 81.29% $\pm$ 58.20 % of the RDA.

Rose and Oliveira (1997B) examined the validity of a self-reported measure of food-insufficiency using nutrient intake data from the 1989-91 Continuing Survey of Food Intake by Individuals (CSFII). Food-insufficient households were defined as those reporting that they sometimes or often did not get enough to eat (n=299); the rest of sample households were classified as food-sufficient (n=5,844). Nutrient adequacy ratios were calculated for 15 nutrients and averaged at the household level using intake data obtained from 24-hour dietary recalls and age- and sex-specific RDA's. Multiple regression analysis was used to study the association of food-insufficiency with indicators of nutrient intake while controlling for other demographic influences on dietary patterns. Mean intake of energy for food-insufficient households was 68.3% of the Recommended Energy Intake and was significantly ($p < 0.05$) lower than the energy consumption by the food-sufficient households. Results indicated a significant difference in iron intake, measured as a percentage of the RDA, between the food-sufficient and food-insufficient groups (124.2% and 99.3%, respectively, $p < .05$).

Cristofar and Basiotis (1992) found that 19-50 year old women from households reporting food-insufficiency had significantly lower nutrient intakes than those from food-sufficient households ($p \leq 0.01$). Iron intake was 10.6 mg per day for the groups reporting food-sufficiency, while iron intake decreased to 9.8 mg per day for the food-insufficient group. Kendall et al. (1996) also found iron intake to be lower in the food-insufficient group than in the food-sufficient group.

Looker et al. (1997) used data from the third National Health and Examination Survey 1988-94 (NHANES III) to determine the prevalence of iron deficiency and iron deficiency anemia in the US population. The sample used in this study was restricted to 24,894 males and non-pregnant females aged 1 year and older for which there were data for the biochemical indicators of iron status used in the NHANES III study. Iron deficiency was defined as having an abnormal value for at least 2 of 3 laboratory tests of iron status (erythrocyte protoporphyrin, transferrin saturation, or serum ferritin). Iron deficiency anemia was defined as iron deficiency plus low hemoglobin. Demographic variables were also included in the analysis to assist in the description of the population. Eleven percent of the female population aged 20-49 years were iron deficient and 5% were anemic. Iron deficiency was more common among poor women with incomes less than 100% of the poverty threshold (PIR = 1.00) than non-poor women with incomes greater than 100% of the poverty level (PIR > 1.00).

An Expert Scientific Working Group (1985) evaluated the iron nutritional status of the US population based on biochemical data for persons aged 1 through 74 years in the second National Health and Nutrition Examination Survey, 1976-80. Three approaches were used to estimate the prevalence of low iron status. The first (ferritin model) required that at least 2 of 3 indicators be abnormal (serum ferritin, transferrin saturation, erythrocyte protoporphyrin). A second approach (MCV model) used mean corpuscular volume instead of ferritin. This model also required at least 2 of 3 indicators to be abnormal. Finally, the change or shift in the median hemoglobin concentration (50^{th} percentile) of a population after excluding individuals with one or more abnormal values was referred to as the hemoglobin percentile shift. The association of impaired iron status with socioeconomic and demographic variables was also examined. Researchers found that iron status of those below the poverty level was associated with higher prevalence estimates of poor iron status. Using the ferritin model, the prevalence of abnormal values was 14% higher for females aged 15-19 years with income below the poverty level than for those above the poverty level. This difference approached statistical significance ($p< 0.10$). Using the MCV model, a higher prevalence of abnormal values was associated with poverty. These differences were statistically significant ($p< 0.05$) for females aged 15-19 years, and approached significance ($p< 0.10$) for females aged 20-44 years.

Relation Between Demographic Factors and Iron Intake and Status

Emmons (1986) found that both white and black low-income women had an iron intake less than 100% of the RDA in week one (80.97 ± 55.47 % vs. 82.10 ± 56.14%, respectively) and week four (75.31 ± 44.18% vs. 83.73 ± 63.27%, respectively). Black women, when considered separately, had a higher total iron intake than white women, but were still below 100% of the RDA. When nutrient density of the diet was analyzed, results indicated that the diets of the black women were significantly denser ($p < 0.01$) in iron than the white women.

Looker et al. (1997) found iron deficiency to be twice as high or greater ($p < 0.001$) in minority women as compared with white women. Iron deficiency was also more common among women with less education. Prevalence of iron deficiency was highest among women aged 16-49 years (11%). Researchers concluded that those most at risk for iron deficiency were women of childbearing age who were black or Mexican-American, poor, and had 12 or fewer years of education.

Frith-Terhune et al. (2000) used data from NHANES III to estimate the prevalence of iron deficiency anemia between Mexican-American and non-Hispanic white females aged 12-39 years. Iron deficiency anemia was defined as abnormal results from 2 of 3 tests (erythrocyte protoporphyrin, transferrin saturation and serum ferritin) and a low hemoglobin concentration. Results indicated that after adjustment for poverty level, parity, and iron supplement use, the prevalence of iron deficiency anemia was 2.3 times higher in Mexican-American than in non-Hispanic white women.

Cook et al. (1974) evaluated iron status of 1564 subjects living in the northwestern United States by measurements of transferrin saturation, erythrocyte protoporphyrin, and serum ferritin. Individual measurements of iron status were considered to be abnormal at the following levels: transferrin saturation below 15%, erythrocyte protoporphyrin above 100 μg/dl, and serum ferritin below 12 ng/ml. The presence of at least two abnormal parameters indicated iron deficiency. Iron-deficiency anemia was considered present when in addition to this; the hemoglobin level in adult females was less than 12 g/dl. As expected by the researchers, the highest incidence of iron deficiency was observed in premenopausal women aged 18-45 years (20%), as compared with an incidence of less than 3% in male subjects of the same age.

Results from an Expert Scientific Working Group (1985) indicated that women in the NHANES II (1976-80) study, aged 20-44 years, had a relatively high prevalence of low iron status. The highest prevalence of abnormal values using the ferritin model was found in non-pregnant women aged 15-19 years (14.2%). Black women tended to have a higher prevalence of abnormal values than did white women, suggestive of impaired iron status. This difference was statistically significant ($p < 0.05$) for females aged 15-19 years. Some association between higher prevalence of abnormal values and lower levels of education was seen for females aged 20-44 years using both the ferritin and MCV models.

Increased Risk of Low Folate Intake and Poor Status as Income Decreases and Food-Insufficiency Becomes More Prevalent

It is well established that maternal requirements for most nutrients increase during pregnancy (Whitney and Rolfes, 1996). Increasing evidence from human studies indicate a link between low maternal intakes of vitamins and minerals, and poor outcomes for both mother and infant (Milunsky et al., 1989; Picciano, 1997). For instance, maternal deficiencies of iron, folate, and B_{12} can lead to anemia, which is associated with increased risk for low birth weight and pre-term delivery. According to the results of NHANES II, the prevalence of low folate status was greatest in females (including pregnant women) ages 20-44 years (Yetley and Johnson, 1987). Folate deficiency can lead to repression of DNA synthesis, impaired cell division, and alterations in protein synthesis; hence, folate is considered to be a potential public health issue (Federation of American Societies for Experimental Biology, 1989). A primary concern is that females with a marginal folate status have increased risk of giving birth to infants with neural tube defects (NTD), such as spina bifida. Multivitamin supplementation, before conception, that includes folic acid at a level of 0.4 mg/day has been shown to reduce the occurrence of neural tube defects and other congenital abnormalities (Daly et al., 1995; Rush, 1994).

Folate is not only important in preventing NTD's, but studies indicate that folate is also linked with a decreased risk of cardiovascular disease (Tucker et al., 1996). Evidence suggests that low folate concentrations are associated with elevated homocysteine levels in the blood. Homocysteine is an amino acid that is produced when the body breaks down the essential amino acid methionine (Selhub et al., 1993). Folate and vitamin B_{12} assist in recycling homocysteine back into methionine, therefore if consumption of either of these vitamins is low; homocysteine levels rise in the blood (Selhub et al., 1993; Appel et al., 2000). Research varies on what is considered to be high levels of homocysteine, however several studies have found an increased risk of cardiovascular disease if the levels range from 9-14 mmol/L (Refsum, 1998; Graham et al., 1999).

Among the women at greatest risk for vitamin under nutrition during their reproductive years are those with limited resources for food purchasing (Graham et al., 1997). Data from the 1985-86 CSFII showed that mean folate consumption was below the 1989 RDA for about 50% of women whose income was less than 130% of the federal poverty level (Cristofar and Basiotis, 1992). Based on evidence that folate intake was low in the U.S. population and that low intake and low blood levels can result in birth defects and increased risk of heart disease, the Food and Drug Administration recently required cereal grain products to be fortified at the level of 140 μg/100 g product (FDA, 1996).

Rose and Oliviera (1997A) found that food-insufficiency, net of other factors that influence the diet, was significantly related to lower nutrient intakes ($p < 0.05$). When controlling for confounding factors using multiple regression, the researchers discovered that in the total population folate intake was 15.4% lower ($p < 0.01$) in the food-insufficient households than in the food-sufficient households. However, folate intake was above 100% of the 1989 RDA (200 μg) for both food-insufficient and food-sufficient groups of women (102.2% vs.

115.5%, respectively). Although folate intake was above 100% of the 1989 RDA, it was still below the current RDA of 400 μg. This data was collected before fortification.

Lutz et al. (1996) and Kendall et al. (1996) discovered similar results in their studies. They both found that the frequency of consumption of fresh fruits, fruit juices and vegetables declined and food-insufficiency was more prevalent as income decreased. Results from Lutz et al. (1996) indicated that low-income households consumed 21% less fresh fruits and 13% less vegetables than the national average. Kendall et al. (1996) found that the frequency of consumption of vegetables was significantly lower ($p = 0.007$) in the food-insufficient households as compared to the food-sufficient households (7.1 vs. 8.0 times/week, respectively). Frequency of consumption of fruit and green salad was also significantly lower ($p < 0.001$) in the food-insufficient group when compared to the food-sufficient group (3.6 vs. 6.0 times/week and 2.3 vs. 2.9 times/week, respectively). Data from Lutz et al. (1996) and Kendall et al. (1996) was collected before fortification.

According to Cristofar and Basiotis (1992), as food-insufficiency worsened, women's intake of fruits and vegetables significantly decreased ($p \leq 0.01$). Fruit and vegetable intake was 273 g in the group that reported always having enough food and the kind wanted, while intake of fruits and vegetables fell to 231 g in the group that reported sometimes or often not having enough food to eat. As intake of fruits and vegetables diminished so did folate intake. Results indicated that women's folate intake was 198.2 μg/day in the group that reported always having enough food and the kind wanted, and was 168.9 μg/day in the group that reported sometimes or often not having enough food to eat ($p \leq 0.01$).

