University of Tennessee, Knoxville
TRACE: Tennessee Research and Creative Exchange

Masters Theses
Graduate School

8-1996

Dietary Staus Index: Association with Food Groups and Body Mass Index in Rural East Tennessee Women Living in Public Housing

Linda Lou Knol
University of Tennessee, Knoxville

Follow this and additional works at: https://trace.tennessee.edu/utk_gradthes

Part of the Nutrition Commons

Recommended Citation

Knol, Linda Lou, "Dietary Staus Index: Association with Food Groups and Body Mass Index in Rural East Tennessee Women Living in Public Housing. " Master's Thesis, University of Tennessee, 1996.
https://trace.tennessee.edu/utk_gradthes/3830

This Thesis is brought to you for free and open access by the Graduate School at TRACE: Tennessee Research and Creative Exchange. It has been accepted for inclusion in Masters Theses by an authorized administrator of TRACE: Tennessee Research and Creative Exchange. For more information, please contact trace@utk.edu.

To the Graduate Council:

I am submitting herewith a thesis written by Linda Lou Knol entitled "Dietary Staus Index: Association with Food Groups and Body Mass Index in Rural East Tennessee Women Living in Public Housing." I have examined the final electronic copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Nutrition.

Betsy Haughton, Major Professor

We have read this thesis and recommend its acceptance:

Paula Zemel, Charles Hamilton

Accepted for the Council:
Carolyn R. Hodges

Vice Provost and Dean of the Graduate School

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

To the Graduate Council:

I am submitting herewith a thesis written by Linda Lou Knol entitled "Dietary Status Index: Association with Food Groups and Body Mass Index in Rural East Tennessee Women Living in Public Housing." I have examined the final copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Nutrition.

Betsy Haughton

Dr. Betsy Haughton, Major Professor

We have read this thesis
and recommend its acceptance:

Paula Zemel

Charles Hamilton

Accepted for the Council:

[signature]

Associate Vice Chancellor and
Dean of the Graduate School

Dietary Status Index:

Association with Food Groups and Body Mass Index

in Rural East Tennessee Women

Living in Public Housing

A Thesis

Presented for the

Master of Science

Degree

The University of Tennessee, Knoxville

Linda Knol

August 1996

Dedication

This thesis is dedicated to my mom and dad. I will always carry a part of you wherever I may go. Thank you.

Acknowledgments

I would like to take this time and acknowledge those people who have influenced my life in ways they will never know. Kathy Lyons taught me how to believe in myself. Dr. Ruth Eshelman showed me what my talents were and how best to use them. Lastly, Dr. Betsy Haughton taught me diligence and professionalism. I am deeply indebted to these women. I would also like to acknowledge Dr. Charles Hamilton and Dr. Paula Zemal not only for serving on my committee, but also for providing the knowledge and tools that make me a better public health nutritionist.

I would like to acknowledge all the staff from the Housing Health Education Rural Outreach (HHERO) Project for their help in collecting data. A special thanks to Dr. Barb Levine and Dr. Bobbi Legg for including a nutrition component in the assessment portion of the HHERO Project.

Lastly, I would like to thank my sisters Laura, Joan and Diane for their love and support.

Abstract

Dietary Status Index: Association with Food Groups and Body Mass Index in Rural East Tennessee Women Living in Public Housing

Objective: To determine if any differences existed in the number of servings per week consumed from designated food groups between women with low, medium or high Dietary Status Index (DSI) scores. Also, to determine if an association exists between Dietary Status Index (DSI) and Body Mass Index (BMI). DSI, a measure of both dietary adequacy and moderation, is the arithmetic mean of the Dietary Adequacy Score (DAS) and the Dietary Moderation Score (DMS).

Subjects: 121 non-pregnant females, 18 years or older living in rural public housing were self-selected from a multi-stage larger study, Housing Health Education Rural Outreach (HHERO).

Design: Health Habits and History Questionnaire (HHHQ) Brief 87 version was used to derive estimated nutrient intakes, which were used to calculate DSI. The DSI score was rank ordered and expressed as tertiles (HIGH, MID, and LOW). Foods from the HHHQ foods list were compressed into 27 food groups and respective servings per week calculated. The women were also categorized as normal/ underweight or overweight using a cut off point for BMI of ≥ 27.3 kg/m^2 to represent the overweight group.

Statistical Analysis: . Kruskall-Wallis test was performed to determine statistical differences between weekly servings per food group and a LOW, MID, or HIGH DSI

($p \leq 0.001$). The Wilcoxon rank-sum test was performed to establish if a difference existed in DSI scores between the overweight and normal/underweight groups.

Results: The only food group whose consumption was found to be statistically different between DSI tertiles was fruits and juices (p=0.0009). Although trends in consumption between DSI tertiles were noted for all food groups, large standard deviations in servings per week limited statistical test differences. Prevalence of obesity in this population sub-group was 51%. Mean BMI (28.85 +/- 7.45 kg/m^2) fell within the obese category. Caloric estimates were slightly higher in the normal weight group than in the overweight group. Means for DSI, DAS, and DMS were 48.39 (+/- 17.50), 46.56 (+/- 28.44) and 50.21 (+/- 31.37), respectively. When DSI (p= 0.91), DAS (p= 0.85), DMS (p=0.90) were tested for between BMI category differences, no statistical differences were found.

Conclusions: The diets of East Tennessee women living in rural public housing could be improved by increasing consumption of fruits and juice. Also, in this study of East Tennessee women no differences were found between DSI, DAS, and DMS scores between those women who were overweight versus those who were normal/underweight.

Preface

To aid the reader, an explanation of the format used for this thesis follows. This thesis consists of three parts. Part I contains an introduction, an extensive review of the literature and the proposed research questions. Parts II and III contain the actual study written in journal style format for two publications.

Table of Contents

List of Tables

List of Figures

Part 1 Introduction, Purpose and Review of Literature

Introduction and Purpose

Knowledge of dietary patterns and nutritional status within a population is the basis for nutrition monitoring. By monitoring nutritional status within a community, the public health nutritionist can plan appropriate dietary interventions. When knowledge of eating patterns or nutritional status is not known, then interventions may not target the specific dietary patterns that are associated with poor health outcomes in the community (1). This study assessed the food group patterns of East Tennessee women living in rural housing projects. Food group patterns rather than nutrient intakes were investigated because interpretation of these patterns can produce very specific intervention criteria (1-4).

A nutritious diet is one which is adequate in nutrients and without excess. The Dietary Status Index (DSI), proposed by the United States Department of Agriculture, measures both dietary moderation and adequacy. The intended use for this index is the measurement of attainment of national dietary recommendations (5). In this study, the DSI was used to analyze food group patterns in terms of dietary moderation and adequacy and examined the association of the DSI with body fatness. Previous studies using DSI measured dietary intake only. This study used for the first time the DSI as a variable in determining associations between it and other variables (Body Mass Index [BMI] and Food Groupings).

The purpose of this study was to determine the association between food group patterns (as measured by food group analysis) and the DSI and body fatness (as

measured by BMI) and the DSI. Based on this analysis, population specific comprehensive dietary interventions can be planned.

A review of the present available literature is discussed next.

Review of the Literature

Introduction

This chapter discusses demographic characteristics associated with poor health outcomes, what specific chronic disease states affect women, and the validity and reliability of the proposed measures and methods (BMI, Health Habits and History Questionnaire [HHHQ], DSI, and food groupings). Lastly this chapter discusses the eating patterns of low income women.

Demographics Associated With Health

Certain populations are at higher risk for developing disease than others. Epidemiologists use demographic characteristics to describe associations between health or disease risk and inclusion in a particular population. Although populations can be divided into many demographic groups, those most often used are income, race or ethnicity, level of education, and place of residence (ie, rural or urban) (6-7).

Healthy People 2000 (8), the national health promotion and disease prevention objectives, reported highest risk populations, those with a greater risk for disease, disability and death, as: low income, minority and the disabled. In an editorial, Blane (6) stated that when United States (US) morbidity and mortality data are expressed in

terms of demographics, morbidity and mortality rates decreased as income and education increased.

The National Longitudinal Mortality Study, analyzed by Sorlie et al (7), reported the relative risk of family income, education, occupation and employment status on mortality. Relative risk is a ratio of the incidence of a disease (in this case morbidity and mortality rates) in persons exposed to a variable (income, education) to the incidence in persons not exposed (9). This was a prospective longitudinal study of non-institutionalized United States citizens who were 25 years of age or older. After adjusting for factors associated with income (ie, employment status, education, marital status and household size), there was a steady decrease in mortality risk as income increased in both sexes. Relative risk for low income populations (income below $5,000) was 1.00 for both men and women, while relative risk for high income populations (income above $50,000) was 0.63 for men and 0.69 for women. Sorlie et al concluded that as income rises, mortality risk decreases (7).

Demographic statistics taken from the Nationwide Food Consumption Survey (NFCS) 1987-88 reported women between the age ranges of 19-24 and 51+ years were less likely to live in households with both a female and male head of household than 25-50 year old females (10). The percentage of women in this national dietary study that were living in poverty was 22.1% of the 19-24 year olds, 9.3% of the 25-50 year old group and 15.4% of the 51+ group (10). A factor playing a significant part in income and poverty is the gender of the household head. The 1990 US Census Data

(11) reported 16% of all households in the US are headed by women and 31% of these households live in poverty. Of the households headed by women with children under 5 years of age, 57% live below the 1989 poverty index. Thus, female headed households are at higher risk for poverty. Income plays a key role in access to medical care, ability to purchase medicine and food, and the stage of a disease at which a person seeks medical attention. All these factors make women living in poverty a vulnerable population.

The Longitudinal Mortality Study addressed relative risk of educational status on mortality. Sorlie et al (7) concluded that relative risk for mortality decreases with increasing educational status. This relationship was strongest in populations under 65 years of age. Of the populations below 65 years of age, relative risk was almost two times higher in people with less than a fourth grade education (rr = 1.35 for women and 1.16 for men) compared to those with a college education (rr = 0.85 for women and 0.70 for men).

The Piedmont Health Survey (12), conducted in five counties of South Carolina, measured the relationship between active life expectancy and educational attainment. Active life expectancy, estimated by using life expectancy tables and years of life left free of disabling diseases, is a good measure of health status. It reflects quality of life not just quantity. The study concluded that people with less than 12 years of education had an active life expectancy of 2.4 to 3.9 years less than those with an educational attainment of more than 12 years.

Blane (6) described five mechanisms that can explain the relationship between educational status and mortality: 1) Educational status is related to resources available in the home as a child and the importance placed on education by the parent. These factors affect attainment of adult educational status and behaviors carried into adulthood. 2) Education and adult occupation are associated. When higher educational status is attained, people can work in more technical/professional jobs, which may have less work-related health risks. 3) Health education messages may be received differently based on educational status. Degree of literacy is important in the understanding of many technical aspects of health and disease. 4) Self concept of a child affects both level of education and behaviors associated with health. 5) Health status during childhood effects future health and educational attainment.

In the Longitudinal Mortality Study, Sorlie et al (7) clearly demonstrated that education and income are independent risk factors for mortality. However, Cronin et al (2) warned that when using demographic data such as income, one must be aware that other factors (ie, education, family size, race) influence results. Therefore, the effects on morbidity and mortality may not be the results of one demographic variable alone, but rather many demographic variables working in concert.

Women's Health

Although women live longer than men, their health may not be as good (13). Women are at greater risk for disabling diseases that affect mobility and decrease the ability to accomplish activities of daily living. Chronic disease states affect women

more than men. Many of the problems women face add to poor health status. These problems include higher rates of poverty, poor access to medical care and lack of education. The American Dietetic Association and the Canadian Dietetic Association (13) in a joint position paper on women's health stated that the top five nutritionally related diseases affecting women are cardiovascular disease, cancer, osteoporosis, obesity and diabetes. These disease states and risk factors are discussed next.

Cardiovascular Disease. Although cardiovascular disease (CVD) is thought of as a man's disease, approximately 52% of all deaths from CVD in North America are among women. CVD is the leading cause of death in women with half of all female deaths in North America attributed to some cardiovascular event (13-14). CVD usually occurs in women 10 to 12 years later than men and women are usually first diagnosed with chronic versus acute stages of heart disease. Educational attainment has a strong association with risk for cardiovascular disease in women (14). CVD is associated with high intakes of total dietary fat, saturated fat, and cholesterol as well as obesity (15). For this reason, a diet low in fat, saturated fat and cholesterol while maintaining a healthy body weight is advised (15-17).

Cancer. Death from all cancers combined is the second leading cause of death in women. Breast cancer is the most frequently diagnosed cancer in women followed by lung and colo-rectal cancers (18). The association of breast cancer and dietary fat is a controversial subject at this time. Epidemiological evidence and animal studies suggest such a relationship exists, but clinical trials do not support this hypothesis (13,

18). Colo-rectal cancer has been associated with a diet high in fat and low in fruits, vegetables and dietary fiber (13). For this reason, a diet low in fat with plenty of fruits, vegetables and whole grain products is advised (16-17).

Osteoporosis. Osteoporosis is a condition where bones become less dense and more porous. Osteoporosis can lead to bone fractures or disability due to decompensation of the spine in post-menopausal women and the elderly. This disease affects women more severely and more often than men. Factors that affect osteoporosis include attainment of peak bone mass within the first 20-30 years of life and rate at which bone is lost later in life. One factor that plays an important role in both peak bone mass and rate of bone loss is calcium intake (19). For this reason, it is critical that a woman's intake of calcium meet or exceed recommended levels throughout her lifetime.

Obesity. Obesity is a risk factor for heart disease, hypercholesterolemia, hypertension, some types of cancer, diabetes, and atherosclerosis. It can contribute to osteoarthritis, gallstones, and social/psychological problems (20-22). Kushner (22) reported that when Body Mass Index (BMI), a measure of body fatness, exceeds 35 kilograms per meters squared, mortality risk doubles, but the strength of this association decreases with age.

Prevalence of obesity in the United States has been tracked by various national surveys over the last 35 years. The first survey that addressed the prevalence of obesity in this country was the National Health Examination Survey (NHES), 1960 to

1962 (23). At that time the prevalence of obesity in the overall population was 24.3%. Women had a slightly higher prevalence (25.7%) than did men (22.8%) with a greater disparity between the two sexes found in the black population (women 41.6%, men 22.1%) (24). From 1971 through 1974 data for the National Health and Nutrition Examination Survey I (NHANES I) were collected (25). Prevalence of obesity increased slightly for the entire population to 25.0% (24). Prevalence increased equally in both races and sexes (24).

Subsequent NHANES surveys (NHANES II and NHANES III) were completed in 1976-1980, and then again in 1988-1991 (26-27). Prevalence of obesity for the entire adult population was 25.4% (NHANES II) and 33.3% (NHANES III) (24). NHANES III data showed a higher prevalence of obesity in women (34.9%) than men (31.7%) with a much greater disparity in the black population (women 49.2%; men 31.8%). Women's prevalence rates for obesity remained equal to men's rates until after age 30. Differences were the largest between men and women in the age range of 50-59 years of age (women 52.0%; men 42.1%). After age 60, the difference in rates between males and females was similar with the rate in women only slightly higher than that in men (women 41.4%; men 40.9%). The prevalence of obesity in the US population has increased dramatically over the last thirty years. Results of national surveys show that US women have a greater tendency toward obesity than men and the greatest risk for obesity is in black women. Since obesity is a

risk factor for many chronic diseases, this risk factor alone places women at greater risk for chronic diseases than men (24).

Diabetes. Obesity places women at greater risk for diabetes mellitus, a metabolic disorder associated with abnormal metabolism of carbohydrate, fat and protein. Diabetes affects over 13 million people in the US. Incidence of diabetes in women is approximately 60% of all new cases (28). Common problems linked with diabetes result from the inability of the body to maintain blood sugar levels (euglycemia) properly within strict parameters resulting in either high blood sugar (hyperglycemia) or low blood sugar (hypoglycemia). Complications associated with high blood sugar include: blindness, heart disease, hyperlipidemia, hypertension, peripheral neuropathy, and nephropathy (28). Complications can be reduced through proper control of diet, medication, and exercise to promote euglycemia (29). Social and cultural factors play an important role in whether a person with diabetes can control her/his diabetes (28).

Nutrition can play a key role in development and possible prevention of cardiovascular disease, some forms of cancer, osteoporosis, diabetes and obesity. The Dietary Guidelines for Americans (17), National Research Council's recommendations on diet and health (16) and the Food Guide Pyramid (30) incorporate the latest research into nutrition goals that Americans can follow to prevent the onset of chronic disease. These recommendations are to decrease the amount of fat, saturated fat, cholesterol and sodium, while increasing the number of servings from fruit, vegetables, low fat dairy and whole grain groups. These

recommendations also include the maintenance of a desirable healthy weight for height. The next section discusses measurements of body weight and determination of body fatness.

Body Mass Index

There are many ways to measure body fatness. The measure of body fatness and that measurement's standard cut off points for obesity and severe obesity affect prevalence rate reporting. Available methods include hydrostatic weighing, skin fold measurements, bioelectric resistance, and combinations of height and weight measures (31).

Hydrostatic Weighing. Hydrostatic weighing is a common technique used to determine percent body fat. The body is composed of two compartments: adipose and lean body mass. The lean body mass compartment consists of bone, muscle and extra-cellular water. Hydrostatic weighing is based on the premise that the adipose compartment weighs less than lean body mass. Subjects are weighed underwater with special equipment. Mathematical equations are utilized in determining percentage of body fat. This technique has been labeled the gold standard for determining body fatness. Limitations are expense and willingness of participants to travel to measurement sites and to undergo the procedure (31). Hydrostatic weighing is not recommended if the participant is elderly, a child, or obese (32).

Skinfold Measures. Skinfold measures are a very common way to determine body fatness (32). Skin is pinched and the diameter of the fat folds is measured with a caliper at specific sites on the body. Measurement requires a caliper and measuring tape. Skinfold measures are easy to administer and portable. Inter-observer error can be introduced if multiple measurements are not taken by a trained professional (31-32). Skinfold measures estimate subcutaneous fat stores (32). When subcutaneous fat is not equally distributed, then single skinfold measures may not provide valid estimations of total body fat. Skinfold measures are best used when multiple measurements at different times and sites can be taken and subsequent measurements are evaluated for changes or in clinical situations when protein calorie malnutrition is suspected (31-32).

Bioelectric Resistance. Bioelectric resistance measurements are based on the premise that the water and electrolyte portion of the lean body mass conducts electricity better than fat mass (31). Electrodes are placed on one hand and the corresponding foot and resistance to an electrical current is measured. Mathematical equations are used to derive the percentage of body fat (32). The procedure is simple, safe and quick (31). However, any condition that may cause water retention (eg, heart failure, hypertension, renal failure, or edema) or dehydration (eg, fever) will decrease its accuracy (32).

Weight and Height Indices. Weight and height measurements are the most common measures of obesity used in epidemiological studies (31). Willett (31) suggests that

height and weight indices used to measure obesity should meet the following criteria: a) correlate well with percent of body fat and b) not correlate with height. Two common obesity measures derived from only height and weight data are relative weight and obesity indices (31).

Relative Weight. Relative weight is weight expressed as a percentage of a standard weight (31, 33). This method often uses a table of heights and weights. The Metropolitan Life Insurance Company's height and weight tables are the most commonly used height and weight tables. They are derived from mortality data gathered from people who purchased life insurance. The weights on the tables are associated with the lowest mortality rate for height and body frame size. The Metropolitan Life Insurance Tables are used to derive desirable or ideal weight for weight gain or loss in the clinical setting (34).

The Metropolitan Life Insurance Tables were established in 1959 for adults 25 years of age and older. In 1983 the tables were revised. The weights in the 1983 tables were slightly higher than the 1959 tables and applied to adults aged 25-59 years of age (32-33). The table's standard weight for height tends to be much lower than standards based on national studies (31). The Dietary Guidelines for Americans contains also a height/weight table derived from National Research Council data (35).

Relative weight correlates poorly with height (33), thus, meeting one of the criteria set by Willett (31). Although, relative weight is easy to interpret, calculate,

and measure, it varies depending on what standard is used (33). This would allow for many interpretations of study data (31).

Obesity Indices. Obesity indices are ratios of height and weight (31). The most accepted ratio used today is Quetelet's Index, which is commonly referred to as Body Mass Index (BMI). BMI is calculated by dividing weight in kilograms by height in meters squared. Of the obesity indices that can be used, Quetelet's Index has the lowest correlation with height, making it the better indicator of body fatness (31). BMI indicates relative fatness and can be a reasonable substitute for other measures of percentage of body fat (21). BMI does not measure percent of body fat directly, but rather measures body fat in relation to height (34). Advantages of using BMI are the elimination of reference height and weight tables (21), the use of one standard value which aids in interpretation, low cost, ease of use, and accuracy (34). Calculations may be more difficult than relative weight, but interpretation is simpler. The disadvantage of BMI is heavily muscled individuals (eg, body builders or construction workers) will have a high BMI, but not necessarily high body fat (34).

Roche et al (36) reported on the validity of BMI as a measure of percent body fat and total body fat. They (36) used underwater weighing as the standard reference data for percent of body fat and total body fat (percent of body fat multiplied by weight). Hydrostatic weighing usually is referred to when testing validity of a measure for body fat composition. Anthropometric data were taken and BMI, weight, relative weight, and other obesity indices were calculated. Among men aged 18 to 49 years,

BMI had the highest correlation with both percent of body fat (0.77) and total body fat (0.87). Among women age 18 to 49 years, BMI had the highest correlation with total body fat (0.92) and the second highest, after tricep skinfolds (0.77), with percent body fat (0.75) (36). Thus, BMI may be used as an indicator of body composition in adults.

Using BMI to Determine Obesity Prevalence. Determining the prevalence of obesity in a population should be dependent on a single standard of one of the previously mentioned measures. A review of the literature revealed that this is not the case (22,33,36-42). Cut off points are established for BMI for overweight and severely overweight. However, a single standard cut off point has not been established and used by all researchers. Some researchers can not even agree on the terminology used to describe obesity. What is termed obese and severely obese by one researcher is termed overweight and severely overweight or morbidly overweight to another researcher (22,33,36-42). Cut off points for overweight based on the Metropolitan Life Insurance Tables are generally 120% of desirable weight for adults age 25-59 years (34) or a BMI of 27.0 kg/meters squared.

The National Center for Health Statistics (NCHS) established cut off points for overweight and severely overweight using NHANES II data (34,37). Overweight was defined as greater than or equal to the 85th percentile of adults age 20-29 years or a BMI of 27.3 kg/m^2 (37). Severe overweight was defined as greater than or equal to the 95th percentile of adults age 20-29 years or a BMI of 32.3 kg/m^2. The age group

of 20-29 years was used as a reference because most adults complete growth or have stopped growing in this decade and therefore weight gain is no longer associated with growth. These cut off points are used as the standard reference to calculate prevalence of obesity for both NHANES II and NHANES III. This standard reference was applied to adults age 20-74 years of age in NHANES II and adults equal to or greater than 20 years in NHANES III (34). The reasoning behind NHANES III using the same standard reference cut off points for obesity as NHANES II was to establish if the population as a whole was heavier in 1988-1991 than in 1976-1980 (34). When using the same cut off point, researchers can analyze trends over time as described earlier in this thesis.

Whether there should be a different standard cut off point for BMI in the elderly and the age at which it should be used are controversial. The normal effects of aging can result in changes in body composition (loss of muscle mass), changes in skin texture, and a slight decrease in height (38). The age at which these changes occur varies with the individual. Chumlea et al (38) reported that after age 50-60 years stature and weight start to decrease. Height can decrease by 0.5-1.5 centimeter per decade, while weight can decrease by approximately 1.0 kg/ decade. Kuczmarski (39) reported changes in body composition, with a decrease in lean body mass, around 75 years of age. He (39) explained the decrease in lean body mass as organ atrophy, loss of skeletal muscle, decease in total body water, and small losses in skeleton depending on degree of osteoporosis. For these reasons, BMI standards will be difficult to

determine in the elderly until a national study incorporating large numbers of elderly citizens can be conducted (37-38). NHANES II (26) only contained data on individuals below 74 years of age. Oversampling of the elderly in the NHANES III study (27) may provide national data necessary to determine BMI standards for categories of obesity in the elderly. However, these data are not available currently. The Dietary Guidelines Advisory Committee (35) in their *Report of the Dietary Guidelines Advisory Committee on the Dietary Guidelines for Americans, 1995* reported no justification at this time for differing BMI cut off points for obesity at differing ages.

Factors Affecting BMI. There are many factors associated with obesity. Tavani et al (43) in a study conducted in Milan, Italy described correlations between BMI and possible factors affecting BMI in 832 women age 19-80 years. His findings were as follows:

- BMI increased with age until age 45-54 years.
- BMI decreased with an increase in education and income.
- Married women had higher BMIs than single women.
- Light and moderate alcohol consumption had no effect on BMI, but heavy alcohol drinkers had lower BMIs.
- Women in the highest category of total energy and total fat intakes had BMIs significantly lower than women with the lowest intakes.

- Oral contraceptive users had higher BMIs than those who did not use oral contraceptives.
- Smokers had lower BMIs than non-smokers.
- No association was found between BMI and servings of bread, vegetables or fruits.
- Number of children a woman had was positively associated with BMI. Women younger than 25 years or older than 35 years at time of first delivery had higher BMIs (43).

Pasquali et al (44) studied the effects of menopause on BMI in 596 women ages 43-58 years. They (44) concluded that women gain weight while going through menopause, but lose some but not all of that weight gain post-menopause.

From the literature (43-44) cited it appears that women at risk for obesity and obesity related diseases are of low income, low educational attainment, with multiple numbers of children, non-smokers, married, and have low calorie and fat intakes.

Dietary Assessment

Dietary data collection methods include dietary history, food records, 24 hour recalls, and food frequency questionnaires. These methods attempt to examine usual and actual dietary intake. No one method can truly measure dietary intake, but from these methods estimates of dietary intake can be obtained. Advantages and disadvantages of each method are explored in this section.

Diet History. A diet history is a combination of the 24 hour recall and a history of eating habits. Extensive interviews are conducted using questions regarding food likes/dislikes and food behaviors (32). Often dietary history can establish eating patterns of the past and present which can be associated with risk factors of disease (45). The disadvantages are requirement of a trained professional to extract a dietary history and amount of time required for data collection (32).

Diet Record. In the diet record method a survey participant records all food and drink consumed in a given time period (32). Participants are trained on how to weigh, measure, estimate portion size, identify cooking preparation techniques and ingredients in recipes and record all foods and beverages eaten. For precise and accurate dietary data, participant compliance and motivation must be extremely high. Diet record data of seven consecutive days is considered optimal to decrease bias due to day to day variation in the diet (32). However, if the length of the survey time becomes too long, then compliance may decline. Bias can be introduced also if a survey participant under-reports foods eaten (46). Strengths of this method are it: does not depend on the participant's memory; provides detailed information of dietary intake; and is reasonably valid. Limitations of this method are: a high degree of participant compliance is needed; participants must be literate; it is time consuming; and the act of recording itself may alter the diet (47).

24 Hour Recall. In the 24 hour recall method, the participant is asked to recall all foods and beverages consumed in a 24 hour period, or the previous day. The recall

includes descriptions of all food and beverages eaten, preparation techniques, and portion sizes (32). This method requires participants with good short term memories. The strengths of this method are it: takes only 15 to 20 minutes to administer; is inexpensive; provides detailed information on foods eaten; requires less participant burden than diet records; can be used to estimate a survey group's nutrient intakes; and does not alter the usual diet. The limitations of this method are it: may not represent usual intake; may under or over-report dietary intake (due to omissions of condiments and beverages) ; and can produce inaccurate data when unusual food intake occurred on the recall day. The 24 hour recall method can be a weak measure of usual dietary intake when high day to day variability exists. When used in large surveys, an assumption is made that deviations in intakes will balance one another. Multiple days of 24 hour recalls and dietary records usually are needed to portray usual dietary intakes more accurately (47-48).

Many factors affect the ability of dietary records and 24 hour recalls to represent usual intake. These factors include: the number of data collection days; nutrients being investigated; whether the collection days represent typical food intake; accuracy of the food record; and survey sample size (49-50). Bastiotis et al (50) used food records obtained over a full year period from 29 subjects to estimate the number of days of food records needed to estimate nutrient intakes to within 10% of the participant's average intake 95% of the time. Researchers assumed that one full year of dietary records could represent usual dietary intake. Bastiotis et al (50) concluded

that the number of days needed to estimate usual dietary intake was 14 days in those individuals with little daily variation in caloric intakes. However, the number of days needed to estimate usual dietary intake increased with an increase in variability of day to day caloric intake. The number of days needed to estimate a group's usual dietary intake was less than that of an individual and increasing the number of subjects decreased the number of days needed. Bastiotis et al concluded also that the number of days of dietary records needed depended on the nutrients in question and the sample size.

In an effort to reveal how often over and underreporting of dietary intake by study participants occurs, Mertz et al (51) compared dietary records to caloric intakes needed for weight maintenance in 266 subjects. Participants were fed an isocaloric diet and asked to keep detailed dietary records for 45 days or more. Of the participants, 81% reported dietary intakes of 700 +/- 379 kilocalories less than intakes necessary to maintain weight, 8% reported diets higher in kilocalories needed to maintain weight and only 11% reported isocaloric intakes. The number of kilocalories reported versus the number of kilocalories required to maintain weight was under-reported by women by 428 kilocalories. No significant changes in weight could explain the discrepancy between reported caloric intake and caloric intake needed to maintain weight (51). Therefore the number of days of dietary data collected, sample size and degree of under or over-reporting are important factors when using dietary records and 24 hour recalls to estimate nutrient intake.

Food Frequency Questionnaire. Food frequency questionnaires (FFQ) can assess usual diet through a series of questions concerning the frequency with which the participant consumes certain foods known to be major sources of dietary components in the diets of similar populations (45,47-48). Foods are grouped together by major nutrients provided (eg, apples and applesauce). Serving size is representative of serving sizes eaten in a larger but similar population. The interviewer asks questions regarding portion sizes consumed and frequency that each food/ food group is eaten. Advantages of using food frequency questionnaire are it: can be self administered or administered by a trained professional; is easy to administer; is low cost; has limited participant burden; and better represents usual intake than other dietary intake methods (47). Limitations of food frequency questionnaire are it: is dependent on the participant's ability to conceptualize and describe his/her diet; may not represent eating patterns, portion sizes, and preparation techniques of certain sub-groups of the population and thus under or over-estimates dietary intake; does not collect data on specific foods but food groups, therefore decreasing accuracy of reporting of specific foods eaten; estimates portion size in broad terms (eg, medium bowl), therefore decreasing accuracy of reporting of portion size; and cannot estimate absolute value of macro and micronutrients (43,52-53).

Food frequency questionnaire (FFQ) can be a useful tool. Appropriate uses include: assessing the relationships between dietary patterns and dietary guidelines (52); assessing relationships between factors affecting dietary intake (ie, dietary

knowledge, attitudes, and behaviors) and health indicators (52); and comparing nutrient intakes of differing demographic groups (53). Since FFQ data are more representative of usual dietary intake, FFQ data can be used to report on the relationship between diet and disease (53).

Block et al (3,54) state that the food list for a FFQ should: include foods that make large contributions to a nutrient's requirement in a population; be short enough to limit the burden placed on the participant, but long enough to include all those foods necessary to ensure adequate nutrient estimations; and include foods in the food list that contribute large amounts of nutrients, but are not consumed as often. Block incorporated these principles into making the National Cancer Institute's (NCI) food frequency questionnaire, entitled Health Habits and History Questionnaire (HHHQ) (3,54). Block et al used NHANES II data to determine the food list and servings sizes of the HHHQ (3,54). HHHQ uses 98 food grouping categories that represent 90% of the US population's consumption of 18 nutrients and 93% of the caloric intake from the NHANES II (55-56). Since US population data were used to determine the food list for the HHHQ, it can be assumed to represent the diets of most persons living in the United States.

HHHQ is comprised of three parts. The first is a food frequency questionnaire that requires a participant to think back over the past year and estimate how often a food or food category was consumed per day, week, month or year and whether his/her usual serving size was small, medium, or large. Foods not on the list can be

added to the end of the list. Respondents can declare foods eaten frequently and not on the list in a separate optional section. The second part consists of additional food questions that may qualify the responses to the food lists. These questions include: how often the participant eats at a variety of different restaurants, how often the participant eats fruits and vegetables or the fat on meats, and food preparation techniques. Researchers using HHHQ can decide which questions in this section fit their research needs best and ask only those questions. The third section asks about vitamin and mineral supplementation. This section is optional for researchers as well. The HHHQ can be self administered or administered through face to face or telephone interviews (55-56).

A diet analysis software program (Health Habits and History Questionnaire, Dietsys Version 3.0, National Cancer Institute; 1994) is provided with the HHHQ. This software program analyzes the three parts of the HHHQ described above. The software includes an edit checking option to identify questionnaires that may be of poor quality. The software analyzes portions using age and sex adjustments and frequency of foods eaten to arrive at estimates of usual nutrient intake. To assure the nutrient intake data are accurate and reliable, a FFQ needs to undergo validity and reliability tests. The following paragraphs in this section discuss these studies.

Reliability or Reproducibility of HHHQ. Reliability or reproducibility is the ability of a FFQ to produce similar results on more than one occasion. This definition assumes that no changes have occurred that would have changed dietary intake in the

interim (47). Block et al (57) state that the following factors may affect results in a study of FFQ reproducibility: subjects may be unreliable; dietary change occurred between the first and second administration of the FFQ; more variables in the questionnaire make the questionnaire less reproducable; poor instructions were given; and improper coding and keying of information into the data system occurred. If a person's diet is standardized or similar day to day, then reproducibility is increased greatly. Keeping these factors in mind, studies done by Leighton et al (58), Mares-Perlman et al (59) and Bittoni et al (60) are discussed. Willett (31) states that correlations of 0.5 to 0.7 are typical for reproducibility studies of dietary assessment methods. Some researchers would consider correlations of 0.5 to 0.7 as low. Willett states that dietary assessment correlations are similar to other epidemiological variables (eg, serum cholesterol, blood pressure, plasma retinol levels, blood glucose, and pulse) and therefore can be considered good in this range (31).