Effect of Folate Intake on Plasma Homocysteine

According to Brouwer et al. (1999), an elevated plasma homocysteine concentration is a risk factor for cardiovascular disease and neural tube defects (NTD). Folate helps reduce plasma homocysteine concentrations by helping to recycle it back into methionine, therefore an increase in folate intake is beneficial in reducing the risk of heart disease and occurrence of NTD's. Brouwer et al. (1999) studied the effect of a low-dose folate supplementation on plasma homocysteine concentrations in healthy, nonpregnant women aged 18-40. The women were randomly divided into three intervention groups: 500 μg folic acid/day (500 μg group), 500 μg folic acid every other day (250 μg group), and a placebo group. Subjects were asked to maintain their regular diet, but were instructed to avoid liver and marmite, a yeast extract. A 24-hour dietary recall was taken once during the 4-week trial to check their intake of macronutrients and folate. Fasting blood samples were collected at baseline and after week 1, 2, and 4 of the intervention; and then again 4 and 8 weeks after the study period ended. Results indicated that plasma and red blood cell folate concentrations increased significantly in the 2 treatment groups as compared to the placebo group. The increases in plasma folate were significantly higher in the 500 μg group than the 250 μg group ($p < 0.001$). After four weeks of supplementation with 500 μg every other day (250 μg group), plasma total homocysteine decreased by 11.4% compared to 0.8% in the placebo group ($p < 0.001$). Plasma total homocysteine decreased 21.8% in the 500 μg group.

Premenopausal black women have a greater rate of coronary artery disease (CAD) than do premenopausal white women, therefore a study was conducted by Gerhard et al. (1999) to compare plasma total homocysteine and folate concentrations in 89 black and 90 white, healthy, premenopausal women. Mean plasma total homocysteine concentrations were significantly higher ($p = 0.013$) in black than in white women (8.80 $\pm$ 3.38 μmol/L and 7.81 $\pm$ 2.58 μmol/L, respectively). A greater percentage of black (44.9%) than white (24.4%) women had low (<3.4 μmol/L) or low-normal (3.4-5.9 μmol/L) plasma folate concentrations ($p = 0.006$). The median intake of ready-to-eat cereals was significantly higher in white than in black women ($p = 0.007$). A significantly higher percentage of white (42.4%) than black (24.7%) women consumed a daily multivitamin supplement containing folate ($p = 0.019$).

Appel et al. (2000) studied the effect of dietary patterns on serum homocysteine during an eleven-week trial. During the first 3 weeks of the study, the 118 participants, 22 years of age or older, were fed a control diet, low in fruits, vegetables, and dairy products with a fat content typical of the US diet. During the 8-week intervention phase, participants were then randomly assigned diets: the control diet, a diet rich in fruits and vegetables but otherwise similar to the control, and a combination diet high in fruits and vegetables and low-fat dairy products and reduced in fat. At the end of the intervention phase, mean decrease in homocysteine was significantly greater in the combination diet group as compared to the control group (-0.8 μmol/L; p=0.03). The fruits and vegetables group also experienced a decrease in serum homocysteine when compared to the control group, however this decrease was not statistically significant. A change in homocysteine was significantly and inversely associated with change in serum folate (p= 0.03), whereas, an increase in serum folate contributed to a decrease in serum homocysteine concentrations. This research indicated that modification of dietary patterns could change serum homocysteine.

Rasmussen et al. (2000) used data from the Danish Investigation of Iodine Intake and Thyroid Diseases (DanThyr) to investigate the association between folate intake, folate status, dietary and lifestyle factors, and homocysteine concentrations in women aged 25-30 years and 60-65 years. Homocysteine concentrations were measured in 290 women from the younger group and 288 women from the older group. Participants also completed questionnaires about lifestyle and health factors, as well as use of vitamin supplements. Red blood cell folate was measured in 204 subjects and dietary records were obtained from 258 participants. Mean homocysteine concentrations were significantly higher in the older group than the younger group (9.4 μmol/L and 7.6 μmol/L, respectively, p<0.001), however both groups had homocysteine concentrations below the level indicative of high concentrations (14 μmol/L). Folate intake from diet tended to be lower in the older group than the younger group (268 μg/d and 283 μg/d, respectively), however this was not statistically significant.

Riddell et al. (2000) performed a randomized, controlled trial to determine the most appropriate means of increasing dietary folate to reduce plasma homocysteine. Researchers compared three approaches for increasing dietary folate to approximately 600 μg/d in subjects aged 36-71 years with homocysteine concentrations ≥ 9 μmol/L: folic acid supplementation, consumption of folic acid fortified breakfast cereals, and increased consumption of folate-rich foods. Results indicated that an intake of 437 μg folic acid/d from supplements resulted in a 21% reduction in homocysteine. Intake of folic acid fortified breakfast cereal resulted in a 298 μg/d increase in dietary folate, and a 24% reduction in homocysteine concentrations. In subjects who consumed folate-rich foods, folate intake increased by 418 μg/day, and homocysteine decreased by 9%.

Relation Between Demographic Factors and Folate Intake and Status

Emmons (1986) found that the intake of folate was at or above 100% of the RDA for both the black and white women during the first week of the month, and fell to below 100% of the RDA during the fourth week of the month. These differences approached significance. Black women consumed a higher percentage of the RDA for folate in both weeks one and four as compared to the white women (black women week one: 103.89 ± 98.43% vs. white women week one: 100.93 ± 115.58%, and black women week four: 95.87 ± 98.29% vs. white women week four: 82.07 ± 78.24%). Recalling from the research by Emmons that an Index of Nutritional Quality (INQ) of less than 1.0 indicated an inadequate supply of a given nutrient in the diet of the individual, the female group aged 12-19 years had an INQ for folate of 0.59. The female group over the age of 19 had an INQ for folate of 0.53.

Lewis et al. (1999) updated 2 national food consumption surveys, CSFII (1994-1996) and NHANES III (1988-1994), to estimate folate intakes as a result of the recently initiated food fortification program. Adjustments were made to food-composition data by using information about food ingredients and characteristics. After both surveys were updated, total folate intake was estimated for several sex and age groups. Results indicated that approximately 68-87% of females of childbearing age had folate intakes below the recommended intake of 400 μg/d.

Ford and Bowman (1999) utilized data from NHANES III to examine the relation between educational attainment and serum and red blood cell folate concentrations in non-Hispanic white, non-Hispanic black, and Mexican-American men and women aged 17 years and older. Results from analysis of NHANES III data indicated that non-Hispanic white women had significantly higher serum and red blood cell folate concentration (18.4 and 515.9 nmol/L, respectively) than did non-Hispanic black women (16.3 and 415.4 nmol/L, respectively) or Mexican-American women (15.9 and 455.7 nmol/L, respectively) ($p < 0.001$).

Intervention studies by Cuskelly et al. (1996) examined the response of red blood cell folate to intervention with additional dietary folate or supplemental folic acid in amounts up to the recommendation of 400 μg/d. Cuskelly et al. (1996) randomly assigned female subjects to receive one of the following regimens in addition to their usual dietary folate intake: folic acid supplements (0.4 mg/d); folic acid fortified foods (0.4 mg/d); natural food folates (0.4 mg/d);

dietary advice; or no intervention. Females receiving folic acid supplements or folic acid fortified foods had significantly higher red blood cell folate concentrations post intervention as compared to preintervention concentrations ($p < 0.01$).

Jacques et al. (1999) utilized data from phase 2 of NHANES III to describe the distribution of serum homocysteine concentrations in the United States and to determine the difference in homocysteine concentrations among sex, age, and race-ethnicity groups. Results indicated that age adjusted mean homocysteine concentrations were significantly lower in Mexican-American women (7.4 μmol/L) than in non-Hispanic white (7.9 μmol/L)and non-Hispanic black women (8.2 μmol/L) ($p < 0.01$).

Effects of Food Assistance Program Participation on Food and Nutrient Intake and Status

Food assistance programs are intended to improve food security and dietary quality of their participants by providing access to food. Food stamp benefits are distributed for used at retail stores to purchase only food and nonalcoholic beverages. WIC participants receive a voucher for use in purchasing specific authorized foods selected for their nutritional content. WIC foods are high in one or more of the following nutrients: protein, calcium, iron, vitamin A, or vitamin C. The WIC program also provides nutrition counseling and access to health services to low-income women, infants, and children. Wilde et al. (2000) used data from the Continuing Survey of Food Intake by Individuals, 1994-96 (CSFII) to estimate the effect of Food Stamp Program and WIC participation on dietary quality. The detailed food intake data from CSFII were used to determine pyramid servings consumed. Intake of added sugars and added fats were significantly greater in Food Stamp Program participants ($p= 0.05$, $p= 0.05$, respectively), while a greater intake of meats approached significance in Food Stamp Program participants ($p= 0.10$). Vegetables and dairy product intake tended to be slightly increased in those who participated in the Food Stamp Program, however this effect was not statistically significant. Participation in the WIC program also tended to have a positive effect on intake of fruits and dairy, again however, this was not statistically significant.

Rose et al. (1998) utilized data from the 1989-1991 Continuing Survey of Food Intakes by Individuals (CSFII) to examine the effects of household participation in the Food Stamp and WIC programs on the nutrient intakes of preschoolers age 1-4 years. CSFII collected up to three consecutive days of dietary data on individuals. Information for preschoolers was obtained by the household respondent. Nutrient intakes were expressed as nutrient adequacy ratios (the intake of a nutrient by an individual divided by the recommended dietary allowance and then expressed in percentage terms). Results indicated that participation in WIC positively influenced iron intake ($p< 0.05$). The average increase in iron intake due to WIC participation was 16.6% of the preschooler RDA, and the average increase in iron intake due to participation in the Food Stamp Program was 12.3% of the preschooler RDA ($p< 0.05$).

Over a two year period, Havas et al. (1998) implemented an intervention program among women served by 16 WIC sites. Using a randomized crossover design, eight sites were randomized to the intervention group and eight to the control group. To be eligible, women were 18 years of age or older and enrolled in the WIC program or have children enrolled. They also were to be enrolled at the site for at least 6 months. Two types of nutrition education was delivered to intervention participants: (1) brief messages regarding increasing fruit and vegetable consumption given at the time of enrollment in the program and (2) a series of three group discussion sessions. Four months into the study, the intervention sites became control sites and vice versa. This began phase 2 of the study. Persons enrolled in phase 1 were ineligible to participate in phase 2, therefore no significant contamination effects occurred at the sites. Evaluation of fruit and vegetable intake was completed using a self-administered pre and post survey containing questions regarding fruit and vegetable intake as well as demographic characteristics. Results indicated that two months post-intervention, mean daily fruit and vegetable consumption had increased by 0.56 ± 0.11 servings in intervention participants and 0.13 ± 0.07 servings in control participants ($p= 0.002$).

Pehrsson et al. (2001) examined the benefits of participation in WIC in terms of postpartum iron status in nonlactating women. Biochemical tests for iron status (plasma ferritin, transferring receptor, and hemoglobin) as well as information on dietary iron intake was obtained from 57 WIC participants and 53 eligible nonparticipants. Subjects were followed bimonthly over six months postpartum. At the end of six months, the mean hemoglobin concentration of participants was significantly higher than that of nonparticipants (8.01 ± 0.12 and 7.63 ± 0.12 mmol/L, respectively; $p < 0.05$) and the prevalence of anemia was significantly lower (17% and 51%, respectively; $p < 0.05$)

CHAPTER III

METHODOLOGY

Overview and Design of Study

This study was designed to evaluate factors that directly or indirectly affect iron and folate intake and status in low-income women. The objectives of this study were 1) to determine the differences in nutrient intake among low-income women participating and not participating in WIC and Food Stamp programs, 2) to determine the differences in nutritional status among low-income women participating and not participating in WIC and Food Stamp programs, and 3) to identify the prevalence of reported food-insufficiency among low-income women participating and not participating in WIC and Food Stamp programs. This study analyzed data from the 1991-1994 (phase 2) third National Health and Nutrition Examination Survey (NHANES III). Nutrition data from NHANES III are vital to nutrition monitoring and public health.

Description of the NHANES Sample and Data Collection

NHANES III, conducted in 2 phases between 1988 and 1994, was a cross sectional representative sample of the United States population. The goals of NHANES III were:

1. To estimate the national prevalence of selected diseases and risk factors.
2. To estimate national population reference distributions of selected health parameters.
3. To document and investigate reasons for secular trends in selected diseases and risk factors.
4. To contribute to an understanding of disease etiology.
5. To investigate the natural history of selected diseases.

These goals made NHANES the optimal source of secondary data for the research presented here.

The sample for the NHANES III was selected from 81 counties across the United States. Approximately 40,000 persons 2 years of age and over were selected and asked to complete an extensive interview and a physical examination in a large mobile examination center (MEC). Mexican-Americans, black Americans, children younger than 5 years, and persons 60 years of age and older were over-sampled to provide more reliable estimates.

Mobile Examination Center Data Collection

Four types of data collection methods were employed in the Mobile Examination Center (MEC). A professional expert examiner performed the direct physical examination (the physician's and dental exam). Tests and measurements such as radiography, electrocardiography and body measurements, done by health technicians and ultrasonographers represent a second method. The third method of data collection was interviewing. This component was used to collect nutrition-related information as well as other personal and demographic data. With the help of food models to prompt subjects to identify portion sizes of foods consumed, dietary interviewers obtained 24-hour dietary recall and food frequency information. The fourth method of gathering data in the MEC was specimen collection. Blood and urine samples were collected and prepared for analysis and the blood samples were tested for certain hematological assessments. After completing the examination, subjects were compensated with a cash payment of $15.

Home Examination Data Collection

The home examination was designed to gather information on persons in their own homes, who could not participate in data collection in the MEC. This examination was a subset of the components normally performed in the MEC. Blood samples were collected, however urine specimens were not. Participants who were 60 years of age or older and were found by the examiners to be bed bound or in wheel chairs were automatic candidates for the home examination. This examination lasted 30-60 minutes, and the home examiner awarded the participant a cash payment of $15. The examiner then returned to the MEC to process the blood specimen.

Study Sample

Non-pregnant women, 17-45 years of age with incomes at or below 185% of the poverty level for the years 1991-1994, who participated in the second phase of NHANES III, were selected as the sample for this research. Phase 2 was chosen due to the availability of biochemical data for homocysteine and vitamin B_{12}. Only one woman per family was included in the sample. The exclusion criteria was men, women less than 17 years or over 45 years of age, women who participated in the first phase of NHANES III, women who were not examined, women who were pregnant at the time NHANES III was conducted, and women with incomes higher than 185% (PIR=1.85) of the 1991-1994 poverty guidelines. A subject was determined as being in poor B_{12} status if her hemoglobin was less than 12 g/dL and her MCV was greater than 100 fL. These subjects were then excluded from the sample.

Qualification of Low-Income

During the family interview component of NHANES III, a responsible adult provided information about family characteristics such as employment status, family size, and income (USDHHS, 1994). Total family income for the previous 12 months was assigned to a category ranging from less than $1,000 to $80,000 and over. Categories were in $1,000 increments below $19,999, in $5,000 increments between $20,000 and $49,999, and $10,000 increments between $50,000 and $79,999. Poverty income ratio (PIR) was calculated by dividing the midpoint of the family income category by the poverty threshold the year in which the interview occurred and the family reference person's age. The family reference person was the person who responded to the family questionnaire. The poverty threshold values came from the census bureau and are adjusted annually for inflation. Using the PIR instead of annual income allows for comparisons across all six years of the NHANES. PIR data has a high potential for bias because of nonresponse (USDHHS, 1994).

For the present research a PIR $\leq$ 1.85 (185% of the poverty guidelines) was a cutoff value indicative of low-income. This guideline was chosen based on the federal assistance program eligibility criteria for the Food Stamp Program (< 130% of poverty guidelines, PIR=1.30) and for the WIC Program (< 185% of poverty guidelines, PIR=1.85) (Alaimo et al., 1998; Rose et al., 1998).

A subject was classified as a Food Stamp Program participant if the respondent to the family questionnaire or a family member reported receiving Food Stamps in the past twelve months. The same criteria were used to classify individuals as WIC participants (Alaimo et al., 1998).

Variable List

The completed data set for this study included data from the adult household questionnaire data file, the examination data file, and the laboratory data file. Data included in the adult household data file were demographic variables such as age, sex, ethnicity, family size, family identification number, income, rural/urban classification, and poverty income ratio. Also found in this data file were questions pertaining to educational attainment, food-insufficiency, and food assistance program participation. Weight and Body Mass Index (BMI) were among the variables obtained from the examination data file. Other data found in the examination data file included additional questions about food assistance program participation and food-insufficiency, as well as inquiries on current health conditions, specifically pregnancy status. Biochemical markers indicative of iron, folate, and B_{12} status were taken from the laboratory data file. A final completed data set was created from all variables. Individuals who did not meet the inclusion criteria were excluded from the analysis.

Data Processing Procedures

Iron Status

Iron status was quantified using the same methods as NHANES III. Iron deficiency was determined by an abnormal value for at least 2 of 3 tests for erythrocyte protoporphyrin, serum ferritin, or transferrin saturation (Looker et al., 1997; Looker et al., 1995).

Protoporphyrin, a constituent of heme, normally occurs in erythrocytes in very low concentrations (Gibson, 1990; Langer et al., 1972; Lee and Nieman, 1996). In the second stage of iron deficiency, when iron stores are completely exhausted, protoporphyrin accumulates in the developing red blood cells because the supply of iron is not adequate for the synthesis of hemoglobin. Therefore, a rise in erythrocyte protoporphyrin is a sensitive indicator of an inadequate iron supply (Gibson, 1990). An erythrocyte protoporphyrin concentration of greater than 70 μg/dL (1.24 μmol/L) of red blood cells is indicative of iron deficiency. This was the cutoff used for assessing the prevalence of iron deficiency in adults in the NHANES II survey (Pilch and Senti, 1984) as well as NHANES III (Looker et al., 1997).

Ferritin, the primary storage form of iron in the body, is found primarily in the liver, spleen, and bone marrow (Lee and Nieman, 1996). Measurement of serum ferritin is the most sensitive test available for the detection of iron deficiency. In most individuals the concentration of serum ferritin parallels the total amount of storage iron (Cook et al., 1974). Consequently, as iron stores become depleted, ferritin levels decrease. A serum ferritin value of less that 12 μg/L was the cutoff value used to indicate iron deficiency. This was the same value employed in the analysis of NHANES II (Pilch and Senti, 1984) and III (Looker et al., 1997).

Iron is transported in the blood bound to transferrin, a protein molecule synthesized in the liver. Total Iron Binding Capacity (TIBC) measures the amount of iron capable of being bound to proteins such as transferrin while, serum iron is a measure of the amount of iron actually bound to transferrin (Lee and Nieman, 1996). Transferrin saturation is calculated using the following formula:

$$\text{Transferrin Saturation} = \text{Serum iron } (\mu\text{mol/L}) \,/\, \text{TIBC } (\mu\text{mol/L}) \times 100\%$$

Transferrin saturation is the percent of transferrin that is saturated with iron. Serum iron and TIBC may be used individually as indicators of iron status; however, transferrin saturation is considered to be a more sensitive indicator. A transferrin saturation of less than 15% was the cutoff value used in NHANES III to determine iron deficiency (Looker et al., 1997; Gibson, 1990) and was utilized in the present research.

Folate Status

Folate status was quantified using erythrocyte folate (RBC folate). The earliest biochemical sign of reduced folate intake is a reduction in serum folate to levels less than 7 nmol/L (Lee and Nieman, 1996). This serum folate concentration is indicative of negative folate balance but fails to offer useful information on tissue stores. Serum folate values fluctuate with changes in folate intakes. For example, serum folate values increase rapidly after ingestion of folate containing foods and supplements. Only after about 3 weeks on a folate deficient diet, can a reduction in serum folate level be detected (Cooper and Lowenstein, 1964; Lee and Nieman, 1996; Senti and Pilch, 1985). Serum folate cannot discriminate between a temporary fluctuation in serum concentration in response to recent dietary folate intake and chronic folate deficiency accompanied by depleted body stores; therefore, the use of erythrocyte (RBC) folate would be considered a more appropriate indicator of folate status. (Gibson, 1990; Lee and Nieman, 1996).

RBC folate is the best clinical index of depleted tissue stores because RBC folate does not change due to fluctuations in folate intake as do serum folate levels (Senti and Pilch, 1985; Gibson 1990). A reduction of RBC folate concentrations is seen only after several months of folate deprivation, making this measure a prime indicator of folate status (Sauberlich et al., 1987; Herbert, 1967; Bailey, 1990). Folate deficiency was determined by levels of RBC folate that drop below 317 nmol/L (Bailey, 1990). Since a decrease in RBC folate is considered the best quantifiable index of depleted body stores of folate (Bailey, 1990; Herbert, 1967; Sauberlich et al., 1987), the present research used only measures of RBC folate to obtain the most accurate assessment of folate deficiency.

To identify folate deficiency, RBC folate, vitamin B_{12} status and serum homocysteine should be analyzed (Lee and Nieman, 1996, Rasmussen et al, 2000). It is known that changes seen in red blood cells, white blood cells, and bone marrow cells that accompany folate deficiency are identical to those caused by a deficiency in vitamin B_{12} (Gibson, 1990). Therefore deficiency symptoms of B_{12} could mask deficiency symptoms of folate. Current literature suggests that serum homocysteine is a good indicator of folate status (Graham, 1999). An increase in folate intake has been shown to decrease serum homocysteine concentrations (Brouwer et al., 1999); therefore, an elevated level of homocysteine may indicate a decrease in folate status (Graham, 1999; Appel et al., 2000).

Serum Homocysteine Status

A single measure of homocysteine has been shown to reliably characterize a person's average, long-term homocysteine concentration (Garg et al., 1997). The reported serum homocysteine concentrations from NHANES III (phase 2) were used in the present study to determine homocysteine status of the participants. In order to examine the occurrence of high plasma homocysteine concentrations, a high homocysteine concentration was defined as concentrations higher than 14 μmol/L (Selhub et al., 1993).

Vitamin B_{12} Status

An early feature of vitamin B_{12} deficiency is characterized by the presence of abnormally large cells in the peripheral blood (megaloblastic anemia) along with a hemoglobin level of less than 12 g/dL (Lee and Nieman, 1996). A mean corpuscular volume (MCV) greater than 100 fL is also suggestive of megaloblastic anemia (Lee and Nieman, 1996). These two indices were utilized throughout the present study to determine B_{12} deficiency. In the present study B_{12} status was only utilized to exclude subjects.