Many studies have looked at reproducibility of the HHHQ. Leighton et al (58) reported on two studies to determine if differences existed between data collected through face to face interviews and telephone interview or self administered questionnaires. In both studies, each group was interviewed twice using the HHHQ approximately two to three months apart. Mean correlations between the first and second administration of the HHHQ ranged from 0.63 for vitamin A to 0.84 for thiamin in the telephone group and 0.42 for vitamin C to 0.71 for calcium in the self administered group. Leighton et al (58) concluded that HHHQ is reliable when used

in both telephone interview or self administration, but less reliable for self administered questionnaires compared to face to face interview.

Mares-Perlman et al (59) administered the HHHQ to participants in the Beaver Dam Eye Study Nutrition Project. Subjects were middle aged and elderly men and women recruited from the Beaver Dam Eye Study. Participants were grouped on the basis of age (43-64 years and 65-86 years) and gender. Subjects were asked to complete the HHHQ and then repeat the process three months later. Spearman coefficients ranged from 0.74 for vitamin A to 0.92 for alcohol in the 43-64 year old men, 0.68 for thiamin to 0.90 for alcohol in the 65-86 year old men, 0.52 for carbohydrate to 0.88 for alcohol in the 43-64 year old women, and 0.51 for vitamin A to 0.85 for alcohol in the 65-86 year old women. Overall correlations for men and women were 0.8 and 0.7, respectively. Average nutrient intakes within groups did not differ significantly between the first and second administration of the HHHQ. Furthermore, no differences were found in reliability between the older and younger groups. Therefore, the HHHQ produced reliable nutrient intake data in both middle aged and elderly males and females (59).

Bittoni et al (60) in the Ohio State University Comprehensive Cancer Center study used the HHHQ via mail. Female participants formed two groups: those with breast cancer and those at high risk for breast cancer. The HHHQ was administered twice to each participant. Those in the breast cancer group described their diet one year prior to onset of illness. Those in the high risk group described their diet over the

previous year. A second HHHQ was conducted with the same set of criteria. Mean correlations for 28 nutrients were 0.66 for the breast cancer group and 0.62 for the high risk group. There were no differences in correlations between the women over 49 or younger or between the women considered obese (BMI over 34.2) and those considered normal or underweight. This study showed that HHHQ can reliably measure dietary intakes of women with breast cancer and those at high risk for breast cancer.

Validity of HHHQ. Validity is the ability of the FFQ to measure dietary intake accurately (47). True nutrient intake can not be measured. Most methods of dietary assessment provide only estimates of nutrient intake. Therefore, validity of FFQ is usually measured against another well accepted method, such as multiple 24 recall, multiple diet records or biological markers. Common problems associated with FFQ validity studies include: a nutrient with high variability in the diet will have lower correlations (eg, vitamin A); using a very extensive interview style will create higher correlations; adequacy of the reference data (database used) varies; and the number of days of diet records or 24 hour recalls used as reference varies (57). In the following discussion of validity, the HHHQ is compared to other methods or instruments to measure dietary intake. Willett (31) states that nutrient mean correlations of 0.5 to 0.6 are typical for validation studies of dietary assessment methods.

Cummings et al (61) attempted to describe calcium intakes in elderly women. The HHHQ was administered to 37 women over the age of 65 years. Diet records

were kept for seven days following administration of the HHHQ. The average dietary calcium intake for the women using the HHHQ was 637 milligrams while the seven day record produced a mean dietary calcium intake of 612 milligrams. The correlation between the two methods was 0.76. Cummings et al (61) concluded that the HHHQ adequately estimated calcium intake in elderly women in their study.

Sobell et al (62) conducted a study to determine if the HHHQ could be used to assess diet 10 to 15 years in the past. They recruited middle aged or older men from the Baltimore Longitudinal Study of Aging. The participants were split into two groups: self administration through the mail and face to face interview. The standard reference data used were multiple seven day diet records taken 10-15 years earlier. Any participant completing 2-4 seven day food records was used in the study. Mean group correlations for the face to face interview group ranged from 0.38 for calcium and linoleic acid to 0.68 for cholesterol. The mail self-administered group had two nutrients, vitamin A (r = 0.07) and niacin (r = 0.20), that were statistically different. The correlations for the remaining nutrients in the mail self-administered group ranged from 0.25 for protein to 0.46 for saturated fatty acids. Thus, correlations were higher for the interviewer group than the mail self-administered group. Correlations between men over or under 65 years were compared. The older men had correlations slightly lower but not statistically different than the younger men. For most nutrients the older men were able to produce similar correlations to those of the younger men for dietary

intake 10-15 years previously. Sobell et al (62) concluded that the HHHQ could be used to assess usual diet 10-15 years previous.

Block et al (63) conducted a study using 260 women from the Women's Health Feasibility Study (WHT). The WHT was designed to aid women in reaching and maintaining a low fat diet. The women were assigned to two groups: regular American diet group and low fat diet group. The reference data were 3 four day diet records collected over one year: baseline, six months and one year. After the year ended, the HHHQ was administered using the previous year as reference. The mean correlation for nutrients in the usual American diet group ranged from 0.47 for vitamin A to 0.67 for percent of calories from fat with an overall mean correlation of 0.55. The mean correlations for the low fat diet group ranged from 0.37 for vitamin A to 0.66 for phosphorous with an overall mean of 0.54. When the data were adjusted for calories, a technique Willett (31) describes as useful when analyzing FFQ data, the mean of the correlations in both groups improved only by 0.02 suggesting calorie adjustments for all the nutrients are not needed with the HHHQ (63).

Block et al (63) compared also both the nutrient means of a 4 day record and of the HHHQ to two 4 day food records. The mean correlations for the usual diet group were similar: 0.50 for the food records and 0.49 for the HHHQ. However, the mean correlations for the low fat group were slightly different: 0.60 for the food records and 0.46 for the HHHQ. This difference was explained by the training the low fat group received in preparing dietary records. Thus, the dietary records of the low

fat group were much more accurate. Block et al (63) concluded that the HHHQ can reasonably assess the dietary intakes of women with differing fat intakes. They concluded that the HHHQ was equally as good as a 4 day food record in determining usual American diet. However, 4 day food record would be the better choice of dietary assessment method in a group of individuals who are well trained in recording dietary intakes (63).

Mares-Perlman et al (59) in the Beaver Dam Eye Study Nutrition Project, discussed previously, compared the validity of the HHHQ to 2 or more two day food records completed by four groups of women and men aged 43 to 64 and 65 to 86 years. Differences seen between the HHHQ and the dietary records included the following: mean energy intakes were similar in the men, but the HHHQ produced lower mean energy intakes for the women than did the food records; HHHQ fat gram estimates were higher than those estimates from the food records; and estimates of nutrients found in meat (protein, thiamin, niacin, iron, and zinc) were lower in the HHHQ than the food records. Vitamin A estimates in the women were lower in the HHHQ than the food records. Spearman correlation coefficients ranged from 0.28 for vitamin A to 0.80 for alcohol in the 43-64 year old men; 0.16 for niacin to 0.79 for alcohol in the 65-86 year old men; 0.21 for niacin to 0.80 for alcohol in the 43-64 year old women; and 0.26 for protein to 0.70 for alcohol in the 65-86 year old women. Overall mean correlations for women and men were 0.5 and 0.6 respectively. Mares-

Perlman et al (59) concluded that the HHHQ can be an accurate estimate of nutrient intake in middle aged and elderly men and women.

Block et al (45) conducted a study of the HHHQ in Michigan on 85 respondents. The participants were of equal numbers of black and white, men and women, and ages 25-34 years and 35-50 years. The reference data were 4 four day dietary records conducted during all four seasons of the year. After the reference data were collected, the HHHQ then was administered using the previous year as the reference point. This HHHQ did not include the two optional questions concerning numbers of fruits and vegetables eaten, which improves correlations of vitamins A and C, fiber and potassium. Mean correlations ranged from 0.42 for sodium to 0.68 for carbohydrate grams with an overall median correlation of 0.57. This study also addressed the effects of portion size reporting on correlation coefficients. The median correlation for the HHHQ where only the medium serving was used was 0.43 versus 0.57 from the HHHQ using the small, medium and large options. Conclusions from this study were that the HHHQ is a good estimate of nutrient intake in a variety of demographic groups and using variable portion size produces more accurate data than medium serving size only.

In conclusion, the HHHQ has been proven to be reliable and valid in many different settings. The best results in terms of reproducibility come when the HHHQ is administered in a face to face interview. No change in reliability or validity occurs between age groups in adults so the HHHQ can be administered to adults of all ages.

It is valid at assessing the present diet, past diet, low fat diets, and the typical American diet. The HHHQ has better correlations when small, median and large servings options are available and when the optional questions relating to fruit and vegetable consumption are used. When comparing the HHHQ and a 4 day food record, the HHHQ produces correlations similar to that of a 4 day food record when assessing the usual American diet. Therefore, the HHHQ, when used as it is designed, is both reliable and valid.

HHHQ Brief 87. A shorter version of the HHHQ (Full 87) was developed to help ease respondent burden. This version (Brief 87) was derived from the Full 87 HHHQ (64). Foods were omitted from the Full 87 by dropping food categories from the original food list when that food category was a lesser source of the nutrient in question. Food categories were omitted when they fell out of the top 80% on all 18 nutrient lists. Omitted food categories then were evaluated on whether they contributed sufficient nutrients in certain demographic groups. If they did, they were added back to the main list. The Brief 87 contains 60 foods. The Brief 87 was compared to the Full 87 and correlations were 0.94 for percent of calories from fat to 0.99 for calcium, cholesterol, thiamin and riboflavin (64).

The Brief 87 has undergone two validation trials (64). Using data already gathered during the validation of the Full 87 from the Women's Health Trial (63) and the Gerontology Research Center (62), Block et al (64) compared the shorter version against 3 four day food records and 2-4 seven day food records obtained 10-15 years

previous. The Women's Health Trial used 3 four day food records as the reference data in women eating the usual American diet and women eating a low fat diet (< 20% calories from fat). The shorter version produced lower estimates of macronutrient intake than both the longer version and the food records, though percent of calories from fat, calcium, vitamins A and C estimates were similar to those from food records. Mean correlations for the Women's Health Trial ranged from 0.46 for calories to 0.66 for percent of calories from fat in the usual diet group and 0.46 for fiber to 0.68 for phosphorous in the low fat group. Although the low fat group had a greater loss in macronutrient estimates, it was not significant. Most micronutrient estimates had similar correlations to the longer version of the HHHQ. Protein grams and carbohydrate grams in the low fat group were the only two nutrients that had statistically different estimates than food records (64).

The interviewer-administered data from the Gerontology Research Center Study (62) were used for the second validation study of the Brief 87 (64). The reference data in this case were 2-4 seven day diet records taken 10-15 years in the past. Group mean correlations ranged from 0.37 for calcium to 0.67 for cholesterol. Differences noted between correlations of the Full 87 HHHQ and the Brief 87 were small. No statistically different estimates in nutrient intakes were noted between the Brief 87 and food records. Therefore, the Brief 87 correlates well with four day food records of persons eating a usual diet and with food records taken 10-15 years ago (64).

Other changes to the Brief 87 were made to increase correlations with food records. Qualifying questions used in the HHHQ adjust nutrient estimates and increase correlations in validity studies. Adding the qualifying questions regarding consumption of fruits and vegetables decreased overestimates of vitamins A and C. Removing the qualifying questions regarding kinds of cooking fat and added table fats decreased the correlation with the Full 87 from 0.96 to 0.94. However, removing this question decreased the overestimate of the absolute value of percent calories from fat. The Brief 87 underestimates macronutrients and overestimates vitamins A and C, though percent of calories from macronutrients is reliable. In conclusion, the Brief 87 was found to be comparable to the Full 87 for estimating nutrient intakes. The Brief 87 can be used to compare nutrient intakes of sub-population groups or can be compared to national data sets when the Brief 87 questionnaire has been used (64).

After calculations are complete and dietary intake is estimated, a set of specific criteria that can be utilized to explain nutrient estimates. Recommended Dietary Allowances (RDAs) (65), National Research Council's recommendations for diet and health (16), Dietary Guidelines for Healthy Americans (17) or the Food Guide Pyramid (30) are often used for this purpose. Other indices have been proposed as reference standards. The next section examines one proposed index.

Dietary Status Index

A healthy diet is one that is both adequate in nutrients and without excesses. The Dietary Status Index (DSI) is an index that measures both adequacy and

moderation in the diet (5). It uses both the National Research Council's (NRC) diet and health goals (16) and the Recommended Dietary Allowances (RDAs) (65) in its calculation. The DSI, recently developed by the United States Department of Agriculture (USDA), measures the overall diet using a scale of 0-100. The USDA will use the DSI in future national nutrition surveys (5).

The DSI has two major components: Dietary Adequacy Score (DAS) and Dietary Moderation Score (DMS). The DAS reflects the adequacy of the diet by assigning a point scale for 15 common nutrients. One point is given for each nutrient intake ≥ 100% of the RDA. DMS reflects moderation by giving points for meeting the following four Dietary Guidelines for Americans and NRC guidelines: 1) limiting fat intake to ≤ 30% calories from fat; 2) limiting saturated fat intake to ≤ 10% calories from saturated fat; 3) limiting dietary cholesterol to ≤ 300 milligrams; 4) limiting sodium intake to ≤ 2400 milligrams. The DAS and DMS are averaged to produce the DSI (5).

Advantages of the DSI are that it is easy to calculate and reflects both moderation (Dietary Guidelines and NRC guidelines) and adequacy (RDAs). Limitations of the DSI are: only 100% of the RDA for a nutrient is declared sufficient; all dietary measures are weighted equally; and DMS does not reflect all of the dietary guidelines. The obvious missing dietary guideline is maintenance of a healthy weight. Information is lacking on how weight or BMI should be incorporated into the DSI.

Obesity is a major diet related US health concern and BMI should be included in this measure (5).

Another issue in calculating the DSI is the appropriate use of the RDA as the cut-off point to calculate DAS. Variety of the diet, storage capacity for a nutrient, and turnover of a nutrient all play a role in whether the RDA for a particular nutrient needs to be met daily or averaged over a period of time. Some nutrients (eg, vitamins A and B12) are stored easily and their turnover is slow. Therefore, the RDA intake of these nutrients could be averaged over a period of days or months without signs of deficiency occurring. Some nutrient intakes (eg, Vitamin A) vary greatly from day to day while others do not (eg, thiamin and niacin). For these reasons, an inappropriate use of the RDAs is the assessment of an individual's intake over one day. Within populations some individuals will consume more than the respective RDAs while some will consume less. Therefore, an entire population's one day intake of a particular nutrient could be averaged to determine population intake and this would be an appropriate use of the RDA. Therefore, if the dietary assessment technique used is 24 hour recall, then only the population average intake for that nutrient can be determined. When calculating the DAS, points are awarded for each nutrient intake over 100% of the RDA for each individual (65). So, those studies using 24 hour recall would use the RDAs inappropriately when calculating the DAS. If DSI, DAS, and DMS were calculated from dietary assessment data that utilized more than one day's

intake (eg, several days worth of food records or food frequency questionnaire), then the RDAs would be used appropriately.

The DSI has been used previously in one study. Basiotis et al (5) calculated the DSI for participants in the USDA's Continuing Survey of Food Intakes by Individuals (CSFII), 1989-1991. The sample for the CSFII consisted of approximately 1500 households and with half the sample of low income. Participants were adults over 20 years of age. Dietary intake was assessed using one 24 hour recall and two subsequent days of food records. From only the 24 hour recall data, nutrient intakes, group mean intakes, and DSI were calculated. The overall mean DSI score for the population was 45.2. Women had higher DSI scores than males, 46.3 and 44.1, respectively. Persons over 50 years of age had a higher mean DSI than persons 50 years or younger. The higher income group had a mean DSI score significantly higher than those of the lower income groups. Persons above 130% of the federal poverty index (FPI) had a mean DSI score of 45.6 versus those persons below 130% of the FPI with a score of 42.9. Women above 130% FPI had an average DSI score of 46.8, while women below 130% had a DSI of 43.9. Results were similar, but scores were slightly lower for men. When assessing DSI and education level, those persons attaining a high school degree had significantly higher scores than those who had less than a high school degree. Women with a high school degree had a mean DSI of 48.7 versus 44.5 in women not attaining a high school degree. The research concluded that the DSI is a good measure of both adequacy and moderation in the diet, the DSI can

be used as a dependent variable in a multi-variable study, and its relationship to obesity needs further investigation at this time (5).