Iron and Folate Intake

Results from the analysis of the 24-hour dietary recall were used to estimate nutrient intake of the present sample. Dietary Reference Intakes (DRIs) were employed to determine if individuals consumed adequate amounts of iron and folate. DRIs may include three values to measure nutrient adequacy including the Recommended Dietary Allowances (RDA), Adequate Intake (AI), and Estimated Average Requirement (EAR). The EAR is the estimated average requirement that would meet the needs of 50% of the population and was used to measure the adequacy of iron and folate intake (Food and Nutrition Board, 2001). The EAR for iron for women aged 19-50 years is set at 8.1 mg/day while the EAR for folate is 320 μg/day (Food and Nutrition Board, 2001). Therefore, iron intake below 8.1 mg/day and folate intake below 320 μg/day were considered inadequate intake.

Food-Insufficiency

The NHANES III food-insufficiency questions were designed to measure food-insufficiency of the household, defined as "an inadequate amount of food intake due to lack of resources" (Briefel and Woteki, 1992). These questions were asked as a component of the household questionnaire administered in the home. For the purpose of the present study, survey participants were classified as "food-insufficient" if the respondent to the questionnaire reported that the family "sometimes" or "often" did not get enough food to eat (Briefel and Woteki, 1992). Only those individuals who claimed that they got "enough of the kinds of foods we want to eat" or "enough, but not always what we want to eat" were classified as food-sufficient. According to Cristofar and Basiotis. (1992) and Rose and Oliveira (1997B) this question has external validity in that a positive response to the question demonstrated a relationship with poor nutrient intake. Face validity was demonstrated by the fact that respondents understood the question and could answer it easily (Cristofar and Basiotis, 1992; Rose and Oliveira, 1997B).

Statistical Analysis

Specific information and data to conduct the present study were identified and retrieved from existing NHANES III data sources. The Statistical Package for the Social Sciences (SPSS) version 10.0 (Chicago, IL) and SUDAAN version 7.5.6 (Research Triangle Park, NC) were used to conduct the analysis.

The NHANES III data were weighted to account for the unequal probabilities of selection as a result of the cluster design, over-sampling of certain groups, and non-response. These weights were used throughout the analysis of the present data. Because the distributions of folate intake, iron intake, and serum homocysteine were found to be skewed, a logarithmic transformation was applied to these measures, and these values were used for all succeeding analysis.

Analysis of variance (ANOVA) was used to determine the differences in nutrient intake among those participating and not participating in WIC and Food Stamp Programs and Chi Square Analysis was used to assess the difference between reported food-insufficiency and program participation. ANOVA and Chi Square Analysis were also used to determine the difference among women's demographic characteristics (age, poverty status, insecurity status, race, and education) and their nutrient intakes. ANOVA was used determined the relation between reported food-insufficiency and nutrient intake. Multiple regression was employed to determine the relation among food assistance program participation, nutrient intake, and nutritional status.

Null Hypotheses

Null Hypothesis One – Food assistance program participation will have no effect on folate intake and status.

Null Hypothesis Two – There will be no difference in folate intake and status due to women's demographic characteristics.

Null Hypothesis Three – There will be no relation between folate intake and folate status.

Null Hypothesis Four – Food-insufficiency status will have no effect on folate intake and status.

Null Hypothesis Five – Food assistance program participation will have no effect on iron intake and status.

Null Hypothesis Six – There will be no difference in iron intake and status due to women's demographic characteristics.

Null Hypothesis Seven – There will be no relation between iron intake and iron status.

Null Hypothesis Eight – Food-insufficiency status will have no effect on iron intake and status.

Null Hypothesis Nine – There will be no association between food assistance program participation and food-insufficiency status.

Null Hypothesis Ten – There will be no relation among food assistance program participation, age, food-insufficiency, folate intake, and folate status.

CHAPTER IV

RESULTS

The unweighted sample for this study included 982 non-pregnant women of child-bearing age. Table 1 summarizes demographic and dietary data of the sample. The mean age of the women in the sample was 31.5 years with a body weight of 70.8 kg. Estimated mean iron intake for the women was 12.4 *mg*/day and the median iron intake was 10.3 *mg*/day. Estimated mean folate intake was 212.2 μg/day and the median folate intake was 175.13 μg/day.

Table 2 reports sample size and percents of selected demographic characteristics by socio-economic factors. Approximately half of the population reported participating in neither program. However, most women reported an income below 1.30 Poverty Income Ratio (PIR) making them financially eligible to participate in both WIC and Food Stamp programs. Approximately two-thirds of the population had a high school education or above. The sample consisted primarily of women 28-35 years of age who identified themselves as non-Hispanic white. Most women in this population were categorized as food-sufficient. Over two-thirds of the population had an intake that met or exceeded the EAR (8.1 mg/day) for iron, whereas, a majority of the women had intake below the EAR (320 μg/day) for folate.

Table 3 shows the percentage of subjects meeting and not meeting the EAR for folate and iron by selected demographic characteristics. Program participation was not associated with meeting or not meeting the folate EAR. There was also no association between food-insufficiency status, educational attainment, age, or race and meeting or not meeting folate EAR. No significant association was seen between program participation, food-insufficiency status, age, or race and meeting or not meeting the EAR for iron. There was a trend towards a greater percentage of women with high school education or above meeting the iron EAR.

Table 4 summarizes estimated folate intake by demographic characteristics. Folate intake was highest in women participating in WIC only (261.6 μg/day), but was not significantly different by program participation. Folate intake was not different due to education, income level, age, or food-insufficiency status. Folate intake of Mexican-American women was significantly higher than non-Hispanic white and non-Hispanic black women (p= 0.0009), but not different from other women.

Differences in estimated iron intake by demographic characteristics are reported in Table 5. There were no significant differences in iron intake due to demographic characteristics. There was also no significant relation between iron intake and iron status.

The was a significant association between food assistance program participation and categorized food-insufficiency status and is summarized in Table 6 (p= 0.0358). A significantly lower percentage of women receiving food stamps only perceived themselves as food-sufficient compared to the other levels of program participation.

Table 7 summarizes folate status by selected demographic characteristics. Folate status was measured by red blood cell (RBC) folate and serum homocysteine. RBC folate was significantly higher ($p= 0.0126$) in women with at least a high school education compared to women with less than high school education. RBC folate was also significantly higher in the Mexican-American, non-Hispanic white and other group as compared to the non-Hispanic black group ($p= 0.0000$). The non-Hispanic black women had an RBC folate of 302.4 nmol/L, which was below the level of 317 nmol/L and is therefore considered deficient (Bailey, 1990). Using serum homocysteine as an indicator of folate status, mean serum homocysteine was significantly lower among those women participating in both programs compared to those participating in food stamps only and neither program ($p= 0.0013$), although none of the groups had serum homocysteine concentrations that approached levels considered high (>14μmol/L). Significant differences in mean serum homocysteine were also observed among ethnic groups. Mean serum homocysteine concentrations were significantly higher among non-Hispanic white and non-Hispanic black women when compared to Mexican-American women ($p= 0.0006$). Mean serum homocysteine tended to increase with increasing age. Correlation analysis showed a significant negative relation between dietary folate intake and serum homocysteine, in that as dietary folate intake increased, serum homocysteine levels decreased ($r= -.1857$, $p< 0.0001$).

Table 8 reports iron status by selected demographic characteristics. A higher percentage of women across all program participation groups tended to be iron adequate. Iron adequate women were significantly younger than iron inadequate women ($p = 0.0202$). According to results, a significantly higher percentage of non-Hispanic white women were iron adequate when compared to non-Hispanic black women, Mexican-American women and those categorized as other ($p = 0.0194$). PIR did not differ by iron status.

Table 9 contains results of the weighted stepwise multiple regression analysis for red blood cell folate. For this analysis, education was treated as a continuous variable. Race was a categorical variable with 1 = Mexican-American and the other three race groups = 2. Regression analysis confirmed the independent contribution of education and dietary folate intake on predicting RBC folate. Results indicated that as education increased and as dietary folate intake increased, RBC folate increased ($p < 0.0000$).

Table 10 reports similar results of the weighted stepwise multiple regression analysis for serum homocysteine. Results of this analysis indicated that serum homocysteine increased with increasing age, decreased as race moves toward Mexican American, and that as dietary folate intake increased homocysteine decreased ($p = 0.0000$).

Table 1. Demographic, blood parameters, and nutrient intake characteristics of the sample[1].

Demographic characteristics	N	Mean	SEM[2]
Age (y)	982	31.5	0.4
Weight (kg)	982	70.8	1.0
BMI (kg/m^2)	982	27.0	0.4
Poverty Income Ratio (PIR)	982	1.0	< 0.0
Serum transferrin saturation (%)	947	22.7	0.8
Serum ferritin (μg/l)	946	53.0	3.8
Erythrocyte protoporphyrin (μmol/L)	948	1.1	< 0.0
Serum homocysteine (μmol/L	858	8.4	0.4
Red blood cell folate (nmol/L)	941	373.2	17.7
Estimated iron intake (mg)	960	12.4 Median 10.3	0.5
Estimated folate intake (μg)	960	212.2 Median 175.1	8.3

[1]Sample sizes refer to the number of unweighted observations in the data set;
[2]Standard error of the mean with weights

Table 2. Sample size and percents[1] of selected demographic factors.

Demographic/socioeconomic factors	N	Percent
Program Participation		
WIC only	82	6.0
Food Stamps only	302	28.5
Both programs	187	14.0
Neither program	410	51.5
Education		
Below High School Education	452	38.3
High School Education or Above	506	61.7
Poverty Income Ratio (PIR)		
Low-income (PIR < 1.30)	735	67.9
Low middle-income (PIR 1.31-1.85)	224	32.2
Age		
17-27	277	28.9
28-35	357	40.0
36-45	312	31.4
Ethnicity		
Non-Hispanic White	137	48.2
Non-Hispanic Black	421	24.4
Mexican-American	342	11.8
Other	60	15.7
Food-insufficiency status		
Food-sufficient	809	86.6
Food-insufficient	151	13.4
Iron EAR		
Meets EAR	680	70.0
Below EAR	279	30.0
Folate EAR		
Meets EAR	187	18.8
Below EAR	772	81.2

[1]Sample sizes refer to the number of unweighted observations in the data set; percents reflect sample weights.

Table 3. Selected demographic characteristics of subjects meeting/not meeting the Estimated Average Requirement (EAR) for Folate and Iron.