Food Pattern Analysis

Food pattern analysis is synonymous with the term food group analysis. Often dietary intake is reported as nutrients consumed or percent of calories from a nutrient. This approach is limiting in what can be assumed from the data. For example, if a population's vitamin A intake is below 100% of the RDA for vitamin A, then the researcher knows vitamin A is lower than acceptable measures permit and may assume foods high in vitamin A are not eaten, but the researcher does not know which foods or how much. Food pattern analysis allows the researcher to determine which food groupings the population is eating, and their servings sizes and frequency of consumption.

This methodology has several implications. First, foods are not just made of nutrients. Foods have trace amounts of specific constituents not yet known to researchers. Some foods may contain naturally occurring toxic substances that may be implicated in cancer risk (4). Second, the combination of foods chosen may be vital in research on disease causation, especially cancer research (4). Third, variability in the American diet is too great to make wide sweeping hypotheses about which foods are insufficient or missing from the diet when lower than adequate amounts of nutrients are found. Diets of Americans differ due to many factors relating to culture, educational level, income status, and regionality. Researchers should not conclude

that nutrients obtained in one area of the country would come from the same sources as other areas. Fourth, and most important, nutrition education materials and public health nutrition program planning could be much more precise if food grouping analysis were used (1-3,54,66-67). When nutritionists know which foods or food grouping patterns appear most often in the population with which they are working, then nutrition education materials and nutrition counseling can become more precise. Knowing how food usage changes due to seasonal changes, region, race, age or sex can help nutrition educators produce more effective public health messages (68).

Willett in an article entitled *Challenges for public health nutrition in the 1990's* (1) suggests that public health messages should encourage the use of specific targeted foods rather than nutrient guidelines. Further, these messages should be derived from present knowledge of food consumption patterns and behaviors in the population being addressed. Public health messages about nutrient adequacy and excesses leave too much room for public interpretation, which may be false and lead to no behavior changes. Public health messages regarding single foods or food groups may be specific enough to elicit behavior change without ambiguity. No one food should be targeted as a 'bad' food, but poor dietary food patterns can be noted. Food grouping analysis allows the researcher to cluster foods together and identify food groupings that may be more beneficial or deleterious than others (66-67). In conclusion, food grouping analysis may prove to be more beneficial than nutrient intake information.

Many studies have been conducted using data from national nutrition surveys and food grouping analysis. Some vague methodology has been established for grouping foods into specific food groups or clusters. Most researchers set specific protocols on how foods will be grouped prior to the collection of data. Food grouping analysis has been used with both diet recall/ record methods and food frequency questionnaire. No standardized methodologies exist that all researchers at all times use to dictate how foods are grouped into clusters. Criteria used in the past have been similar composition, preparation and uses, nutritional content, or botanical composition (2,69). No method has been considered more valid or more reliable than any other.

The following section describes food grouping analysis studies and their results. Since the focus of this study was low-income women, only data on low income women's diets are presented.

Food Pattern Analysis in Low-Income Women

Food pattern analysis studies can be grouped into two categories: those addressing nutrient adequacy and those addressing moderation. Those studies addressing adequacy are described first.

Food Pattern Analysis Addressing Dietary Adequacy. Cronin et al (2) used Nationwide Food Consumption Survey 1977-78 data to describe demographic variables in food usage. The Nationwide Food Consumption Survey 1977-78 was a stratified probability sample of approximately 15,000 American households. This

survey estimated household and individual consumption patterns. Individual dietary intakes based on 24 hour recall followed by two days of diet records were requested from all household members 18 years of age or less and half the household members over the age of 19 years.

Cronin et al (2) used 65 food groups in their analysis. Demographic variables compared were regionality, urban versus non-metropolitan areas, and income. The US was divided into four regions: northeast, north central, south and the west. Persons living in the South ate more servings of vegetables, and more meat, fish, poultry and eggs than the national average. Southerners ate fewer servings of fruits, milk (all categories including whole, low fat and skim), cheese and yogurt; desserts; and fats. Servings of breads and cereals were similar in all groups.

When individual intakes were analyzed for income, those persons with incomes below $5,000 ate fewer fruits; vegetables; milk (skim only), cheese and yogurt; meat, fish, poultry and eggs; desserts; and fats than did those persons with incomes greater than $20,000. The low income group ate more servings of whole and low fat milk than the higher income group. Servings from the breads and cereals group were similar (2).

When Cronin et al (2) analyzed the data in terms of urban versus non-metropolitan areas, they found the urban group ate more servings of fruit and skim milk than the rural group. The urban group ate fewer servings from the vegetable; breads and cereals; milk (low fat milk), yogurt and cheese; desserts and fats groups

than the non-metropolitan group. Servings of milk in general, whole milk and meat, fish poultry and eggs were similar in both groups. A conclusion drawn from this study was that demographic variables, such as regionality, urbanization, and income, play key roles in food patterns in the US (2).

Kant et al (70) described dietary diversity using the second National Health and Nutrition Examination Survey (NHANES II). NHANES II data were collected between the years 1976 and 1980 and included a one day dietary recall (26). From recall data, Kant et al (70) described intakes of the four basic food groups (fruits and vegetables, grains, meat, and dairy) among varying populations. In the sample of the adult population below 146% of the Federal Poverty Index (FPI), 48% ate two servings of dairy products, 68% ate two or more servings from the meat group, 32% ate four or more servings from the grains group, 23% ate two or more servings from the fruit group, and 51% ate two or more servings of vegetables. The adult population above 146% of the FPI ate more servings of fruits, vegetables, dairy, and meat, but less from the grains group. The researchers concluded that low income populations tended to consume foods from the grains group to compensate for the more expensive and less available fruits, vegetables, meats and dairy (70).

Morris et al (71) compared food choices of persons with high school education or less to those persons with more than a high school education. Persons with less than a high school education were more likely to eat fewer servings of vegetables, high fiber cereal, red meat, poultry or fish, lower fat dairy products, eggs,

and fats, but more likely to eat more servings of fruit (71). Popkin et al (72), in a study of dietary changes in female head of household's eating habits from 1977 to 1985, concluded that with increasing educational attainment in women, the consumption of higher fat meats and milk decreased and higher fiber breads, fruits and vegetable consumption increased (72). Thus, adult education attainment plays a role in food choices.

Food Pattern Analysis Addressing Dietary Moderation. Studies addressing dietary consumption patterns and dietary moderation have focused mainly on percent of calories from fat. Three intervention studies have published changes in dietary consumption patterns in subjects from baseline to conclusion of study (46,49,73). Baseline data in these studies can be considered high fat. In the Multiple Risk Factor Intervention Trial (MRFIT) intervention to reduce risk for coronary artery disease in men, baseline fat intake was greater than 35% of calories from fat (73). Gorbach et al's (49) study of 119 women at risk for breast cancer initially had an average dietary fat intake of 39% of calories from fat. Buzzard et al (46) started with 28 stage 2 breast cancer patients with an average fat intake of 38.4% of calories from fat. Upon conclusion of the intervention, MRFIT participants consumed 33.8%, Gorbach et al study participants ate 22% and Buzzard et al participants ate 22% calories from fat (46,49,73). At conclusion, the diets of the participants in these three studies could be considered low fat. Each study showed a decrease in calories consumed with some weight loss. All three studies showed a slight increase in the percent of calories

coming from protein and a larger increase in percent of calories coming from carbohydrate though grams of carbohydrate stayed the same (46,49,73).

Food group changes in these three studies were similar but dependent on nutritional intervention. In the MRFIT (73) and Buzzard et al (46) studies, the following changes in food consumption were observed: changes in dairy and meat consumption from high fat to low fat, increased consumption of fruits, vegetables and grains and changes in types of fats used in cooking or as spreads, and a decrease in the total amount of fat consumed was found as well. Gorbach et al (49) noted similar changes with one exception: consumption from the grains group did not increase, which was explained by the inclusion of potato chips in the grains group. Buzzard et al (46) reported on nutrient changes in the diet after the intervention. They found zinc and magnesium levels lower than baseline. This was explained by the reduction in meats, nuts and cheese (46). These studies are useful in comparing dietary patterns of low fat and high fat diets. However, they do contain one flaw. Dietary patterns of the low fat group were influenced by the intervention.

Subar et al (69) from the National Cancer Institute, using the annual National Health Interview Survey data (1987), established food grouping patterns and correlated these food groupings with the percent of calories from fat in the general population. The National Health Interview Survey is administered through the Bureau of the Census. This survey is an in home interview of one household member over 18 years of age using the Brief 87 HHHQ to assess dietary intake (69).

Foods from the Brief 87 HHHQ were arranged into 27 food groups based on nutritional content, function of the food in the diet and botanical composition (69). Percentage of calories provided from fat was broken down into quartiles and analyzed by demographics of education, age, income and race. Differences noted included: more Hispanic-Americans were in first quartile (less than 33.9% calories from fat); increasing age brought a decrease in percent of calories from fat; and as income and education rose, the percent of calories from fat decreased. When correlating food groups with percent of calories, there were no differences noted in any demographic group. All low fat eaters (first quartile or less than 33.9% from fat) ate similar median servings per week from the food groups and all high fat eaters (fourth quartile or greater than 43.3% of calories from fat) ate similar servings per week from the food groups with no differences due to demographics (69).

Subar et al (69) noted that as percent of calories from fat decreased, the percent of calories from carbohydrate and protein increased, while consumption of fruits, vegetables, cereal, and low fat dairy increased and consumption of potatoes, starches and breads remained the same. Servings from the fats group in the fourth quartile were twice that of the first quartile. Food groupings with positive correlations with percent of calories from dietary fat were: table fats, processed meats, all meat, salty snacks, red meat, whole milk and cheese, and eggs. Food groupings with negative correlations were: low fat milk, cereal, fruits, vegetables, juice, high fiber breads/cereals and alcohol. The low fat group had lower intakes of vitamin E, zinc

and magnesium than the high fat group. Folate, vitamin C and carotene were higher in the first quartile than in the fourth quartile. There were no significant differences for calcium and iron intakes between the first and fourth quartiles (69).

Conclusions that can be made from these studies addressing dietary consumption patterns and dietary moderation (46,49,69,73) are that low fat eating in the general US population displays certain characteristic eating patterns similar to those eating patterns displayed by participants that have undergone extensive nutrition counseling to reduce percent of calories from fat (46,49,73).

All of these studies either approached food grouping analysis through adequacy or moderation, but not both. Relating the DSI with specific food groupings could result in a list of food groupings consumed by a population that were both nutritionally adequate and without excesses. This list then could form the basis for dietary interventions for this population.

Purpose of Study

The intent of this study was to answer the following questions:

1. For which of the compressed food groups delineated by Subar et al (69) are there significant differences in consumption (servings/ week) between DSI categories (based on tertile distribution) in a population of low income women living in rural public housing in East Tennessee?
2. Are there statistical differences in the DSI score between overweight women and normal or underweight women based on BMI from this population?

References

1. Willett WC. Challenges for public health nutrition in the 1990's. *Amer J Public Health.* 1990;80:1295-1298.

2. Cronin FJ, Krebs-Smith SM, Wyse BW, Light L. Characterizing food usage by demographic variables. *J Amer Diet Assoc.* 1982;81:661-673.

3. Block G, Dresser CM, Hartman AM, Carroll MD. Nutrient sources in the American diet: Quantitative data from the NHANES II Survey. II. Macronutrients and fats. *Amer J Epidemiol.* 1985;122:27-40.

4. Randall E, Marshall JR, Graham S, Brusure J. Patterns in food use and their associations with nutrient intakes. *Amer J Clin Nutr.* 1990;52:739-745.

5. Basiotis PP, Guthrie JF, Bowman SA, Welsh SO. Construction and evaluation of a Diet Status Index. *Family Econ Nutr Rev.* 1995;8:2-13.

6. Blane D. Social determinants of health-socioeconomic status, social status, and ethnicity. *Amer J Public Health.* 1995;85:903-905.

7. Sorlie PD, Backland E, Keller JB. US mortality by economic, demographic, and social characteristics: The National Longitudinal Mortality Study. *Amer J Public Health.* 1995;85:949-956.

8. *Healthy People 2000: National Health Promotion and Disease Prevention Objectives.* Washington, DC: US Dept of Health and Human Services; 1990. DHHS (PHS) publication 91-50213.

9. Monsen ER. *Research: Successful Approaches.* Chicago, IL: The American Dietetic Association; 1992.

10. Murphy SP, Rose D, Hader M, Viteri FE. Demographic and economic factors associated with dietary quality for adults in the 1987-88 Nationwide Food Consumption Survey. *J Amer Diet Assoc.* 1992;92:1352-1357.

11. US Census Bureau. *US Census Data 1990.* Washington DC: Bureau of the Census; 1990.

12. Guralnik JM, Land KC, Blazer D, Fillenbaum GG, Branch LG. Educational status and active life expectancy among older blacks and whites. *N Engl J Med.* 1993;329:110-116.

13. Position of the American Dietetic Association and the Canadian Dietetic Association: Women's health and nutrition. *J Amer Diet Assoc.* 1995;95:362-366.

14. Kris-Etherton PM, Krummel D. Role of nutrition in the prevention and treatment of coronary heart disease in women. *J Amer Diet Assoc.* 1993;93:987-993.

15. *The Surgeon General's Report on Nutrition and Health.* Washington DC: US Dept of Health and Human Services; 1988. DHHS (PHS) publication 88-50210.

16. National Research Council. *Diet and Health: Implications for Reducing Chronic Disease Risk.* Washington DC: National Academy Press; 1989.

17. *Nutrition and Your Health: Dietary Guidelines for Americans.* 3rd ed. Washington DC: US Depts of Agriculture and Health and Human Services. 1990. Home and Gardens Bulletin no. 232.

18. Hankin JH. Role of nutrition in women's health: diet and breast cancer. *J Amer Diet Assoc.* 1993;93:944-999.

19. Wardlaw GM. Putting osteoporosis in perspective. *J Amer Diet Assoc.* 1993;93:1000-1006.

20. St Jeor ST. The role of weight management in the health of women. *J Amer Diet Assoc.* 1993;93:1007-1012.

21. Robinson JT, Hoerr SL, Strandmark J, Mavis B. Obesity, weight loss, and health. *J Amer Diet Assoc.* 1993;93:445-449.

22. Kushner RF. Body weight and mortality. *Nutr Rev.* 1993;51:127-136.

23. National Center for Health Statistics. Plan and initial program of the Health Examination Survey. National Center for Health Statistics. *Vital Health Stat 1*(4). 1965.

24. Kuczmarski RJ, Flegal KM, Campbell SM, Johnson CL. Increasing prevalence of overweight among US adults: The National Health and Nutrition Examination Surveys, 1960-1991. *J Amer Med Assoc.* 1994:272:205-211.

25. National Center for Health Statistics. Plan and operation of the Health and Nutrition Examination Survey, United States 1971-1973. National Center for Health Statistics. *Vital Health Stat 1 (10a)* 1973 and 1(10b) 1977.

26. McDowell A, Engel A, Massey JT, Maurer K. Plan and operation of the Second National Health and Nutrition Examination Survey, 1976-1980. National Center of Health Statistics. *Vital Health Stat 1* (19). 1981.

27. National Center for Health Statistics. Plan and operation of the Third National Health and Nutrition Examination Survey, 1988-1994. Series 1. Hyattsville, MD: National Center for Health Statistics. In preparation.

28. Tinker L. Diabetes mellitus. A priority health care issue for women. *J Amer Diet Assoc.* 1994;94:976-985.

29. The Diabetes Control and Complications Trial Research Group. The effect of intensive treatments of diabetes on the development and progression or long term complications in insulin dependent diabetes mellitus. *N Engl J Med.* 1993;329:977-986.

30. *Food Guide Pyramid: A Guide to Daily Food Choices.* Washington DC: US Dept of Agriculture, Human Nutrition Information Service; 1992. Home and Gardens Bulletin no. 252.

31. Willett W. *Nutritional Epidemiology.* New York: Oxford University Press; 1990.

32. American Dietetic Association. *Handbook of Clinical Dietetics.* 2nd ed. New Haven, London: Yale University Press; 1992.

33. Manson JE, Stampfer MJ, Hennekens CH, Willett WIC. Body weight and longevity: A reassessment. *J Amer Med Assoc.* 1987;257:353-358.

34. Gray DS. Diagnosis and prevalence of obesity. *Med Clinics N America.* 1989;73:1-13.

35. Dietary Guidelines Advisory Committee. *Report of the Dietary Guidelines Advisory Committee on the Dietary Guidelines for Americans, 1995.* Beltsville, MD: United States Dept of Agriculture, Human Nutrition Information Service; 1995.

36. Roche AF, Siervogel RM, Chumlea WIC, Webb P. Grading body fatness from limited anthropometric data. *Amer J Clin Nutr.* 1981;34:2831-2838.

37. Kuczmarski RJ. Prevalence of overweight and weight gain in the United States. *Amer J Clin Nutr.* 1992;55:495S-502S.

38. Chumlea WIC, Baumgartner RN. Status of anthropometry and body composition data in elderly subjects. *Amer J Clin Nutr.* 1989;50:1158-1166.