Demographic Characteristics	N	Folate ≥ EAR %	Folate < EAR %	N	Iron ≥ EAR %	Iron < EAR %
Program Participation						
WIC only	82	21.5	78.5	81	68.6	31.4
Food Stamps only	302	17.6	82.4	293	65.5	34.5
Both programs	187	19.6	80.4	180	72.7	27.3
Neither program	410	22.7	77.3	405	72.4	27.6
		p = 0.8422			p = 0.6187	
Food-insufficiency status						
Food-sufficient	809	17.6	82.4	809	69.9	30.1
Food-insufficient	151	27.1	72.9	151	70.5	29.5
		p = 0.1805			p = 0.9372	
Education						
Below High School Education	452	18.2	81.9	452	64.5	35.5
High School Education or Above	506	19.3	80.7	506	73.4	26.6
		p = 0.7969			p = 0.0584	
Race-ethnicity						
non-Hispanic white	137	19.4	80.6	137	69.5	30.5
non-Hispanic black	421	17.1	82.9	421	68.6	31.4
Mexican-American	342	25.8	74.2	342	75.5	24.5
Other	60	14.6	85.4	60	69.6	30.4
		p = 0.2695			p = 0.2082	
		Mean ± SEM	Mean ± SEM		Mean ± SEM	Mean ± SEM
Age (years)		31.6 ± 0.4[a]	31.6 ± 0.9[a]		31.5 ± 0.7[a]	31.6 ± 0.5[a]

[1] Percents reflect sample weights.
[2] Chi-square comparisons are across demographic variables between meeting and not meeting each nutrient EAR.
[a] Means between meeting or not meeting the EAR were not significantly different using two-tailed independent t-test.

Table 4. Estimated folate intake[1] (μg) of low-income women by selected demographic characteristics.

Demographic characteristics	N	Mean Folate Intake (μg)	SEM	P-value
Program participation				
WIC only	81	261.6	38.8	
Food Stamps only	293	194.3	13.2	
Both programs	780	219.5	19.8	
Neither program	405	214.9	13.4	0.4964
Education				
Below High School Education	452	211.6	14.3	
High School Education or Above	506	212.5	11.1	0.6223
Poverty Income Ratio (PIR)				
Low-income (PIR<130)	735	212.1	8.3	
Low middle-income (PIR 1.31-1.85)	224	211.0	16.8	0.7788
Age				
17-27	279	213.7	17.4	
28-35	365	207.3	12.3	
36-45	316	217.1	13.9	0.9700
Ethnicity				
Non-Hispanic White	137	201.5[a]	17.2	
Non-Hispanic Black	421	209.2[a]	9.7	
Mexican-American	342	279.1[b]	19.8	
Other	60	199.1[a,b]	24.8	0.0009
Food-insufficiency status				
Food-sufficient	809	207.3	9.5	
Food-insufficient	151	244.2	19.8	0.0778

[1]Sample sizes refer to the number of unweighted observations in the data set: percents reflect sample weights.

[a]Means in columns with different superscripts were significantly different using analysis of variance at $p<0.05$.

Table 5. Estimated iron intake (mg) of low-income women by selected demographic characteristics.

Demographic characteristics	N	Mean Iron Intake (mg)	SEM	P-value
Program participation				
WIC only	81	13.7	1.5	
Food Stamps only	293	11.4	0.6	
Both programs	180	13.3	1.5	
Neither program	405	12.6	0.7	0.3212
Education				
Below High School Education	452	11.9	0.7	
High School Education or Above	506	12.7	0.7	0.1241
Poverty Income Ratio (PIR)				
Low-income (PIR<130)	735	12.5	0.5	
Low middle-income (PIR 1.31-1.85)	224	12.1	0.8	0.5017
Age				
17-27	279	12.2	0.7	
28-35	365	12.9	0.9	
36-45	316	12.0	0.6	0.8369
Ethnicity				
Non-Hispanic White	137	11.8	0.8	
Non-Hispanic Black	421	12.5	0.6	
Mexican-American	342	13.2	0.7	
Other	60	13.6	1.5	0.1567
Food-insufficiency status				
Food-sufficient	809	12.2	0.5	
Food-insufficient	151	13.7	1.1	0.6089
Iron Status				
Iron adequate	748	12.3	0.6	
Iron inadequate	177	13.2	1.4	0.5524

[1]Sample sizes refer to the number of unweighted observations in the data set; means and standard error of the mean reflect sample weights.

Table 6. Food assistance program participation[1] and food-insufficiency status.

Food Assistance Program Participation	N	Percent Food-sufficient	Percent Food-insufficient	P-value
WIC only	82	85.8	14.2	
Food Stamps only	302	77.9	22.1	
Both Programs	187	90.5	9.5	
Neither Program	410	90.7	9.3	0.0358

[1]Sample sizes refer to the number of unweighted observations in the data set: percents reflect sample weights

Table 7. Folate status[1] of low-income women by selected demographic characteristics.

Demographic characteristics	N	Mean RBC Folate (nmol/L)	SEM	P-value	N	Mean Serum Homocysteine (μmol/L)	SEM	P-value
Program Participation								
WIC only	76	403.2	44.9		71	7.7	0.4[a,b]	
Food Stamps only	293	342.3	21.6		270	8.5	0.3[a]	
Both programs	178	360.9	17.9		164	7.1	0.2[b]	
Neither program	393	391.3	24.4	0.6841	353	8.7	0.7[a]	0.0013
Education								
Below High School Education	436	342.9[a]	19.7		396	9.2	1.0	
High School Education or Above	504	392.0[b]	20.2	0.0126	461	7.9	0.2	0.3125
Poverty Income Ratio (PIR)								
Low-income (PIR<1.30)	718	360.9	17.0		661	8.4	0.4	
Low middle-income (PIR 1.31-1.85)	222	398.9	30.0	0.4438	196	8.3	0.8	0.8143
Age								
17-27	276	360.9	24.2		246	7.9	0.6	
28-35	355	391.3	24.4		332	8.1	0.4	
36-45	310	361.8	16.4	0.3757	280	9.2	0.7	0.1169
Ethnicity								
Non-Hispanic White	141	388.5[a]	28.0		116	9.0[a]	0.8	
Non-Hispanic Black	412	302.4[b]	9.7		376	8.3[a]	0.2	
Mexican-American	330	408.7[a]	18.2		312	7.5[b]	0.2	
Other	58	407.8[a]	28.9	0.0000	54	7.4[a,b]	0.4	0.0006
Food-insufficiency status								
Food-sufficient	792	374.0	17.4		717	8.3	0.5	
Food-insufficient	149	368.1	32.0	0.7096	141	8.7	0.5	0.2806

[1]Sample sizes refer to the number of unweighted observations in the data set; means and Standard error of the mean reflect sample weights

[a]Means in columns with different superscripts were significantly different at $p < 0.05$ using independent two-tailed t-test.

Table 8. Iron status[1] of low-income women by selected demographic characteristics.

Demographic characteristics	N	Iron Adequate %	Iron Inadequate %	P-value
Program participation				
WIC only	76	89.2	10.8	
Food Stamps only	293	83.7	16.3	
Both programs	180	77.9	22.1	
Neither program	396	83.4	16.6	0.5222
Education				
Below High School Education	440	80.3	19.7	
High School Education or Above	505	84.3	15.7	0.3794
Age				
17-27	277	87.4	12.6	
28-35	357	84.0	16.1	
36-45	312	77.1	22.9	0.2322
Ethnicity				
Non-Hispanic White	141	89.8	10.2	
Non-Hispanic Black	411	80.4	19.6	
Mexican-American	336	78.0	22.0	
Other	58	67.6	32.4	0.0194
Food-insufficiency status				
Food-sufficient	794	82.0	18.0	
Food-insufficient	152	88.1	11.9	0.0713
		Mean ± SEM	Mean ± SEM	
PIR		1.02 ± 0.0396	1.01 ± 0.0502	0.7301
Age		31.2 ± 0.4798	33.4 ± 0.8003	0.0202

[1]Sample sizes refer to the number of unweighted observations in the data set; percents reflect sample weights.

[2]Means and SEM reflect sample weights.

Table 9. Weighted stepwise multiple regression for red blood cell folate (N = 918).

RBC Folate[1]	β	p
Y-intercept	5.0277	0.0000
Folate intake	0.1210	0.0000
Education	0.0144	0.0345

[1] R^2=0.047512, Prob>F<0.0001

[2] Education was a categorical variable with 1= below high school education and 2= high school education or above.

Table 10. Weighted stepwise multiple regression for serum homocysteine (N = 836).

Serum Homocysteine[1]	β	p
Y-intercept	2.2154	0.0000
Age	0.0079	0.0058
Folate intake	– 0.0821	0.0003
Race[2]	– 0.0855	0.0406

[1] R^2=0.060456, Prob>F<0.0001

[2] Race was a categorical variable with 1 = Mexican American and 2 = all others

Table 11. Null hypotheses reject or fail to reject summary.

Null Hypotheses	Reject/Fail to Reject
1[1]: Food assistance program participation will have no effect on: folate intake. folate status (RBC folate) folate status (serum homocysteine)	Fail to reject-Table 3 & 4 Fail to reject-Table 7 Reject-Table 7
2: There will be no difference in folate intake and status due to women's demographic characteristics. folate intake (race only) folate status (RBC folate/education, race) folate status (serum homocysteine/race)	Reject-Table 4 Reject-Table 7 Reject-Table 7
3[2]: There will be no relation between folate intake and folate status.	Reject
4: Food-insufficiency status will have no effect on folate intake and status.	Fail to reject-Table 3,4,&7
5: Food assistance program participation will have no effect on iron intake and status.	Fail to reject-Table 5 & 8
6: There will be no difference in iron intake and status due to women's demographic characteristics. iron intake iron status (iron adequacy/race)	Fail to reject-Table 3 & 5 Reject-Table 8
7: There will be no relation between iron intake and iron status.	Fail to reject-Table 5
8: Food-insufficiency status will have no effect on iron intake and status.	Fail to reject-Table 3,5,&8
9[3]: There will be no association between food assistance program participation and food-insufficiency status.	Reject-Table 6
10: There will be no association between food assistance program participation, age, education food-insufficiency, folate intake, and folate status.	Reject-Table 9 & 10

[1]1HO, 2HO, 4HO, 5HO, 6HO, 8HO were determined from Chi-square comparisons, weighted ANOVA, and two-tailed independent t-test.
[2]3HO and 7HO were determined from two-tailed independent t-test.
[3]9HO and 10HO were determined from multiple regression analysis.

CHAPTER V

DISCUSSION

The objectives of this study were (1) to determine the differences in nutrient intake among low-income women participating and not participating in WIC and Food Stamp Programs, (2) to determine the differences in nutritional status among low-income women participating and not participating in WIC and Food Stamp Programs, and (3) to identify the prevalence of food-insufficiency among low-income women participating and not participating in WIC and Food Stamp Programs. This study primarily focused on the effect that Food Assistance Program participation and food-insufficiency might have on nutritional status through nutrient intake.

In the past, much effort has been devoted to defining hunger and food-insufficiency in the United States. According to the Life Sciences Research Office, food-insufficiency exists "whenever the availability of nutritionally adequate, safe foods, or the ability to acquire personally acceptable foods in socially acceptable ways is limited or uncertain" (FASEB, 1990).

By study design, the majority of women had an income below 1.30 PIR. Despite the apparent lack of money, a high percentage of women (86.6%) were categorized as food-sufficient and a third of the population reported not participating in the Food Stamp or WIC programs.

Hypothesis One

Food assistance program participation will have no effect on folate intake and status.

There was no significant difference in estimated dietary folate intake (Table 4) or percent of women that met the folate EAR (Table 3) when compared by food assistance program participation. These findings were similar with those of Wilde et al. (2000), who indicated that participation in the Food Stamp Program or the WIC Program was not significantly associated with a higher intake of fruits and vegetables.