39. Kuczmarski RJ. Need for body composition information in elderly subjects. *Amer J Clin Nutr.* 1989;50:1150-1157.

40. Bray GA. Pathophysiology of obesity. *Amer J Clin Nutr.* 1992;55:488S-494S.

41. Bray GA. Classification and evaluation of the obesities. *Med Clinics of N Amer.* 1989;73:161-183.

42. Stamler J. Epidemic obesity in the US. *Arch Intern Med.* 1993;153:1040-1044.

43. Tavani A, Negri E, LaVecchia C. Determinants of body mass index: a study from Northern Italy. *Int J Obesity*. 1994;18:497-501.

44. Pasquali R, Casimirri F, Morselli-Labate AM, Tortelli O, Pascal G, Anconetani B, Antonella-Gatto MR, Flamia R, Capelli M, Barbara L. Body weight, fat distribution and the menopausal status in women. *Int J Obesity*. 1994;18:614-621.

45. Block G, Thompson FE, Hartman AM, Larkin FA, Guire K. Comparison of two dietary questionnaires validated against multiple dietary records collected during a 1 year period. *J Amer Diet Assoc*. 1992;92:686-693.

46. Buzzard M, Asp EH, Chlebowski R, Boyar AP, Jeffey RW, Nixon DW, Blackburn GL, Jochimsen PR, Scanlon EF, Insull W, Elashoff RM, Butrum R, Wynder EL. Diet intervention methods to reduce fat intake: nutrient and food group composition of self-selected low fat diets. *J Amer Diet Assoc*. 1990;90:42-50,53.

47. Lee RD, Nieman DC. *Nutritional Assessment*. Madison, WI: Brown and Benchmark Publishers; 1993.

48. Simko MD, Cowell C, Gilbride JA. *Nutrition Assessment: A Comprehensive Guide for Planning Intervention*. Rockville, MD: Aspen Publications; 1984.

49. Gorbach SL, LaBrode A, Woods MN, Dwyer JT, Selles WD, Henderson M, Thompson D, Clifford C, Sheppard L. Changes in food patterns during a low fat dietary intervention in women. *J Amer Diet Assoc*. 1990;90:802-809.

50. Basiotis PP, Welsh SO, Cronin FJ, Kelsay JL, Mertz W. Number of days of food intake records required to estimate individual and group nutrient intakes with defined confidence. *J Nutr.* 1987;117:1638-1641.

51. Mertz W, Tsui JC, Judd JT, Reiser S, Hallfrisch J, Morris ER, Steele PD, Lashley E. What are people really eating? The relation between energy intake derived from estimated diet records and intake determined to maintain body weight. *Amer J Clin Nutr.* 1991;54:291-295.

52. Briefel RR, Flegal KM, Winn DM, Loria CM, Johnson CL, Sempos CT. Assessing the nation's diet: limitation of the food frequency questionnaire. *J Amer Diet Assoc.* 1992;92:959-962.

53. Block G, Subar AF. Estimates of nutrient intake from a food frequency questionnaire: The 1987 National Health Interview Survey. *J Amer Diet Assoc.* 1992;92:969-977.

54. Block G, Dresser CM, Hartman AM, Carroll MD. Nutrient sources in the American diet: Quantitative data from the NHANES II Survey I. Vitamins and minerals. *Amer J Epidemiol.* 1985;122:13-26.

55. Block G, Hartman AM, Dresser CM, Carroll MD, Gannon J, Gardner L. A database approach to diet questionnaire design testing. *Amer J Epidemiol.* 1986;124:453-469.

56. National Cancer Institute. *Dietsys Version 3.0 User's Guide: Health Habits and History Questionnaire: Diet History and Other Risk Factors.* Beltsville, MD: National Cancer Institute, Information Management Services, Inc; 1994.

57. Block G. Hartman AM. Issues in reproducibility and validity of dietary studies. *Amer J Clin Nutr.* 1989;50:1133-1138.

58. Leighton J, Neugut AI, Block G. A comparison of face to face food frequency interviews with telephone interviews and self-administered questionnaires. *Amer J Epidemiol.* 1988;128:891. Abstract.

59. Mares-Perlman JA, Klein BEK, Klein R, Ritter LL, Fisher MR, Freudenheim JL. A diet history questionnaire ranks nutrient intakes in middle-aged and older men and women similarly to multiple food records. *J Nutr.* 1993;123:489-501.

60. Bittoni MA, Wilkins JR. Assessment of the reliability of a diet history questionnaire. *Nutr Cancer.* 1994;21:143-155.

61. Cummings SR, Block G, machinery K, Baron RB. Evaluation of two food frequency methods of measuring dietary calcium intake. *Amer J Epidemiol.* 1987;126:796-802.

62. Sobell J, Block G, Koslowe P, Tobin J, Andres R. Validation of a retrospective questionnaire assessing diet 10-15 years ago. *Amer J Epidemiol.* 1989;130:173-187.

63. Block G, Woods M, Potosky A, Clifford C. Validation of a self-administered diet history questionnaire using multiple diet records. *J Clin Epidemiol.* 1990;43:1327-1335.

64. Block G, Hartman AM, Naughton D. A reduced dietary questionnaire: development and validation. *Epidemiol* 1990;1:58-64.

65. Food and Nutrition Board. *Recommended Dietary Allowances.* 10th ed. Washington DC: National Academy of Sciences; 1989.

66. Nicklas TA, Webber LS, Thompson B, Berenson GS. A multivariate model for assessing eating patterns and their relationship to cardiovascular risk factors: The Bogulusa Heart Study. *Amer J Clin Nutr.* 1989;49:1320-1327.

67. Tucker KL, Dallal GE, Rush D. Dietary patterns of elderly Boston area residents defined by cluster analysis. *J Amer Diet Assoc.* 1992;92:1487-1491.

68. Krebs-Smith SM, Cronin FJ, Haytowitz DB, Cook DA. Food sources of energy, macronutrients, cholesterol, and fiber in the diets of women. *J Amer Diet Assoc.* 1992;92:168-174.

69. Subar, AF, Ziegler RG, Patterson BH, Ursin G, Graubard B. US dietary patterns associated with fat intake: The 1987 National Health Interview Survey. *Amer J Public Health.* 1994;84:359-366.

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

71. Morris DH, Sorensen G, Stoddard AM, Fitzgerald G. Comparison between food choices of working adults and dietary patterns recommended by the National Cancer Institute. *J Amer Diet Assoc.* 1992;92:1272-1274.

72. Popkin BM, Haines PS, Reidy KC. Food consumption trends of US women: Patterns and determinants between 1977 and 1985. *Amer J Clin Nutr.* 989;49:1307-1319.

73. Forder D, Dolecek T, Coleman G, Tillotson J, Brown H, Lenz-Litzow K, Bartsch GE, Grandits G. Dietary intake in the Multiple Risk Factor Intervention Trial (MRFIT): Nutrient and food group changes over 6 years. *J Amer Diet Assoc.* 1986;86:744-751.

Part 2 Dietary Status Index: Association with Food Groups in Rural East Tennessee Women Living in Public Housing

Introduction

Often dietary intake is reported in terms of nutrients composition (1-2). If a population's intake of a particular nutrient is below or above acceptable levels, inferences are made about food consumption based on foods which are good sources of that particular nutrient. However, the researcher truly does not know which foods, what quantities and with what frequency a particular food or food group is eaten. Food pattern analysis or food group analysis allows a researcher to determine this information.

Data from food group analysis studies are important for several reasons. First, foods are composed of more than just nutrients and may have trace amounts of constituents whose functions in the body are not yet known (3). Second, the combination of foods chosen may be vital in research on disease causation (3). Third, variability of the American diet is too great to make a wide sweeping hypothesis about which foods are missing from the population's diet when inadequate or excessive nutrient intake is present. The American diet differs from one sub-population to the next due to many factors such as culture, level of education, income status, and regionality. Lastly, when nutritionists know which food or foods groups are eaten, then nutrition education materials and nutrition interventions can become more precise (4-9).

In a recent article regarding the future of public health nutrition, Willett (4) suggests public health nutrition messages should encourage the use of specific foods

rather than nutrient guidelines. Further, these messages should be derived from present knowledge of food consumption patterns and food-related behaviors in the population being addressed. Public health messages regarding nutrient adequacy and excess may be vague and difficult for the public to interpret. However, public health nutrition messages aimed at single foods or food groups may be specific enough to elicit a behavior change. Food group analysis allows the researcher to identify single foods or food groups that may be more beneficial or deleterious than others (8-9). Therefore, food group analysis may prove to be beneficial in preparing population-specific nutrition education materials.

Food group analysis studies in the past have addressed either adequacy or moderation in the diet (5,10-16). The Dietary Status Index (DSI), recently developed by the United States Department of Agriculture (USDA), measures both dietary adequacy and moderation (17). DSI uses both the Recommended Dietary Allowances (RDAs) (18) and the National Research Council's (NRC) diet and health goals (19) in its calculation. A high DSI score represents a diet that meets both RDAs and NRC goals. A food group analysis using DSI could measure the extent to which foods or food groups contributed to both adequacy and moderation in the diet.

Although women live longer than men, their health may not be as good. Women are at greater risk for disabling diseases that affect mobility and decrease the ability to accomplish activities of daily living. Chronic disease states affect women more than men. Many of the problems women face add to poor health status. These

problems include higher rates of poverty, poor access to medical care and lack of education. The American Dietetic Association and the Canadian Dietetic Association in a joint position paper on women's health stated that the top five nutritionally related diseases affecting women are cardiovascular disease, cancer, osteoporosis, obesity and diabetes (20). For these reasons, low income women were targeted for dietary intervention and study.

This study investigated the eating habits of women living in rural housing projects. The intent of the overall project was to develop culturally sensitive dietary intervention materials for this specific population. The purpose of this study, in particular, was to determine if any significant differences existed in number of medium servings per week from specified food groups between those persons with low, medium or high DSI scores (tertile distribution) in a population of East Tennessee women living in rural public housing.

Methods

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

HHERO Project

Participants for this study were chosen from a larger study, Housing Health Education Rural Outreach (HHERO). HHERO is a project grant funded by the US Department of Health and Human Services to the LaFollette Housing Authority, LaFollette, Tennessee. The grant focuses on primary health care services, health

education and disease prevention for women and children living within the LaFollette Housing Projects in the rural counties of East Tennessee where access to health care facilities may be limited. The grant period runs three years with Year 1 used to assess current health care needs while Years 2 and 3 will focus on interventions addressing the needs identified in Year 1 (21).

HHERO staff recruited participants through door to door solicitation in each of the housing projects that comprise LaFollette Housing Authority in Campbell, Clairborne, Union, Fentress, Morgan and Scott counties from May to December 1995. Figure 1 shows the flow of participants through the larger HHERO project. The female head of household was identified and her participation solicited. Once the female head of household agreed to participate (n=524), the HHERO staff person administered the Carter Health Risk Appraisal (22) in the home (Phase 1).

After the Health Risk Appraisal was completed, the participant could elect to continue to participate, at which time she was escorted to a community room where a trained HHERO staff person measured height, weight, blood pressure and obtained a blood sample (Phase 2) (n=252). Height, in stocking feet, was measured to the nearest 0.1 centimeters (Appendix B). Weight, in light clothing and stocking feet, was measured to the nearest 0.2 kilograms (Appendix B) (23).

After competing Phase 2, the participant could elect to continue or end participation. If she continued, then a face to face, verbal dietary interview (Phase 3, n=211) was conducted by a trained HHERO staff person, using a questionnaire

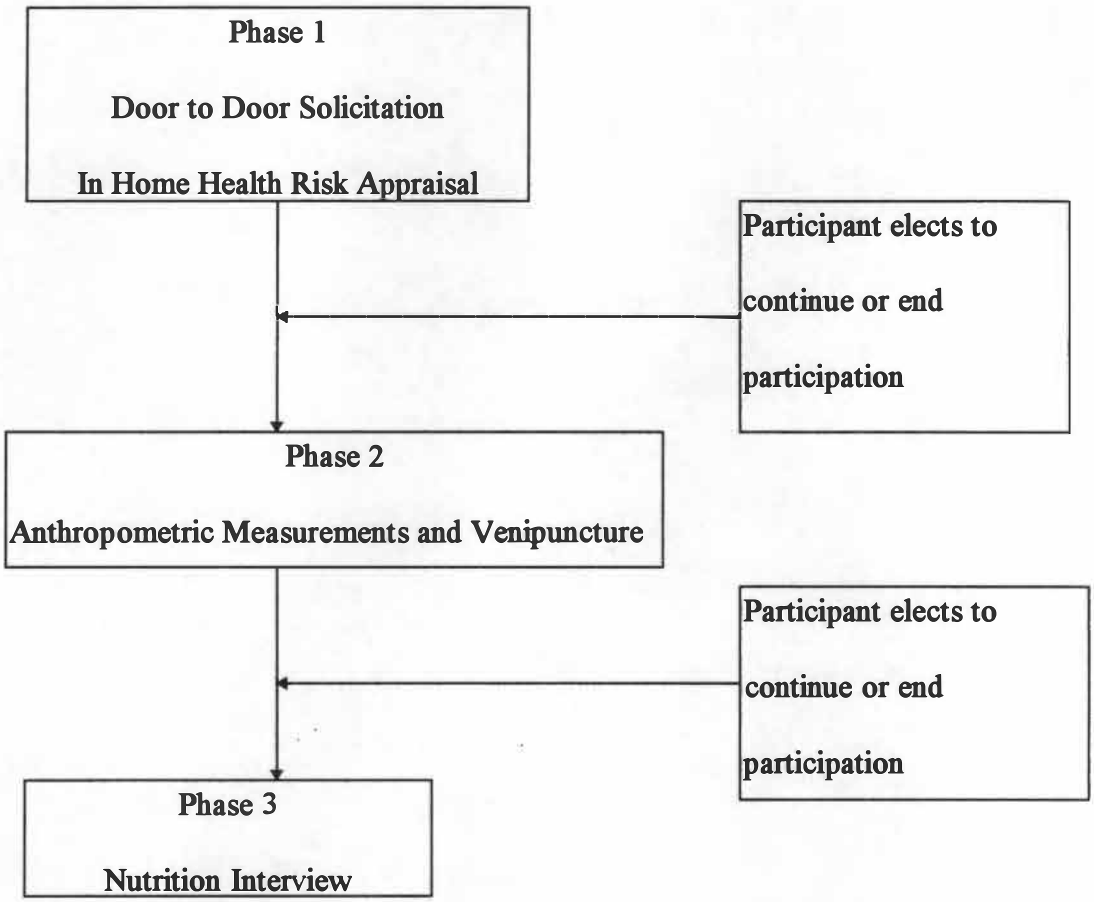

Figure 1: Participant Flow Chart in HHERO Project

adapted from the National Cancer Institute's Health Habits and History Questionnaire (HHHQ) Brief version (Appendix C) (24).

As an incentive to participate in the entire project, a drawing was conducted when interviews of all participants at each site were completed. To qualify for the drawing a participant was required to finish all three phases. The incentive was a cooler full of food. Participation rates for each phase by county are shown in Table 1.

Table 1: Participation rates by county for each phase of the HHERO project			
County	**No. of participants (%) for the Health Risk Appraisal** [1]	**No. of participants (%) for measurements and venipuncture** [1]	**No. of participants (%) for the nutrition assessment (HHHQ)** [1]
Campbell	211 (63)	98 (29)	51 (15)
Claiborne	102 (58)	58 (33)	21 (12)
Fentress	50 (65)	16 (21)	21 (28)
Morgan	35 (73)	17 (35)	25 (52)
Scott	96 (43)	36 (16)	63 (28)
Union[2]	30 (64)	27 (57)	30 (64)
Total	524 (58)	252 (28)	211 (23)

[1] Percent of participation equals number of female head of households participating in phase divided by number of female head of households in LaFollette Housing Authority for that county.
[2] Union County was used as a pilot test of the entire HHERO project protocol. Alterations were made to HHHQ after the pilot test. Therefore, Union County data were not used in the study.

Dietary Interview (Phase 3)

The 60 item HHHQ Brief 87 (24) was chosen over the longer version of the HHHQ due to time constraints. The HHHQ Brief 87 was derived from a longer version of the HHHQ containing 98 foods (25). The 98 item version has proven both reliable and valid in many studies (26-32). Nutrient estimates derived from the Brief version correlate highly (r =0.94 to 0.99) with the longer version (25). The Brief version does produce lower estimates of macronutrient (eg, protein, fat, and carbohydrate) and some micronutrient intakes and higher estimates of vitamins A and C than both the longer version and food records, but is fairly accurate at determining percent of calories from fat (24-25). Thus, the HHHQ Brief 87 is valid at predicting estimates of nutrient intake.

Features of the standard HHHQ were modified to fit the needs of the HHERO project. Optional questions regarding smoking status and vitamin and mineral supplementation were omitted. Two questions were added : 1) "Are you pregnant?" and 2) "Are you on a special diet? If yes, what type?" The first question was asked so the researcher could eliminate all pregnant women from the study. The second question was asked to ascertain the prevalence of reporting special diet use in this population. The 60 item food list remained the same. Serving sizes were reported as small, medium and large. Frequency of food item consumption was reported by day, week, month, and year.

Analysis of the Dietary Questionnaire

All dietary questionnaires were coded, entered and analyzed using Health Habits and History Questionnaire, Dietsys Version 3.0 (National Cancer Institute; 1994). Questionnaire responses were entered, reentered, verified for accuracy of data entry, and then edit checked. The edit check program flags questionnaires that may have significant problems, as per established Dietsys criteria, that would alter nutrient estimates. All questionnaires flagged with severe errors were not used in this study. Nutrient analysis was completed using the database for nutrient estimates (DIETPORT,V30 and DIETNUT.V30) from Dietsys Version 3.0 which is the same database used in NHANES II (24). Nutrient estimates then were utilized to determine the Dietary Status Index.

Participant Selection for Dietary Status Index Study

All participants over 18 years of age with recorded weights, heights and a valid, complete HHHQ were eligible for this study with the exception of all pregnant women. Validity of a questionnaire was established in two ways. First, the interviewer assessed a participant's responses. If a participant's responses were vague or the participant could not follow instructions, the interviewer reported that questionnaire as invalid. Second, all questionnaires with severe error codes were deemed invalid and omitted.

Dietary Status Index

The Dietary Status Index is an arithmetic mean of the Dietary Adequacy Score (DAS) and the Dietary Moderation Score (DMS). Nutrient estimates derived from the HHHQ Brief 87 version were used to determine both DAS and DMS (17). Nutrient estimates for protein, vitamin A, thiamin, riboflavin, niacin, vitamin B6, folate, vitamin C, vitamin E, iron, zinc, calcium, phosphorous, and magnesium were converted to percentages of the RDA based on the age and sex specific RDAs of the individual participant.

Dietary Adequacy Score. DAS is based on RDAs for the following nutrients: protein, vitamin A, thiamin, riboflavin, niacin, vitamin B6, vitamin B12, folate, vitamin C, vitamin E, iron, zinc, calcium, phosphorous, and magnesium. One point is awarded for each nutrient intake that meets or exceeds 100% of the RDA for that nutrient. This allows a participant to have a score of 0 to 15. This score is multiplied by 6 2/3,

so DAS can be represented by a 100 point scale (17). The Dietsys software does not calculate an estimate of vitamin B12 intake. Since no vegans, vegetarians who eat no dairy products or eggs, were identified in this study population, all participants were awarded one point for vitamin B12 intake.

Dietary Moderation Score. The DMS is calculated based on the following criteria: limit dietary fat to ≤ 30% of calories, saturated fat to ≤ 10%, cholesterol to ≤ 300 milligrams and sodium to ≤ 2400 milligrams. One point is given for each nutrient estimate that falls within the above criteria. A total of four points could be awarded. So DMS can be represented by a 100 point scale, the score is multiplied by 25 (17).

DSI Categories. DSI was calculated for each Phase 3 participant. No established standard exists to describe the results of DSI at present (17). Therefore, participant's DSI scores were rank ordered and expressed on a tertile basis. Tertiles were classified as HIGH (upper third), MID (middle third) and LOW (lower third). Tertiles were utilized rather than quartiles to allow a large enough number of participants to fall within each group and, therefore, enhance the statistical ability to test differences between categories.

Food Groupings

The food grouping system used in this study was established previously by Subar et al (16). This system has been utilized with the HHHQ Brief 87 in the National Health Interview Survey (16). Foods from the HHHQ food list were collapsed into 27 food groups based on nutritional content, function of the food in the diet and botanical

composition (16). The food group classification system used in this study is depicted in Table 2.

Servings per week for each food group were calculated in the following manner: 1) Servings per week for each food category of the HHHQ were computed by multiplying daily servings by 7 and weekly servings by 1; or dividing monthly servings by 4 and yearly servings by 52. This resulting number was multiplied by the serving size coefficient: 0.5 for small serving, 1.0 for a medium serving, and 1.5 for a large serving. The product was the servings per week for each food category. 2) To determine servings per food group, the researcher added the number of servings per week from each food item within each food group. For example, if the food group to be calculated was alcoholic beverages, the servings per week were added for the following food categories: beer, wine, and other alcoholic beverages. The sum of these three food items equaled the servings per week for that food group.

Statistics

All data were entered and verified for analysis using Statistical Analysis System (version 5, 1985, SAS Institute, Cary, NC). Descriptive statistics were used to describe demographic characteristics of the population and estimate nutrient intakes and servings per week from the food groups. Since DSI was ranked by tertile, the Kruskal-Wallis test was performed to determine statistical difference between weekly servings per food group and LOW, MID, and HIGH DSI ($p \leq .001$). The likelihood

Table 2: Food groups and their corresponding food categories from the HHHQ	
1. Alcoholic beverages	beer; wine; liquor
2. All breads	white bread, rolls, crackers; dark breads; cornbread, corn muffins, corn tortilla, grits
3. All meat	hamburgers, cheeseburgers, meatloaf; beef, beef stew/potpie; liver; pork; fried chicken; chicken, turkey (baked, stewed or broiled); fried fish, fish sandwiches; bacon; sausage; hot dogs; ham, lunch meats
4. All vegetables	carrots, mixed vegetables with carrots; tomatoes; green salad; broccoli; spinach; mustard greens, turnip greens, collards; coleslaw, cabbage, sauerkraut; french fries, fried potatoes; potatoes (baked, boiled, mashed); sweet potatoes, yams; beans (baked, pinto, kidney, chili)
5. Citrus fruit	orange juice, grapefruit juice; oranges; grapefruit
6. Dairy products	whole milk; 2% milk; skim milk; 1% milk, buttermilk; cheese, cheese spreads
7. Desserts	ice cream; pie; doughnuts, cookies, cake, pastry; chocolate candy
8. Eggs	eggs
9. Fish/ chicken	fried chicken; chicken, turkey (baked, stewed or broiled); fried fish, fish sandwiches
10. Fried potatoes	french fries, fried potatoes; potatoes; potatoes (baked, boiled, mashed)
11. Fruits and juice	orange juice, grapefruit juice; oranges; grapefruit; cantaloupe; apples, applesauce
12. Fruits and vegetables	orange juice, grapefruit juice; oranges; grapefruit; cantaloupe; apples, applesauce; carrots, mixed vegetables containing carrots; tomatoes; green salad; broccoli; spinach; mustard greens, turnip greens, collards; coleslaw, cabbage, sauerkraut; sweet potatoes, yams
13. Garden vegetables	carrots, mixed vegetables containing carrots; tomatoes; broccoli; spinach; mustard greens, turnip greens, collards; coleslaw, cabbage, sauerkraut
14. High fiber bread and cereal	high fiber cereals; dark breads
15. Low fat milk	2% milk, skim milk, 1% milk, buttermilk
16. Non-fried potatoes	potatoes (baked, boiled, mashed)
17. Peanuts	peanuts, peanut butter
18. Processed meats	bacon; sausage; hot dogs; ham, lunch meat
19. Ready to eat cereal	high fiber cereals; highly fortified cereals; other cold cereals
20. Red meat	hamburgers, cheeseburgers, meatloaf; beef; beef stew/ pot pie; pork
21. Salads	green salad; tomatoes; coleslaw, cabbage, sauerkraut
22. Salty snacks	chips, popcorn
23. Soft drinks	soda/soft drinks with sugar
24. Soup and stew	vegetable, vegetable beef, minestrone, tomato soups; beef stew/pot pie
25. Starches	rice; beans (baked, pinto, kidney, chili); french fries, fried potatoes (baked, boiled, mashed); spaghetti, lasagna, pasta
26. Table fats	salad dressing, mayonnaise; butter; margarine
27. Whole milk and cheese	whole milk; cheese, cheese spreads

Source: Subar AF, Ziegler RG, Patterson BH, Ursin G, Graubard B. US dietary Patterns Associated with Fat Intake: The 1987 National Health Interview Survey. *Am J Public Health.* 1994:84; 359-366.
Subar AF. Personal Communication. Bethesda, MD: March 1995.

of finding significant results by DSI tertile when none exists, type 1 error, is highly likely when performing tests for all 27 food groups. For this reason, a high probability level ($p \leq 0.001$) was established. The 27 food groups were condensed into 15 food groups. Those food groups that could not be included in another larger food group were analyzed. For example, garden vegetables are part of all vegetables. Therefore, garden vegetables were omitted and the all vegetable group was analyzed. Although the fruit and vegetable group is comprised of the all fruit group plus the all vegetable group, all fruits and all vegetables were analyzed separately to be consistent with food groups from the Food Guide Pyramid (33).

Results

Of the 181 questionnaires submitted to the researcher after questionnaire pilot testing, 121 proved valid and useful in assessing nutritional status of the eligible female head of households living in LaFollette Housing Authority. Of the 181 questionnaires, 10 were incomplete, 10 were men and 2 were omitted because the women were pregnant. Of the 159 left, 4 more questionnaires were omitted because the interviewer deemed them invalid and 34 were omitted when the nutrition program's edit check system deemed them invalid.

Table 3 shows selected characteristics of both the eligible Phase 3 participants and those deemed valid. The valid and all eligible groups were similar for all characteristics listed. The valid group can be characterized as mostly Caucasian, with a high school education or less.

Table 3: Characteristics of the Phase 3 HHERO sample by validity		
Characteristic	**Only Valid Questionnaires (n=121)**	**All Questionnaires excluding Pregnant Women (n=159)**
Age	48.95 +/- 18.53	48.60 +/- 18.91
Race or Ethnicity		
Caucasian	119 (98%)	155 (97%)
African American	1 (1%)	2 (1%)
Hispanic	1 (1%)	2 (1%)
Education		
8th grade or below	48 (40%)	62 (39%)
Below High School	77 (64%)	99 (62%)
High School	44 (36%)	60 (37%)
Greater than High School	7 (6%)	11 (7%)
Special Diet		
None	87 (72%)	112 (70%)
Weight Loss	3 (3%)	6 (4%)
Unspecified Medical Condition	15 (12%)	21 (13%)
Vegetarian	2 (2%)	2 (1%)
Low Salt	9 (7%)	12 (8%)
Low Cholesterol	12 (10%)	16 (10%)
Unspecified	0 (0%)	1 (1%)
More than 1 Special Diet	8 (7%)	11 (7%)
Height (m)	1.6 +/- 0.1	1.6+/- 0.1
Weight (kg)	74.5 +/- 18.1	74.5 +/- 18.4
BMI	28.85 +/- 7.45	28.76+/- 7.37

In an effort to determine if similarities existed between Phase 1 and Phase 3 participants, responses to 6 selected questions from the Carter Health Risk Appraisal were compared. Three of these questions related to demographic variables: age, race, and highest grade completed. The other three questions related to behavior and included: 1) "How would you describe your cigarette smoking habits?" (never smoked, used to smoke, still smoke); 2) "Do you eat some food every day that is high

in fiber, such as whole grain bread, cereal, fresh fruits or vegetables?" (yes or no); and 3) "Do you eat foods every day that are high in cholesterol or fat such as fatty meat, cheese, fried foods, or eggs?" (yes or no). Of the 121 eligible participants with valid questionnaires from Phase 3, 110 could be matched by identification number to their corresponding Carter Health Risk Appraisal. The frequency of responses to the six questions from the Carter Health Risk Appraisal in all Phase 1 participants and the 110 Phase 3 participants that could be matched are shown in Table 4. Both group responses were similar for race, highest education level attained, fiber and cholesterol/fat intake. The matched Phase 3 participants were more likely to be younger and less likely to have smoked.

To check for interviewer bias a chi-square test was performed to detect any differences in frequency of DSI tertile scores between interviewers. No differences were noted (p= 0.41). Chi-square test to check for temporal changes in DSI score due to changes in season also revealed no differences in DSI tertile scores and season (p= 0.25).

Mean nutrient intakes comprising the DSI score for eligible and valid Phase III participants, hereafter referred to as participants, are shown in Table 5. Mean nutrient estimates were expressed as percentages of the RDA when possible. Mean group nutrient intakes fell below 100% of the RDA for calcium (88%), iron (61%), thiamin (99%), niacin (85%), vitamin E (95%), zinc (68%), vitamin B6 (75%) and magnesium (99%). Of the nutrients representing moderation in the diet, cholesterol and sodium

Table 4: Responses to selected Carter Health Risk Appraisal questions by Phase 1 and matched Phase 3 participants		
Question	**Number of all Phase 1 participants (%) (n=524)**	**Number of all matched Phase 3 participants (%) (n=110)**
Age in years		
18-24	59 (11)	9 (8)
25-44	149 (28)	42 (38)
45-64	151 (29)	35 (32)
65-74	79 (15)	12 (11)
75 and older	85 (16)	12 (11)
No response	1 (0)	0 (0)
Race		
Caucasian	509 (97)	106 (96)
African American	5 (1)	2 (2)
Other	8 (1)	2 (2)
No response	2 (0)	0 (0)
Highest education level		
Grade school or less	223 (43)	46 (42)
Some high school	137 (26)	27 (25)
High school	128 (25)	31 (28)
Some college	32 (6)	6 (5)
College graduate	3 (1)	0 (0)
No response	1 (0)	0 (0)
Smoking status		
Never smoked	189 (36)	47 (43)
Used to smoke	109 (21)	20 (18)
Still smoke	226 (43)	43 (39)
Fiber Intake		
Yes	430 (82)	88 (80)
No	92 (18)	22 (20)
No response	2 (0)	0 (0)
Fat and Cholesterol Intake		
Yes	261 (50)	46 (42)
No	261 (50)	64 (58)
No response	2 (0)	0 (0)

Table 5: Estimated mean participant nutrient intake		
Nutrient	**mean intake (n=121)**	**Percentage of RDA[1]**
Adequacy		
Calories	1376.85 +/- 594.00	
Protein (grams)	52.35 +/- 20.05	104
Fat (grams)	54.81 +/- 27.61	
Saturated fat (grams)	19.11 +/- 10.23	
Carbohydrate (grams)	171.53 +/- 92.21	
Calcium (mg)	703.49 +/- 359.19	88
Phosphorus (mg)	932.69 +/- 370.10	177
Iron (mg)	9.18 +/- 4.23	61
Vitamin A (RE)	1158.35 +/- 1027.07	145
Thiamin (mg)	1.09 +/- 0.49	99
Riboflavin (mg)	1.58 +/- 0.78	121
Niacin (mg)	12.73 +/- 5.84	85
Vitamin C (mg)	115.28 +/- 80.52	192
Folate (mcg)	235.24 +/- 126.24	131
Vitamin E (α TE)	7.56 +/- 4.88	95
Zinc (mg)	8.12 +/- 3.92	68
Vitamin B6 (mg)	1.21 +/- 0.56	75
Magnesium (mg)	278.60 +/- 206.33	99
Moderation		
% Calories from fat	35.22 +/- 7.88	
% Calories from saturated fat	12.20 +/- 3.38	
Cholesterol (mg)	210.14 +/- 128.27	
Sodium (mg)	2127.96 +/- 961.17	

[1] Percentage of RDA calculated using 25-50 female age/sex RDA category.

intakes fell below the National Research Council recommendations while percentage of calories from fat and saturated fat were higher.

Mean weekly servings for each of the 27 food groups is shown in Table 6. The fruits and vegetables group had the highest frequency of consumption or 18.9 servings per week. This population ate more vegetables than fruits, 15.1 and 9.9, respectively. Of the 9.9 servings from the fruit group, 5.3 were from citrus fruits.

Table 6: Mean weekly servings by food group	
Food Group	**Mean Weekly Servings**
Alcoholic Beverages	0.2 +/- 1.2
All breads	8.7 +/- 6.0
All meat	7.4 +/- 4.8
Fish/ Chicken	1.4 +/- 1.1
Processed Meats	3.1 +/- 3.3
Red Meat	2.7 +/- 2.0
Fruits & Vegetables	18.9 +/-14.2
All Vegetables	15.1 +/- 9.7
Garden Vegetables	7.0 +/- 7.3
Salads	4.4 +/- 4.1
Fried Potatoes	1.5 +/- 1.9
Non-Fried Potatoes	2.8 +/- 2.8
Fruits & Juice	9.9 +/- 9.8
Citrus Fruit	5.3 +/- 6.5
Dairy Products	6.6 +/- 5.4
Low Fat Milk	4.0 +/- 4.5
Whole Milk and Cheese	2.6 +/- 3.7
Desserts	5.3 +/- 5.9
Eggs	1.1 +/- 1.4
High-Fiber Bread & Cereal	2.7 +/- 3.7
Peanuts	1.2 +/- 1.8
Ready to Eat Cereal	3.1 +/- 3.4
Salty Snacks	1.9 +/- 3.0
Soft Drinks	6.6 +/-17.3
Soups & Stew	1.4 +/- 1.7
Starches	7.6 +/- 5.2
Table Fats	5.4 +/- 5.1

When salads, potatoes, fried potatoes, sweet potatoes and dried beans were excluded from the vegetable group, only 7.0 servings of garden vegetables were eaten and 4.4 servings of salads. Weekly servings from the all meat group were 7.4. Within this group processed meats (ie, bacon, ham, hot dogs and sausage) were consumed more frequently (3.1 servings per week), compared to red meat and chicken/fish which were consumed 2.7 and 1.4 times per week, respectively. Consumption of dairy products was 6.6 servings per week. When dairy products were chosen, the low fat milk option was consumed more often than high fat milk and cheese, 4.0 versus 2.6. The all breads group was eaten 8.7 times per week, but high fiber breads were eaten only 2.7 times per week. Desserts, salty snacks, and soft drinks were chosen 5.3, 1.9 and 6.6 times, respectively. Servings per week from table fats were 5.4. Consumption of alcoholic beverages was 0.2 servings per week.