Although RBC folate was not significantly different among women with various levels of food assistance program participation, mean serum homocysteine was significantly lower in those women participating in both programs compared to women who participated in Food Stamps only or neither program (Table 7). None of the program group means were above 14 μmol/L, a homocysteine level indicative of folate deficiency (Selhub et al., 1993).

Serum homocysteine levels have been identified as a strong indicator of folate status, in that an improved folate status is associated with a decreased serum homocysteine level. Both RBC folate and serum homocysteine are considered good indicators of folate status (Bailey, 1990), however both have limitations. RBC folate reflects long-term intake, but false high or low measurements are not uncommon (Ueland et al., 1993), and serum homocysteine concentrations are influenced by several factors other than folate intake, such as intake of vitamin B_{12} and vitamin B_6 (Selhub et al., 1993).

Women with low vitamin B_{12} intake were excluded from the current study and therefore, would not affect homocysteine levels in the present research. Vitamin B_6 intake was not explored in the present study, and therefore could be a limitation of this research. During extensive literature review, no further research was found linking folate intake, RBC folate, or serum homocysteine as an indicator of folate intake and status when compared by food assistance program participation.

Hypothesis Two

There will be no difference in folate intake and status due to women's demographic characteristics.

Mexican-American women had a significantly higher estimated dietary folate intake (μg/day) than non-Hispanic white and black women (Table 4). If the diets of Mexican-American women contain high folate foods, this may explain the difference. No significant differences were found among other demographic characteristics (age, education, income) and estimated dietary folate intake as defined by meeting and not meeting the folate EAR or μg/day (Tables 4 and 3, respectively). Although Emmons (1986) did not study Mexican-Americans, she found a similar trend between black and white women as was found in the current study between Mexican-Americans and non-Hispanic white and black women. Emmons (1986) found a slightly higher folate intake in black low-income women as compared to white women, however not significantly higher. Rose and Oliviera 1997A found that folate intake was slightly higher in food-sufficient women when compared to food-insufficient women, but results were not significant. According to Lewis et al. (1999), when NHANES III dietary folate intake data was updated to reflect food fortification, 85% of women aged 20-49 years met or surpassed the EAR for folate. No research was found comparing folate intake by age, education, or income.

In the current study, folate status, as defined by RBC folate, was significantly different due to selected demographic characteristics (Table 7). Women with high school education or above had a significantly higher mean RBC folate than did those with less education, and non-Hispanic black women had a significantly lower mean RBC folate (302.4 nmol/L) as compared to other race/ethnic groups (Table 7). This level of RBC folate is below 317 nmol/L, which is the value indicative of folate deficiency. No other group of women in this study had RBC folate values indicative of folate deficiency. This is in partial agreement with research by Ford and Bowman (1999). Ford and Bowman (1999) examined the relation between RBC folate and race and education in women of all income groups using data from NHANES III. White women had significantly higher RBC folate levels than African-American women or Mexican-American women across all income groups. In the current study, no difference in RBC folate was seen between low-income Mexican-American and non-Hispanic white women. The difference in RBC folate may actually be influenced more by income than by race/ethnicity. In disagreement with results from the current study, Ford and Bowman (1999) found no significant relation between RBC folate and educational attainment, which again may be due to a greater influence of income.

When using serum homocysteine as an indicator of folate status, a significant difference was discovered only among race/ethnic groups and food assistance program participation (Table 7). Non-Hispanic white and non-Hispanic black women had a significantly higher serum homocysteine level when compared to Mexican-American women. This agrees with research from Jacques et al. (1999) who studied differences in serum homocysteine concentrations among sex, age, and race-ethnicity across all income categories using data from NHANES III. Jacques et al. (1999) discovered that serum homocysteine concentrations were significantly lower in Mexican-American females than in non-Hispanic white and black females. Consistent with the findings of the current study, Jacques et al. (1999) found no significant difference in serum homocysteine levels based on age. No research could be found that studied food assistance program participation and serum homocysteine levels.

Hypothesis Three

<u>There will be no relation between folate intake and folate status.</u>

Results of correlation analysis indicated a significant negative correlation between folate intake and folate status using serum homocysteine as the folate status indicator. This agrees with Rasmussen et al. (2000) who found that folic acid intake from supplements and total folate intake were inversely associated with homocysteine concentrations in women age 25-30 years and 60-65 years using multiple linear regression analyses. Riddell et al. (2000) found that an increase of folic acid intake to the target intake of 600 μg/d, whether by consuming folate rich foods, fortified breakfast cereals or by supplements tended to effectively reduce serum homocysteine concentrations in men and women aged 36-71 years.

Hypothesis Four

Food-insufficiency status will have no effect on folate intake and status.

Folate intake was not significantly different due to food-insufficiency status based on meeting or not meeting the EAR for folate or intake of μg/day (Tables 3 and 4, respectively). This disagrees with research from Rose and Oliviera (1997A), who found that when controlling for other factors, estimated folate intake was significantly lower in the food-insufficient households than in the food-sufficient households ($p < 0.05$). Lutz et al. (1996), Kendall et al. (1996), and Cristofar and Basiotis (1992) discovered results similar to those of Rose and Oliviera (1997A), in that the frequency of consumption of fresh fruits, fruit juices and vegetables declined as income decreased and food-insufficiency was more prevalent.

There was no significant difference in folate status using RBC folate or serum homocysteine due to food-insufficiency status (Table 7). No current literature was found documenting a link between folate status and food-insufficiency. Researchers of the current study speculate that a possible reason for no difference in folate intake and status due to food-insufficiency status was that a high percentage of women in the present study were classified as food-sufficient.

Hypothesis Five

Food assistance program participation will have no effect on iron intake and status

As hypothesized by the researchers of the current study, there was no difference in the estimated mean iron intake among various levels of food assistance program participation based on meeting or not meeting the iron EAR or intake of mg/day (Tables 3 and 5, respectively). This disagrees with research from Rose et al. (1998), when studying children. Rose et al. (1998) examined the effects of participation in the Food Stamp and WIC Programs on nutrient intakes of preschoolers using data from the 1989-1991 Continuing Survey of Food Intake by Individuals (CSFII). Participation in WIC, Food Stamps, or a combination of both programs resulted in increased iron intake as measured by a percentage of the RDA for preschool children.

Block et al. (1985) used data from NHANES II to provide information regarding the contributions of specific foods to the total population intake of several nutrients including iron. Meat was among the top contributors of iron in the American diet. Findings of the current study are inconsistent with results from the analysis of the 1994-1996 by Wilde et al. (2000) CSFII. Wilde et al.

(2000) discovered a trend toward a greater intake of meats in Food Stamp participants as compared to others in the sample. Wilde et al. (2000) also found that Food Stamp Program participation had a significant positive effect on the intake of added sugars and total fats, which implies that the dietary quality of Food Stamp participants may be negatively affected by participation in the program, and therefore, although participants had a greater intake of meats, they may be selecting meats that are not necessarily good sources of iron.

There were no significant differences in iron status among various levels of food assistance program participation (Table 8). This disagrees with research from Pehrsson et al. (2001), who studied the iron status of participants and nonparticipants in the WIC program. Pehrsson et al. (2001) found that the prevalence of iron deficiency anemia was significantly lower in WIC participants than in nonparticipants.

Hypothesis Six

There will be no difference in iron intake and status due to women's demographic characteristics.

No significant differences were found in estimated iron intake by to demographic characteristics (Table 5). There were also no significant differences in meeting or not meeting the iron EAR due to demographic characteristics (Table 3).

Significant differences were found in iron status among race/ethnicity groups (Table 8). Results indicated a significantly higher percentage of non-

Hispanic white women were iron adequate compared to non-Hispanic black and Mexican-American women. This agrees with the research of Frith-Terhune et al. (2000), who studied iron deficiency anemia using data from NHANES III and found after adjustment for poverty level, parity, and iron supplement use, the prevalence of iron deficiency was 2.3 times higher in Mexican-American women than in non-Hispanic white women. No significant differences were found in iron status due to other demographic characteristics in the present study, and this agrees with Looker et al. (1997). Looker et al. (1997) found a trend for iron deficiency to be more common among women with less education, but results were not significant. Women with less than a high school education tend to fall into lower income groups, therefore, possible reasons for decreased iron intake in women with less education is the inability to afford foods adequate in iron.

Hypothesis Seven

There will be no relation between iron intake and iron status.

Results indicated no relation between iron intake and iron status, as hypothesized (Table 5). This may be due to other biological and lifestyle factors that affect iron status indicators. Time of day has been shown to affect the measure of transferrin saturation (Looker et al., 1995). Data on heavy menstrual blood loss and use of intrauterine devices were not available and therefore not taken into consideration in this study. Daily dietary iron intakes were measured using a single 24 hour dietary recall, which can be used to assess the average intake of a population, but may misrepresent usual individual intakes. Extensive literature was found on the measurement of iron status using various measurement methods, however, none of the current research correlated dietary iron intake to the iron status of the population.

Hypothesis Eight

Food-insufficiency status will have no effect on iron intake and status.

As hypothesized, food-insufficiency status had no significant relation with iron intake as measured by meeting or not meeting the EAR for iron or mg/day (Tables 3 and 5, respectively). This disagrees with the views of current literature. Rose and Oliveira (1997A) found that the estimated iron intake of food-insufficient women, as measured by a percentage of the 1989 RDA, was considerably lower than the iron intake of food-sufficient women. Rose and Oliveira (1997B) found significantly lower iron intakes, as measured by a mean percentage of the 1989 RDA, in the food-insufficient group (99.3%) as compared to the food-sufficient group (124.2%). Net of other socioeconomic influences, food-insufficient households consumed about 20% less iron than food-sufficient households (Rose and Oliveira, 1997B). Cristofar and Basiotis (1992) also found that iron intake tended to be lower in the food-insufficient group compared to the food-sufficient group, but the difference was not significant.

Results of the current study indicated that food-insufficiency status had no significant effect on iron status (Table 8). No research was found linking food-insufficiency and iron status, however Looker et al. (1997) found that iron deficiency was more common among poor women with incomes less than 100% of the poverty threshold than non-poor women with incomes greater than 100% of the poverty level. However in the present study, results indicated that low-income was not necessarily associated with food-insufficiency.

Hypothesis Nine

There will be no association between food assistance program participation and food-insufficiency status.

A significantly higher percentage of women across all food assistance programs were classified as food-sufficient with women participating in both or neither program being food-sufficient (Table 6). Rose and Oliveira (1997A), while utilizing data from CSFII 1989-91 to estimate nutrient intakes of food-insufficient individuals, briefly examined the prevalence of food-insufficiency among participants in food assistance programs such as the WIC and Food Stamp Programs. Results indicated that a higher percentage of women claiming food-insufficiency (69.3%) were participants in a food assistance program. Alaimo et al. (1998) analyzed data from NHANES III and found that in the low-income population, a larger proportion of food-insufficient individuals (52.6%) than food-sufficient individuals (36.6%) tended to participate in the Food Stamp Program, but the association was not significant.

Hypothesis Ten

There will be no relation among food assistance program participation, age, education, food-insufficiency, folate intake and folate status.

When multiple regression was employed to predict folate status, a positive relation was seen between education and RBC folate and a positive relation was also seen between dietary folate intake and RBC folate. No literature was found confirming the relation between education and folate status as found in the present study. However, results from McNulty et al. (2000) confirm the direct relation between dietary folate intake and RBC folate. Results of McNulty et al. (2000) indicated that consuming folate fortified food or folic acid supplements increased RBC folate.

When using serum homocysteine as an indicator of folate status in the same model, folate intake and race were inversely associated with serum homocysteine and age was positively associated with serum homocysteine. Mexican-American women resulted in a lower serum homocysteine level. This agrees with research from Brouwer et al. (1999), who stated that dietary folate intake is directly correlated with serum homocysteine levels, in that as dietary folate intake increases, serum homocysteine levels decrease. Rasmussen et al. (2000) also found that as age increased, serum homocysteine levels increased.

CHAPTER VI

CONCLUSIONS AND IMPLICATIONS

The objectives of this study were 1) to determine the differences in nutrient intake among low-income women participating and not participating in WIC and Food Stamp programs, 2) to determine the differences in nutritional status among low-income women participating and not participating in WIC and Food Stamp programs, and 3) to identify the prevalence of reported food-insufficiency among low-income women participating and not participating in WIC and Food Stamp programs.

Objective One

To determine the differences in nutrient intake among low-income women participating and not participating in WIC and Food Stamp programs.

No significant differences in nutrient intake were found among women participating and not participating in WIC and Food Stamp programs.

Objective Two

To determine the differences in nutritional status among low-income women participating and not participating in WIC and Food Stamp programs

Although RBC folate was not different among women with various levels of food assistance program participation, mean serum homocysteine was significantly lower in women receiving food stamps and participating in WIC. No differences were found in iron status among women with various levels of food assistance program participation.

Objective Three

To identify the prevalence of reported food-insufficiency among low-income women participating and not participating in WIC and Food Stamp programs

According to results of this study, a relatively small amount of women in this study were classified as food-insufficient using the food-sufficiency questions from NHANES III (appendix A).

There are many additional areas for future research about nutrient intake, program participation, and food-insufficiency status. Using the same basic methods of the current study, other influences on nutrient intake, such as supplement use, food choices, and food security could be examined for their relation to nutrient intake and status. Perhaps instead of focusing on nutrients, research could be performed focusing on foods containing folate and iron, using the food frequency questionnaire (FFQ) from NHANES III. Instead of just observing the folate and iron intake from the 24-hour food recall, using the FFQ would allow for observing folate and iron intake for a longer time period.

Limitations

The current study had several limitations. One limitation is that iron and folic acid supplement use was not included in the analysis. In addition, variables were not always in the best form for what the current study's researchers were studying, such as program participation and food-insufficiency variables, so researchers in the present study made adjustments. However, this study did use a nationally representative sample (NHANES III data set), and selected each variable for the analysis based on previous studies.

BIBLIOGRAPHY

Alaimo K, Briefel RR, Frongillo EA, Olson CM. Food insufficiency exists in the United States: results from the Third National Health and Nutrition Examination Survey (NHANES III). *Am J Publ Health*. 1998;88(3): 419-426.

American College of Obstetricians and Gynecologists Educational Bulletin. Oct. 1996. Number 229.

Appel LJ, Miller III ER, Jee SH, Stolzenberg-Solomon R, Lin PH, Erlinger T, Nadeau MR, Selhub J. Effect of dietary patterns on serum homocysteine, results of a randomized, controlled feeding study. *Circulation*. 2000;102:852-857.

Bailey LB. Folate status assessment. *J Nutr*. 1990;120:1508-1511.

Basiotis PP. Validity of the self-reported food sufficiency status item in the US Department of Agriculture Food Consumption Surveys. In: Proceedings of the 1992 annual meeting of the American Council in the Consumer Interest: March 25-28, 1992; Toronto, Ontario, Canada.

Blaylock JR, Smallwood DM. An alternative approach to defining and assessing poverty thresholds. *Western J Ag Econ*. 1986;11:100-105.

Blaylock JR. Evaluating food plans and poverty thresholds. *Applied Economics*. 1987;19:1341-1352.

Block G, Dresser CM, Hartman AM, Carroll MD. Nutrient sources in the American diet: quantitative data from the NHANES II survey. *Am J Epidemiol*. 1985;122:13-26.

Blumberg SJ, Bialostosky K, Hamilton WL, Briefel RR. The effectiveness of a short form of the household food security scale. *Am J Public Health*. 1999;89(8):1231-1234.

Briefel RR, Woteki CE. Development of the food sufficiency questions for the third National Health and Nutrition Examination Survey. *J Nutr Educ*. 1992;24:24S-28S.

Brouwer IA, Van Dusseldorp M, Thomas CMG, Duran M, Hautvast JGAJ, Eskes TKAB, Steegers-Theunissen RPM. Low-dose folic acid supplementation decreases plasma homocysteine concentrations: a randomized trial. *Am J Clin Nutr*. 1999;69:99-104.

Cook JD, Lipschitz DA, Miles LE, Finch CA. Serum ferritin as a measure of iron stores in normal subjects. *Am J Clin Nutr.* 1974;27:681-687.

Cooper BA, Lowenstein L. Relative folate deficiency of erythrocytes in pernicious anemia and its correction with cyanocobalamin. *Blood.* 1964;24:502-521.

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

Cuskelly GJ, McNulty H, Scott JM. Effect of increasing dietary folate on red-cell folate: implications for prevention of neural tube defects. *Lancet.* 1996;347:657-659.

Daly LE, Kirke PN, Molloy A, Weir DG, Scott JM. Folate levels and neural tube defects. *JAMA.* 1995;274(21):1698-1702.

Emmons L. Food procurement and the nutritional adequacy of diets in low-income families. *J Am Diet Assoc.* 1986;86(12):1684-1693.

Expert Scientific Working Group. Summary of a report on assessment of the iron nutritional status of the United States population. *Am J Clin Nutr.* 1985;42:1318-1330.

Food and Drug Administration. Food standards: amendment of standards of identity for enriched grain products to require addition of folic acid. Federal Register. 1996;61:8781-8797.

Federation of American Societies for Experimental Biology, Life Sciences Research Office. *Third Report on Nutrition Monitoring in the United States.* Washington DC: U.S. Government Printing Office; 1995.

Federation of American Societies for Experimental Biology, Life Sciences Research Office. Nutrition Monitoring in the United States: An Update Report on Nutrition Monitoring. Washington DC: U.S. Government Printing Office; 1989.

Federation of American Societies for Experimental Biology, Life Sciences Research Office. Core indicators of nutritional state for difficult-to-sample populations. *J Nutr.* 1990;120(115):1555-1600.

Food and Nutrition Board, Institute of Medicine. Dietary Reference Intakes: Applications in Dietary Assessment. Washington, DC: National Academy Press; 2000.

Ford ES, Bowman BA. Serum and red blood cell folate concentrations, race, and education: findings from the third National Health and Nutrition Examination Survey. *Am J Clin Nutr.* 1999;69:476-481.
Frith-Terhune AL, Cogswell ME, Khan LK, Will JC, Ramakrishnan U. Iron deficiency anemia: higher prevalence in Mexican American than in non-Hispanic white females in the third National Health and Nutrition Examination Survey, 1988-1994. *Am J Clin Nutr.* 2000;72:963-968.

Frongillo EA, Rauschenbach BS, Olson CM, Kendall A, Colmenares AG. Questionnaire-based measures are valid for the identification of rural households with hunger and food insecurity. *J Nutr.* 1997;127:699-705.

Garg UC, Zheng ZJ, Folsom AR. Short-term and long-term variability of plasma homocysteine measurement. *Clin Chem.* 1997;43:141-145.

Gerhard GT, Malinow MR, DeLoughery TG, Evans AJ, Sexton G, Connor SL, Wander RC, Connor WE. Higher total homocysteine concentrations and lower folate concentrations in premenopausal black women than in premenopausal white women. *Am J Clin Nutr.* 1999;70:252-260.

Geronimus AT, Bound J, Waidmann TA, Hillemeier MM, Burns PB. Excess mortality among blacks and whites in the United States. *N Eng J Med.* 1996; 335:1552-1558.

Gibson RS. Principles of Nutritional Assessment. New York, NY: Oxford University Press; 1990:367-370.

Graham IM, Daly LE, Refsum IM, Robinson K, Brattstrom LE, Ueland PM. Plasma homocysteine as a risk factor for vascular disease. *JAMA.* 1997;277:1775-1781.

Graham IM. Homocysteine in health and disease. *Ann Intern Med.* 1999;131(5):387-388.

Haggerty M, Johnson C. The social construction of the distribution of income and health. *J Econ Issues.* 1996;30(2):525-530.

Hamilton WL, Cook JT, Thompson WW, Buron LF, Frongillo Jr. EA, Olson CM, Wehler CA. Household food security in the United States in 1995. Summary Report of the Food Security Measurement Project. 1997.

Havas S, Anliker J, Damron D, Langenberg P, Ballesteros M, Feldman R. Final results of the Maryland WIC 5-A-Day promotion program. *Am J Public Health.* 1998;88(8):1161-1167.

Herbert V. Biochemical and hematological lesions in folic acid deficiency. *Am J Clin Nutr.* 1967;20:562-568.

Jacques PF, Rosenberg IH, Rogers G, Selhub J, Bowman BA, Gunter EW, Wright JD, Johnson CL. Serum total homocysteine concentrations in adolescent and adult Americans: results from the third National Health and Nutrition Examination Survey. *Am J Clin Nutr.* 1999:69;482-489.

Jeffery RW, French SA. Socioeconomic status and weight control practices among 20- to 45-year-old women. *Am J Public Health.* 1996;86(3): 1005-1010.

Kant AK, Block G, Schatzkin A, Ziegler RG, Nestle M. Dietary diversity in the US population, NHANES II, 1976-1980. *J Am Diet Assoc.* 1991;91(12):1526-1531.

Kendall A, Olson CM, Frongillo EA. Relationship of hunger and food insecurity to food availability and consumption. *J Am Diet Assoc.* 1996;96(10):1019-1024.

Langer EE, Haining RG, Labbe RF, Jacobs P, Crosby EF, Finch CA. Ferritin in the serum of normal subjects and patients with iron deficiency and iron overload. *Br Med J.* 1972;4:206-208.

Lee RD, Nieman DC. Nutritional Assessment 2nd ed. St Louis, MO: Mosby-Year Book, Inc; 1996:405-407.

Lewis CJ, Crane NT, Wilson DB, Yetley EA. Estimated folate intakes: data updated to reflect food fortification, increased bioavailability, and dietary supplement use. *Am J Clin Nutr.* 1999:70;198-207.

Looker AC, Dallman PR, Carroll MD, Gunter EW, Johnson CL. Prevalence of iron deficiency in the United States. *JAMA.* 1997;227(12):973-976.

Looker AC, Gunter EW, Johnson CL. Methods to assess iron status in various NHANES surveys. *Nutr Rev.* 1995;53(9):246-254.