Means (+/- standard deviations) for DSI, DAS, and DMS were 48.39 (+/- 17.50), 46.56 (+/- 28.44) and 50.21 (+/- 31.37), respectively.

Table 7 shows the consumption of the 27 food groups by tertile of DSI scores, LOW, MID, and HIGH, and the ratio (HIGH:LOW) of mean servings per food group from the HIGH to LOW tertiles. Three trends emerged in consumption of food groups (servings per week) and DSI tertile. First, in some food groups, servings per week increased from the LOW to MID to HIGH DSI tertiles. These food groups included: all breads, fruits and vegetables, all vegetables, garden vegetables, fruits and

Table 7: Average weekly servings for each food group by DSI tertile				
Food Group	**LOW (n=40)**	**MID (n=40)**	**HIGH (n=41)**	**Ratio: High/Low**
Alcoholic Beverages	0.1 +/- 0.2	0.4 +/- 2.0	0.0 +/- 0.2	0.06
All breads	7.6 +/- 4.7	7.9 +/- 5.0	10.6 +/- 7.6	1.40
All meat	7.5 +/- 4.2	8.9 +/- 5.6	5.9 +/- 4.1	0.78
Fish/ Chicken	1.4 +/- 1.2	1.3 +/- 0.8	1.5 +/- 1.3	1.05
Processed Meats	3.3 +/- 2.8	4.0 +/- 3.9	2.0 +/- 2.9	0.60
Red Meat	2.8 +/- 1.6	3.2 +/- 2.1	2.3 +/- 2.2	0.83
Fruits & Vegetables	12.7 +/- 9.4	18.5 +/- 9.7	25.3 +/- 18.5	2.00
All Vegetables	12.4 +/- 6.1	16.2 +/- 8.0	16.6 +/- 13.2	1.34
Garden Vegetables	5.1 +/- 3.9	6.9 +/- 4.5	9.1 +/- 10.9	1.78
Salads	3.6 +/- 2.7	4.9 +/- 4.0	4.8 +/- 5.1	1.35
Fried Potatoes	1.8 +/- 2.3	1.8 +/- 1.9	0.9 +/- 1.4	0.49
Non-Fried Potatoes	2.5 +/- 2.2	3.0 +/- 3.5	2.8 +/- 2.5	1.09
Fruits & Juice	6.2 +/- 6.2	9.0 +/- 6.4	14.2 +/- 13.3	2.30
Citrus Fruit	2.9 +/- 3.8	5.2 +/- 4.4	7.7 +/- 9.0	2.66
Dairy Products	4.4 +/- 3.2	8.2 +/- 6.1	7.2+/- 5.8	1.63
Low Fat Milk	2.0 +/- 3.2	3.9 +/- 3.5	6.1 +/- 5.6	3.11
Whole Milk and Cheese	2.4 +/- 2.4	4.3 +/- 5.4	1.1 +/- 1.7	0.44
Desserts	5.4 +/- 6.1	6.0 +/- 5.7	4.6 +/- 6.1	0.86
Eggs	1.5 +/- 1.8	1.2 +/- 1.2	0.6 +/- 0.8	0.37
High-Fiber Bread & Cereal	1.3 +/- 2.3	3.0 +/- 4.3	3.8 +/- 3.8	2.98
Peanuts	1.1 +/- 1.9	1.4 +/- 2.0	1.0 +/- 1.6	0.90
Ready to Eat Cereal	1.8 +/- 2.1	3.1 +/- 3.0	4.3 +/- 4.3	2.43
Salty Snacks	1.9 +/- 2.3	1.9 +/- 2.7	2.0 +/- 3.9	1.07
Soft Drinks	4.8 +/- 8.1	4.3 +/- 6.5	10.5 +/- 27.8	2.17
Soups & Stew	1.3 +/- 1.2	1.8 +/- 2.4	1.2 +/- 1.2	0.91
Starches	6.9 +/- 4.2	8.2 +/- 5.1	7.6 +/- 6.1	1.10
Table Fats	5.0 +/- 4.4	6.4 +/- 4.9	4.8 +/- 5.9	0.96

juice, citrus fruit, low fat milk, high fiber bread and cereal, ready to eat cereal, and salty snacks (very slight increase). Second, servings per week in the fried potatoes and egg group decreased with each increase in DSI tertile. Last, servings per week for many food groups increased from LOW to MID and then decreased from MID to HIGH. These groups included: alcoholic beverages, all meat, processed meats, red meat, salads, non-fried potatoes, dairy products, whole milk and cheese, desserts, peanuts, soups and stews, starches, and table fats. Soft drink and chicken/fish consumption decreased slightly from LOW to MID DSI tertile, but increased from MID to HIGH tertile. Soft drink consumption remained the same in the LOW and MID DSI tertile, but increased in the HIGH DSI tertile.

Ratios of HIGH to LOW ranged from 0.37 for eggs to 3.11 for low fat milk. Participants ranked within the HIGH DSI group were 2-3 times more likely to consume fruits and vegetables (2.00), fruit and juice (2.30), citrus fruit (2.66), low fat milk (3.11), high fiber bread and cereal (2.98), ready to eat cereal (2.43), and regular soft drinks (2.17) than those ranked in the LOW group, but less likely to consume fried potatoes (0.49) and eggs (0.37).

Differences in the number of servings from each of the 15 compressed food groups by DSI tertile are shown in Table 8. The fruit and juice group was the only food group to show statistical difference between the DSI tertiles (p=0.0009). However, dairy products (p= 0.009) and ready to eat cereal groups (p=0.003) approached significance.

Table 8: Results of Kruskall Wallis: Servings per Food Group by DSI Tertile	
Food Group	**p value**
All Bread	0.073
Alcoholic Beverages	0.867
All Meat	0.020
All Vegetables	0.105
Dairy Products	0.009
Desserts	0.305
Egg	0.013
Fruit and juice	0.001[1]
Peanuts	0.086
Ready to eat cereal	0.003
Salty Snacks	0.237
Soft Drink	0.844
Soup Stew	0.352
Starch	0.441
Table Fat	0.057

[1] Statistically different at $\alpha \leq 0.001$ level.

Discussion

Mean Nutrient Intakes

The mean nutrient estimates of the women who participated in this study were similar to those reported in national studies (2,17). Basiotis et al (17), using data from the Continuing Survey of Food Intakes by Individuals (CSFII), 1988-1991, reported women consumed less than 100% of the RDA for energy, vitamin E, vitamin B6, calcium, magnesium, iron, and zinc. This study found similar intakes, but in addition found lower intakes for thiamin and niacin. The Third Report on Nutrition Monitoring in the United States (2) reported less than recommended levels of vitamin A, vitamin

E, vitamin B6, calcium, copper, iron, magnesium, and zinc in US women's diets. Except for vitamin A, this study's findings were similar with respect to nutrient intake. The HHERO women's intakes of fat, saturated fat, cholesterol and sodium were similar to those reported for US women from CSFII, 1988-1991 (17).

Dietary Status Index

The Dietary Status Index, Dietary Adequacy Score and Dietary Moderation Score have been used in one study previously (17). Basiotis et al (17) reported on DSI, DAS and DMS from CSFII, 1988-1991 data. Overall, DSI and DAS scores computed from national dietary data were lower in women below the Federal Poverty Index than those in the total population. All three indices were lower in women with a high school education or less compared to those with more than a high school education. Since only 6% of the HHERO women had attained greater than a high school education and all lived in public housing, one would expect all the index scores to be similar to that of the lower income, less educated women in Basiotis et al's study. However, the HHERO women's DSI, DAS and DMS were all slightly higher than all females regardless of income and education. Since Dietsys does not estimate B12 intake, all women were awarded 6.67 points to their DAS score. This may explain the higher DSI and DAS scores. Women on special diets made up 28% of participants in this study, whereas women on special diets made up only 18% of the national study group. This may explain the higher DMS scores seen in the HHERO

Phase 3 women. However, these findings should be studied further as they may represent other factors, such as culture or geographic area.

As noted in Part III of this thesis, the women of this study had a much higher prevalence of obesity (51%) than the current national prevalence (35%) (34). Since obesity is a risk factor for many chronic diseases (eg, heart disease, hypercholesterolemia, some types of cancer, diabetes, and atherosclerosis), these women may be predisposed to chronic disease through obesity (34-37). Therefore, the women may have special dietary considerations due to existing chronic diseases. This may explain the higher frequency of special dietary considerations reported by the HHERO women.

The DSI calculation is limiting in and of itself. DSI is based on whether an individual meets or exceeds a standard, but does not take into consideration to what extent an individual meets that standard. For example, a person getting 99% of the RDA for vitamin C would not receive the points awarded for vitamin C in the DAS score. Thus, the DSI may not be sensitive to slight changes in the diet. Since the DSI is calculated for each individual, the type of dietary assessment measurement used needs to be representative of the participant's overall diet.

Further, in populations with a higher incidence of chronic disease and with a larger percentage of people on special diets, the overall population average DMS may become inflated. Therefore, in this population equal weighting of the DAS and DMS may have led to a higher overall DSI.

In comparison to the Healthy Eating Index (38), proposed by the USDA, the DSI may be easier to compute. The Healthy Eating Index calculates adequacy of the diet through the Food Guide Pyramid (33) food groups. For a researcher, determination of content of each food group by each food consumed may be time consuming and tedious. Another component of the Healthy Eating Index is a variety score. The variety score is based on eating 16 foods in three days. Using the Healthy Eating Index with a food frequency questionnaire would be difficult, although possible if a category were created to identify foods on the list that were eaten in the last three days. Therefore, the DSI is more researcher friendly.

Food Group Analysis

Conclusions from the food group analysis are many. Although not statistically significant, some trends can be seen in food group consumption. First, when mean servings from a particular food group are highest in the LOW DSI tertile, this suggests foods from that food group contribute less to either dietary adequacy (DAS) or moderation (DMS). Only two food groups met this criteria: eggs and fried potatoes. Second, when mean servings from a particular food group are highest in the MID DSI tertile, then foods in this group may represent those that either contribute to adequacy (DAS) or moderation (DMS) or contribute slightly to both. Food groups falling in this category were: alcoholic beverages, all meat, processed meat, red meat, salads, non-fried potatoes, dairy products, whole milk and cheese, desserts, peanuts, soups and stews, starches, and table fats. Third, when mean servings from a food group are

highest in the HIGH DSI tertile, this group's foods contribute to both adequacy and moderation. These food groups included: all breads, fruits and vegetables, all vegetables, garden vegetables, fruits and juice, citrus fruit, low fat milk, high fiber bread and cereal, ready to eat cereal, salty snacks, and soft drinks.

Only one other study has used this food grouping system with the HHHQ Brief 87. Subar et al (16) reported from the National Health Interview Survey, 1988, on the consumption of percent of calories from fat, expressed as ranks and grouped in quartiles, and consumption of the median weekly intakes of the 27 food groups. Caution should be taken when comparing results from Subar et al to this DSI study due to differences in the two populations. Subar et al (16) included all population sub-groups within the US. These researchers concluded that people with dietary fat intakes from the lowest quartile (< 33.9% of calories from fat) ate less salty snacks, peanuts, processed meats, whole milk and cheese, desserts, eggs, fried potatoes, and soft drinks and more high fiber breads and cereals, fruits and fruit juices, ready to eat cereal, citrus fruits, alcoholic beverages, and low fat milk than those people in the highest quartile (>43.3% calories from fat) (16).

Results from this study are slightly different. This study suggests salty snacks, though only slight, and regular soft drinks are part of a healthier diet, but the reverse was seen by Subar et al, where salty snacks and soft drinks were consumed more often by those who consumed a higher fat diet. Salty snacks and soft drinks are not known for their contributions to either dietary adequacy or moderation. A higher soft drinks

consumption in the HIGH DSI tertile in this study can be explained in two ways: 1) the contribution of carbohydrate from the sugar found in the soda increases the percentage of carbohydrate in the diet and thus decreases the percent of calories coming from fat and saturated fat; and 2) the DMS score does not include a variable limiting added sugars in the diet. Both the low fat eaters (Subar et al) and HIGH DSI eaters consumed more fruits and vegetables, fruits and juice, citrus, low fat milk, high fiber breads and cereals and ready to eat cereal, but less fried potatoes and eggs.

The composition of each food group may confound the results. For example, foods listed in the starches group include many foods (eg, rice, dried beans and pasta) that are both high in nutrients and moderate in fat, sodium and cholesterol which would contribute to a HIGH DSI score. However, a few foods within that group (eg, fried potatoes) are higher in fat and consumed more frequently. This could reduce this group's contribution to the DSI score and place it into the category of foods whose highest consumption falls within the MID DSI group. Another confounding factor is that if a food is generally low in fat but typically eaten with a high fat food (eg, salads are usually consumed with salad dressing), then that food group would be high in nutrients but low in moderation components and therefore may appear to contribute more servings per week to a LOW or MID DSI. Lastly, when the HHHQ Dietsys software analyzes foods for nutrient intake, the software averages nutrient estimates for the many different cooking and preparation techniques that may be used with each

food item on the food list. Thus, nutrient estimates derived from the foods list may utilize cooking techniques not utilized by this population.

Those food groups with a HIGH: LOW DSI ratio of 2.0 or greater are twice as likely to contribute to DSI, while food groups with a ratio of less than 0.5 are half as likely to contribute to DSI. Therefore, fruits and vegetables, fruits and fruit juice, citrus fruit, low fat milk, high fiber bread and cereal, ready to eat cereal, and regular soft drinks may contribute to a diet higher in nutrients and lower in moderation components. Eggs and fried potatoes may be part of a diet contributing to a lower DSI score.

Trends in data and ratios of HIGH :LOW DSI were the only means of assessing all of the 27 food groups. Statistical analysis of servings per food group and DSI tertile were performed for 15 of the 27 food groups due to a greater ability to detect a type 1 error with all 27 food groups. When the 27 groups were compressed to 15, only one group, fruits and fruit juice, was found to be statistically different between DSI categories. Since the ratio of HIGH:LOW was greater than 2.0, it can be assumed that persons consuming a diet with a high DSI score are consuming more fruit and fruit juices than those consuming a diet with a low DSI score.

Study Limitations

This study protocol is a self-selected, multi-stage design where the participant elected to continue participation during each stage. Sample bias can be introduced when participants self select. A random sampling technique would be a better means

of selecting a sample. Every effort was made to solicit at least 50% of all female head of households during Phase 1 of the study to increase the likelihood that the Phase 1 sample would represent the population of female head of households living in the LaFollette Housing Authority. However, continued participation through all phases of the study was poor with only 23% of the female head of households completing Phase 3.

When the responses of 6 selected questions from the Carter Health Risk Appraisal from Phase 3 participants were matched by identification number to the Phase 1 participants , the responses were similar for race, highest education level attained, fiber, cholesterol and fat intake. The two study groups differed in age, with the Phase 3 group being younger. The differences in age may be related to the incentive used to encourage participation in all three phases. The younger women, especially those with children, may have had a greater desire or need for the food prize than the older women. The Phase 3 group was less likely to have ever smoked. Since responses to questions regarding dietary variables were similar, the assumption can be made that Phase 1 participants and Phase 3 participants would most likely have similar dietary habits. Thus, information from this study could be extrapolated to participants within the whole study. Lastly, these women represent a subset of the US population mainly low income, Caucasian women from Appalachian culture living in rural public housing. Therefore, study results are limited to only those women living in public

housing in rural East Tennessee since these women may eat in a manner associated with their specific culture, socio-economic status, and level of education.

Conclusions

Improvements in the diets of female head of households living in rural public housing in East Tennessee are needed. Although not proven to be significant, the trends seen between DSI tertiles may suggest that these women could improve their overall diet by increasing the number of servings eaten from all breads, all vegetables, garden vegetables, fruit and juice, citrus fruit, low fat milk, high fiber breads and cereals, and ready to eat cereal and decreasing the number of servings per week from eggs and fried potatoes. However, incorporation of fruit and juice into the diets of these women would significantly raise their DSI score.

Implications

Food group analysis for this small population provided detailed information that could be used in interventions within the community. Educational materials regarding proper sources of inadequate nutrients (eg, calcium and iron) can now be tailored to this population and distributed through HHERO staff.

Research into food groups and their association with the DSI was completed. If the women of this study want to improve their DSI score, they should consume more fruits and fruit juices. Also, eating more servings from the food groups whose highest consumption was in the HIGH DSI tertile could improve the diets of these women.