Lutz SM, Smallwood DM, Blaylock JR. Limited financial resources constrain food choices. *Food Rev.* 1996;18(1):13-17

Lynch JW, Kaplan GA, Shema SJ. Cumulative impact of sustained economic hardship on physical, cognitive, psychological, and social functioning. *N Eng J Med.* 1997;337(26):1889-1895.

McNulty H, Cuskelly GJ, Ward M. Response of red blood cell folate to intervention: implications for folate recommendations for the prevention of neural tube defects. *Am J Clin Nutr.* 2000;71:1308s-1311s.

Milunsky A, Jick H, Jick S, Bruell C, MacLaughlin D, Rothman KJ, Willett W. Multivitamin/folic acid supplementation in early pregnancy reduces the prevalence of neural tube defects. *JAMA*. 1989 ;262(20) :2847-2852.

Mirwosky J, Hu PN. Physical impairment and the diminishing effects of income. *Social Forces*. 1996;74(3):1073-1089.

National Research Council. Diet and Health: Implications for Reducing Chronic Disease Risk. Report of the Committee of Diet and Health, Food and Nutrition Board, Commission on Life Sciences, Washington DC: National Academy Press. 1989.

Olson CM, Rauschenbach BS, Frongillo EA Jr, Kendall A. Factors contributing to household food insecurity in a rural upstate New York county. *Fam Econ Nutr Rev*. 1997;10(2):2-17.

Pappas G, Queen S, Hadden W, Fisher G. The increasing disparity in mortality between socioeconomic groups in the United States, 1960 and 1986. *N Eng Jf Med*. 1993;329(2):103-109.

Pehrsson PR, Moser-Veillon PB, Sims LS, Suitor CW, Russek-Cohen E. Postpartum iron status in nonlactating participants and nonparticipants in the Special Supplemental Nutrition Program for Women, Infants, and Children. *Am J Clin Nutr*. 2001;73:86-92.

Peterkin BB, Kerr RL, Hama MY. Nutritional adequacy of diets of low-income households. *J Nutr Educ*. 1982;14(3):102-104.

Physicians Task Force on Hunger in America. Hunger in America: The Growing Epidemic. Middletown, CT: Wesleyan University Press: 1985.

Picciano MF. Special needs of women during their reproductive years. VNIS Health Communicators Conference. 1997.

Pilch SM, Senti FR. Assessment of the iron nutritional status of the US population based on data collected in the second National Health and Nutrition Examination Survey, 1976-1980. Federation of the American Society for Experimental Biology, Bethesda, MD. 1984.

Radimer KL, Olson CM, Greene JC, Campbell CC, Habicht JP. Understanding hunger and developing indicators to assess it in women and children. *J Nutr Educ*. 1992;24:36S-45S.

Rasmussen LB, Ovesen L, Bulow I, Knudsen N, Laurberg P, Perrild H. Folate intake, lifestyle factors, and homocysteine concentrations in younger and older women. *Am J Clin Nutr*. 2000;72:1156-1163.

Refsum H. Homocysteine and cardiovascular disease. *Ann Rev Med.* 1998;49:31-62.

Riddell LJ, Chisholm A, Williams S, Mann JI. Dietary strategies for lowering homocysteine concentrations. *Am J Clin Nutr.* 2000;71:1448-1454.

Rose D, Oliveira V. Nutrient intakes of individuals from food-insufficient households in the United States. *Am J Public Health.* 1997A;87(12):1956-1961.

Rose D, Oliveira V. Validation of a self-reported measure of household food insufficiency with nutrient intake data. U.S. Department of Agriculture, Economic Research Service Bulletin, Food and Consumer Sciences Division. 1997B.

Rose D, Habicht JP, Devaney B. Household participation in the food stamp and WIC programs increases the nutrient intakes of preschool children. *J. Nutr.* 1998;128:548-555.

Rush D. Periconceptional folate and neural tube defect. *Am J Clin Nutr.* 1994;59(suppl):511S-516S.

Sauberlich HE, Kretsch MJ, Skala JH, Johnson HL, Taylor PC. Folate requirement and metabolism in nonpregnant women. *Am J Clin Nutr.* 1987;46:1016-1028.

Selhub J, Jacques PF, Wilson PW, Rush D, Rosenberg IH. Vitamin status and intake as primary determinants of homocysteinemia in an elderly population. *JAMA.* 1993;270:2693-2698.

Senti FR, Pilch SM. Analysis of folate data from the Second National Health and Nutrition Examination Survey (NHANES II). *J Nutr.* 1985:1398-1402.

Tucker KL, Selhub J, Wilson PWF, Rosenberg IH. Dietary intake pattern relates to plasma folate and homocysteine concentrations in the Framingham Heart Study. *J. Nutr.* 1996;126:3025-3031.

Ueland PM, Refsum H, Stabler SP. Total homocysteine in plasma or serum: methods and clinical applications. *Clin Chem.* 1993:39;1764-1769.

United States Department of Agriculture. Food Nutrition Services. http://www.fns.usda.gov/pd/fssummar.htm. Accessed May 12, 2000.

United States Department of Health and Human Services. Plan and operation of the Third National Health and Nutrition Examination Survey, 1988-1994. *Vital Health Stat.* 1994;1(32):94-1308.

Whitney EN. Rolfes SR. Understanding Nutrition 7th ed. St. Paul, MN: West Publishing Company; 1996:554-558.

Wilde PE, McNamara PE, Ranney CK. The effect on dietary quality of participation in the Food Stamp and WIC programs. Food and Rural Economics Division, Economic Research Service, U.S. Department of Agriculture. Food Assistance and Nutrition Research Report Number 9. 2000.

Yetley E, Johnson C. Nutritional applications of the Health and Nutrition Examination Surveys (HANES). *Ann Rev Nutr*. 1987;7:441-463.

APPENDICES

Appendix A

Food-insufficiency question from the Continuing Survey of Food Intakes by Individuals (CSFII):

> Which one of the following statements best describes the food eaten in your household: enough of the kinds of food we want to eat; enough but not always what we want to eat; sometimes not enough to eat; or often not enough to eat (Blaylock and Smallwood, 1986; Blaylock, 1987; Basiotis, 1992; Rose and Oliveira, 1997A)?

Appendix B

Radimer/Cornell 10-item food-insufficiency questionnaire[1]:

1. I worry whether my food will run out before I get money to buy more.
2. We eat the same thing for several days in a row because we only have a few different kinds of food on hand and don't have money to buy more.
3. The food that I bought didn't last and I didn't have money to buy more.
4. I ran out of the foods that I needed to put together a meal and I didn't have money to get more.
5. I can't afford to eat properly.
6. I am often hungry but I don't eat because I can't afford enough food.
7. I eat less than I think I should because I don't have enough money for food.
8. I cannot give my child(ren) a balanced meal because I can't afford that.
9. My child(ren) are not eating enough because I just can't afford enough food.
10. I know my child(ren) are hungry sometimes, but I just can't afford more food.

[1] From Table 1 in Frongillo et al., 1997.

Appendix C

Food-insufficiency items[1] from the Community Childhood Hunger Identification Project (CCHIP):

1. Does your household ever run out of money to buy food?
    a. In the past 30 days?
    b. 5 or more days in the past 30 days?
2. Do you ever rely on a limited number of foods to feed your children because you are running out of money to buy food for a meal?
    a. In the past 30 days?
    b. 5 or more days in the past 30 days?
3. Do you ever cut the size of meals or skip because there is not enough food in the house?
    a. In the past 30 days?
    b. 5 or more days in the past 30 days?
4. Do you ever eat less than you should because there is not enough money for food?
    a. In the past 30 days?
    b. 5 or more days in the past 30 days?
5. Do your children ever eat less than you feel they should because there is not enough money for food?
    a. In the past 30 days?
    b. 5 or more days in the past 30 days?

6. Do your children ever say they are hungry because there is not enough food in the house?
    a. In the past 30 days?
    b. 5 or more days in the past 30 days?
7. Do you ever cut the size of your children's meals or do they ever skip meals because there is not enough money to buy food?
    a. In the past 30 days?
    b. 5 or more days in the past 30 days?
8. Do any of your children ever go to bed hungry because there is not enough money to buy food?
    a. In the past 30 days?
    5 or more days in the past 30 days?

[1]From Table 1 in Frongillo et al., 1997.

Appendix D

Six-Item Short Form of the Household Food Security Scale[1]:

1. In the last 12 months, did you (or other adults in your household) ever cut the size of your meals or skip meals because there wasn't enough money for food?
2. [Ask only if #5 = YES] How often did this happen – almost every month, some months but not every month, or in only 1 or 2 months?
3. In the last 12 months, did you ever eat less than you felt you should because there wasn't enough money to buy food?
4. In the last 12 months, were you ever hungry but didn't eat because you couldn't afford enough food?
5. "The food that [I/we] bought just didn't last, and [I/we] didn't have money to get more." Was that often, sometimes, or never true for you in the last 12 months?
6. "[I/we] couldn't afford to eat balanced meals." Was that often, sometimes, or never true for you in the last 12 months?

[1]From Table 2 in Blumberg et al., 1999.

Appendix E

Food-insufficiency questions[1] from the Third National Health and Nutrition Examination Survey (NHANES III):

1. Describe food eaten by family.
    a. Enough food to eat
    b. Sometimes not enough to eat
    c. Often not enough to eat
2. No. days in previous month with no food or money to buy food
    a. 0
    b. 1-4
    c. 5-9
    d. 10-14
    e. more than 14

    (if answer was "0", respondent skipped to question 4)
3. Reasons for no food or money to buy food
    a. Lack of transportation
    b. No working appliances
    c. Not enough money, food stamps, or WIC vouchers
    d. Any other reason
4. Adults cut size of meals because not enough money
5. Children cut size of or skipped meals because of not enough money

[1]From Table 1 in Alaimo et al., 1998.

ℷ

VITA

Taryn Larae Hehl

Candidate for the Degree of

Master of Science

Thesis: FOLATE AND IRON INTAKE AND SELECTED NUTRITIONAL PARAMETERS OF WIC AND FOOD STAMP PROGRAM PARTICIPANTS

Major Field: Nutritional Sciences

Biographical:

Personal Data: Born in Oklahoma City, Oklahoma, on July 22, 1975, the daughter of Jack Pryor and Marilyn Bruce.

Education: Graduated from El Reno High School, El Reno, Oklahoma in May 1993; received Associate of Science degree from Carl Albert State College, Poteau, Oklahoma in May 1995; received Bachelor of Science Degree in Nutritional Sciences from Oklahoma State University, Stillwater, Oklahoma in December 1997. Completed the dietetic internship at Oklahoma State University in May 1999. Completed the requirements for the Master of Science degree with a major in Nutritional Sciences at Oklahoma State University in May 2002.

Experience: Employed by Oklahoma State University, Nutritional Sciences Department as an undergraduate and as a graduate research and teaching assistant, 1996 to 2000. Employed by Integris Baptist Medical Center, Integrated Support Services Department, as a clinical dietitian, Oklahoma City, Oklahoma, 1999 to present.

Professional Memberships: American Dietetic Association, Oklahoma Dietetic Association, Oklahoma City District Dietetic Association, Golden Key honor society, Kappa Omicron Nu honor society; Phi Upsilon Omicron honor society.