The DSI is fairly easy to use and compute. Since HIGH DSI scores were associated with greater consumption of soft drinks, DSI may need to include a DMS variable for added sugars.

References

1. *Healthy People 2000: National Health Promotion and Disease Prevention Objectives.* Washington, DC: US Dept of Health and Human Services; 1990. DHHS (PHS) publication 91-50213.

2. Life Sciences Research Office, Federation of American Societies for Experimental Biology. *Third Report on Nutrition Monitoring in the United States. Executive Summary.* US Government Printing Office, Washington DC: US Dept of Agriculture and Us Dept of Health and Human Services;1994.

3. Randall E, Marshall JR, Graham S, Brusure J. Patterns in food use and their associations with nutrient intakes. *Amer J Clin Nutr.* 1990;52:739-745.

4. Willett WC. Challenges for public health nutrition in the 1990's. *Amer J Public Health.* 1990;80:1295-1298.

5. Cronin FJ, Krebs-Smith SM, Wyse BW, Light L. Characterizing food usage by demographic variables. *J Amer Diet Assoc.* 1982;81:661-673.

6. Block G, Dresser CM, Hartman AM, Carroll MD. Nutrient sources in the American diet: Quantitative data from the NHANES II Survey. II. Macronutrients and fats. *Amer J Epidemiol.* 1985;122:27-40.

7. Block G, Dresser CM, Hartman AM, Carroll MD. Nutrient sources in the American diet: Quantitative data from the NHANES II Survey I. Vitamins and minerals. *Amer J Epidemiol.* 1985;122:13-26.

8. Nicklas TA, Webber LS, Thompson B, Berenson GS. A multivariate model for assessing eating patterns and their relationship to cardiovascular risk factors: The Bogulusa Heart Study. *Amer J Clin Nutr.* 1989;49:1320-1327.

9. Tucker KL, Dallal GE, Rush D. Dietary patterns of elderly Boston area residents defined by cluster analysis. *J Amer Diet Assoc.* 1992;92:1487-1491.

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

11. Morris DH, Sorensen G, Stoddard AM, Fitzgerald G. Comparison between food choices of working adults and dietary patterns recommended by the National Cancer Institute. *J Amer Diet Assoc.* 1992;92:1272-1274.

12. Buzzard M, Asp EH, Chlebowski R, Boyar AP, Jeffey RW, Nixon DW, Blackburn GL, Jochimsen PR, Scanlon EF, Insull W, Elashoff RM, Butrum R, Wynder EL. Diet intervention methods to reduce fat intake: nutrient and food group composition of self-selected low fat diets. *J Amer Diet Assoc.* 1990;90:42-50,53.

13. Gorbach SL, LaBrode A, Woods MN, Dwyer JT, Selles WD, Henderson M, Thompson D, Clifford C, Sheppard L. Changes in food patterns during a low fat dietary intervention in women. *J Amer Diet Assoc.* 1990;90:802-809.

14. Forder D, Dolecek T, Coleman G, Tillotson J, Brown H, Lenz-Litzow K, Bartsch GE, Grandits G. Dietary intake in the Multiple Risk Factor

Intervention Trial (MRFIT): Nutrient and food group changes over 6 years. *J Amer Diet Assoc.* 1986;86:744-751.

15. Popkin BM, Haines PS, Reidy KC. Food consumption trends of US women: Patterns and determinants between 1977 and 1985. *Amer J Clin Nutr.* 989;49:1307-1319.

16. Subar, AF, Ziegler RG, Patterson BH, Ursin G, Graubard B. US dietary patterns associated with fat intake: The 1987 National Health Interview Survey. *Amer J Public Health.* 1994;84:359-366.

17. Basiotis PP, Guthrie JF, Bowman SA, Welsh SO. Construction and evaluation of a Diet Status Index. *Family Econ Nutr Rev.* 1995;8:2-13.

18. Food and Nutrition Board. *Recommended Dietary Allowances.* 10th ed. Washington DC: National Academy of Sciences; 1989.

19. National Research Council. *Diet and Health: Implications for Reducing Chronic Disease Risk.* Washington DC: National Academy Press; 1989.

20. Position of the American Dietetic Association and the Canadian Dietetic Association: Women's health and nutrition. *J Amer Diet Assoc.* 1995;95:362-366.

21. Levin B. The Rural Housing Authority Health Outreach Project for Housing Health Education Rural Outreach (HHERO). Project funded by LaFollette Housing Authority through Dept of Health and Human Services, Office of Rural Health Policy. Grant no. CSD000213-01-0. 1995.

22. Healthier People Version 4.0. Health Risk Appraisal Program: Atlanta, GA: Carter Center of Emory University, 1991.

23. Lohman TG, Roche AF, Martorell R. *Anthropometric Standardization Reference Manual.* Champaign, IL: Human Kinetics Books; 1988.

24. National Cancer Institute. *Dietsys Version 3.0 User's Guide: Health Habits and History Questionnaire: Diet History and Other Risk Factors.* Beltsville, MD: National Cancer Institute, Information Management Services, Inc; 1994.

25. Block G, Hartman AM, Naughton D. A reduced dietary questionnaire: development and validation. *Epidemiol* 1990;1:58-64.

26. Leighton J, Neugut AI, Block G. A comparison of face to face food frequency interviews with telephone interviews and self-administered questionnaires. *Amer J Epidemiol.* 1988;128:891. Abstract.

27. Mares-Perlman JA, Klein BEK, Klein R, Ritter LL, Fisher MR, Freudenheim JL. A diet history questionnaire ranks nutrient intakes in middle-aged and older men and women similarly to multiple food records. *J Nutr.* 1993;123:489-501.

28. Bittoni MA, Wilkins JR. Assessment of the reliability of a diet history questionnaire. *Nutr Cancer.* 1994;21:143-155.

29. Cummings SR, Block G, Machinery K, Baron RB. Evaluation of two food frequency methods of measuring dietary calcium intake. *Amer J Epidemiol.* 1987;126:796-802.

30. Sobell J, Block G, Koslowe P, Tobin J, Andres R. Validation of a retrospective questionnaire assessing diet 10-15 years ago. *Amer J Epidemiol.* 1989;130:173-187.

31. Block G, Woods M, Potosky A, Clifford C. Validation of a self-administered diet history questionnaire using multiple diet records. *J Clin Epidemiol.* 1990;43:1327-1335.

32. Block G, Thompson FE, Hartman AM, Larkin FA, Guire K. Comparison of two dietary questionnaires validated against multiple dietary records collected during a 1 year period. *J Amer Diet Assoc.* 1992;92:686-693.

33. *Food Guide Pyramid: A Guide to Daily Food Choices.* Washington DC: US Dept of Agriculture, Human Nutrition Information Service; 1992. Home and Gardens Bulletin no. 252.

34. Kuczmarski RJ, Flegal KM, Campbell SM, Johnson CL. Increasing prevalence of overweight among US adults: The National Health and Nutrition Examination Surveys, 1960-1991. *J Amer Med Assoc.* 1994:272:205-211.

35. St Jeor ST. The role of weight management in the health of women. *J Amer Diet Assoc.* 1993;93:1007-1012.

36. Robinson JT, Hoerr SL, Strandmark J, Mavis B. Obesity, weight loss, and health. *J Amer Diet Assoc.* 1993;93:445-449.

37. Kushner RF. Body weight and mortality. *Nutr Rev.* 1993;51:127-136.

38. Center for Nutrition Policy and Promotion. *The Healthy Eating Index.* Washington DC: United States Department of Agriculture; 1995.

Part III Dietary Status Index: Association with Body Mass Index in Rural East Tennessee Women Living in Rural Public Housing

Introduction

The role of diet and its contribution to obesity is fairly controversial. Many confounding factors exist, such as effects of smoking and alcohol consumption, socio-economic status, genetic predisposition to obesity, metabolic abnormalities and level of physical activity. If positive energy balance was a predictor of weight gain and Body Mass Index (BMI) a predictor of energy needs, then obese individuals should consume a higher energy diet than normal weight individuals. However, studies addressing caloric intake of the obese versus the non-obese have found little or slight differences in energy intake between the two groups (1-3).

Dietary composition may explain obesity partially when caloric intakes are similar (1,2,4). In ecological studies the association between dietary fat and BMI varies (4). These variations may be explained by the quality of dietary assessment methods utilized and how obesity is measured (4). In most of the cross sectional studies addressing dietary fat and BMI, dietary fat is positively associated with BMI (1,2,4). In the Nurse's Health Study (5), dietary fat was positively associated with recent weight gain in female nurses. A study (6) addressing dietary fat intake and women predisposed to obesity (at least one obese parent) concluded that high dietary fat intake was associated with weight gain in these women. Dietary fiber was inversely associated with BMI while added sugars, those not found originally in a particular food, were positively associated with BMI and recent weight gain (1,5). Thus, dietary components may have significant effects on BMI.

The Dietary Status Index (DSI), proposed by the United States Department of Agriculture, measures both adequacy and moderation in the diet (7). The intended use of this index is the measurement of attainment of national dietary recommendations. The DSI is composed of a Dietary Moderation Score (DMS) and Dietary Adequacy Score (DAS). The DMS measures attainment of the National Research Council's recommendations (8) to limit fat, saturated fat, cholesterol and sodium in the diet, while the DAS measures attainment of the Recommended Dietary Allowances (9) for 15 nutrients. If the DSI is truly a measure of the recommended overall diet, then DSI could be used in studies linking diet and disease causation. Since the DSI encompasses the national recommendations (8-10) for diet, then a high DSI score should be associated with less chronic disease. However, computation of DSI does not include a key recommendation of the Dietary Guidelines for Americans (10) which is maintenance of a healthy weight (7). If a high DSI score represents the best possible diet, then a high DSI score should be inversely associated with BMI if overall diet quality plays a large role in obesity. This study determined if a difference in DSI scores existed between overweight women and normal/underweight women in a population of East Tennessee women living in rural public housing.

Methods

A description of the methods used to determine participant selection (in both the HHERO project and the DSI study), development and analysis of the HHHQ, and

calculations of the Dietary Status Index were described in detail in Part 2 . To save the reader time, only those methods not previously mentioned will be discussed here.

BMI Categories

BMI was calculated using the following equation: Weight (kg)/ height $(m)^2$. The subjects were divided into two groups based on their BMI. The National Center of Health Statistics (NCHS) has established cut off points for overweight in women at ≥ 27.3 kg/m^2. This cut off point has been used to describe overweight in the US population since NHANES II (11-12). All study participants whose BMI < 27.3 kg/m^2 fell into the normal/ underweight category, while those participants whose BMI ≥ 27.3 kg/m^2 fell into the overweight category.

Statistics

All data were entered and verified for analysis using Statistical Analysis System (version 5, 1985, SAS Institute, Cary, NC). Descriptive statistics were used to describe demographic characteristics of the population. Mean and standard deviations for nutrient estimates were calculated. After failing to meet assumptions of normality, even after log transformation, a Wilcoxon rank-sum test ($\alpha = 0.05$) was performed to establish if a difference existed in DSI scores between the overweight BMI group and the normal/ underweight group.

Results

Of the 524 women who participated in Phase 1, 211 completed the dietary interview. Of the 211 HHHQ submitted, 121 were deemed valid for use in this study

(30 were involved in the pilot study, 22 did not meet criteria for study, 34 were omitted due to severe errors reported by Dietsys, and 4 were omitted due by interviewer). The characteristics of the Phase 3 HHERO sample with valid questionnaires, hereafter referred to as the participants or sample, are shown in Table 1. These women were mainly Caucasian (98%) with less than a high school education (64%) and 72% had no special dietary considerations.

Table 1: Characteristics of the HHERO Phase 3 sample

Characteristic	**Valid Questionnaires (n=121)**
Age (years)	48.95 +/- 18.53
Race or Ethnicity	
Caucasian	119 (98%)
African American	1 (1%)
Hispanic	1 (1%)
Education	
8th grade or below	48 (40%)
Below High School	77 (64%)
High School	44 (36%)
Greater than High School	7 (6%)
Special Diet	
None	87 (72%)
Weight Loss	3 (3%)
Unspecified Medical Condition	15 (12%)
Vegetarian	2 (2%)
Low Salt	9 (7%)
Low Cholesterol	12 (10%)
Unspecified	0 (0%)
More than 1 Special Diet	8 (7%)
Height (m)	1.61 +/- 0.07
Weight (kg)	74.50 +/- 18.14
BMI (kg/m^2)	28.85 +/- 7.45

Table 2 depicts the population characteristics by BMI categories. Both age and height are similar between BMI categories, while weight and BMI are different. In this study the prevalence of obesity was 52%.

Table 2: Population characteristics by BMI categories		
Characteristic	**Normal/ Underweight Category (n=59)**	**Overweight Category (n= 62)**
Age (years)	49.55 +/-18.2	48.37 +/- 18.96
Height (m)	1.62 +/-.05	1.60 +/- .08
Weight (kg)	61.09 +/- 8.91	87.25 +/- 15.27
BMI (kg/m^2)	23.10 +/- 2.66	34.31 +/- 6.34

Nutrient estimates by BMI category are listed in Table 3. Calorie estimates were slightly higher in the normal weight group than in the overweight group. All other nutrient estimates were similar between groups. The percentage of the RDA for each mean nutrient estimate was calculated using the 25-50 year old female RDA category. Both categories consumed less than 100% of the RDAs for the following nutrients: calcium, iron, niacin, vitamin E (94%), zinc (69%), and vitamin B6. Those in the overweight group consumed 100% of the RDA for thiamin and magnesium, while those women in the normal/underweight group consumed less than 100% despite the normal/underweight group consuming slightly more calories.

Means (+/- standard deviations) for DSI, DAS, and DMS were 48.39 (+/- 17.50), 46.56 (+/- 28.44) and 50.21 (+/- 31.37), respectively, or approximately 50% of the maximum score for each index. The DSI, DAS and DMS by BMI category are shown in Table 4. When the DSI, DAS and DMS scores were tested for BMI

Table 3: Mean nutrient estimates by BMI category				
Nutrient	**Normal/ Underweight Category (n= 59)**		**Overweight Category (n=62)**	
	Nutrient Estimate	**% RDA[1]**	**Nutrient Estimate**	**% RDA[1]**
Calories	1424.83 +/- 625.48		1331.19 +/- 563.91	
Protein (g)	53.80 +/- 21.43	108	50.98 +/- 18.72	101
% Calories from protein	15.73 +/- 3.95		15.99 +/- 3.37	
Fat (g)	55.79 +/- 28.81		53.87 +/- 26.61	
% Calories from fat	34.57 +/- 8.05		35.84 +/- 7.72	
Saturated fat (g)	19.58 +/- 11.10		18.66 +/- 9.39	
% Calories from saturated fat	11.95 +/- 3.47		12.43 +/- 3.30	
Carbohydrate (g)	180.11 +/- 103.87		163.37 +/- 79.54	
% Calories from carbohydrate	50.54 +/- 8.67		49.06 +/- 8.49	
Cholesterol (mg)	212.81 +/- 124.11		207.60 +/- 133.06	
Sodium (mg)	2167.96 +/- 960.71		2089.90 +/- 967.89	
Calcium (mg)	717.37 +/- 380.25	90	690.27 +/- 340.53	86
Phosphorus (mg)	947.02 +/- 384.16	118	919.05 +/- 358.81	115
Iron (mg)	9.17 +/- 3.46	61	9.20 +/- 4.87	61
Vitamin A (RE)	1139.61 +/- 857.01	143	1176.20 +/- 1173.09	147
Thiamin (mg)	1.06 +/- 0.39	96	1.11 +/- 0.58	111
Riboflavin (mg)	1.58 +/- 0.73	122	1.57 +/- 0.83	121
Niacin (mg)	12.57 +/- 4.96	84	12.87 +/- 6.60	86
Vitamin C (mg)	111.61 +/- 66.18	186	118.77 +/- 92.55	198
Folate (mcg)	227.41 +/- 96.72	126	243.27 +/- 149.44	135
Vitamin E (α TE)	7.53 +/- 4.44	94	7.59 +/- 5.31	95
Zinc (mg)	8.24 +/- 3.92	69	8.01 +/- 3.94	67
Vitamin B6 (mg)	1.19 +/- 0.44	74	1.22 +/- 0.62	76
Magnesium (mg)	259.16 +/- 188.90	93	297.09 +/- 221.59	106

[1] Percentage of RDA for each nutrient estimate was determined using the 25-50 year old female age/sex category.

Table 4: Dietary Status Index, Dietary Adequacy Score, Dietary Moderation Score by BMI category			
Index Score	**Normal Weight/ Underweight**	**Overweight**	**p Value**
Dietary Status Index	48.32 +/-17.05	48.44 +/- 18.04	0.91
Dietary Adequacy Score	47.07 +/- 28.68	46.08 +/- 28.44	0.85
Dietary Moderation Score	49.58 +/- 33.31	50.81 +/- 29.67	0.90

category differences, no statistically significant differences were found at the α=0.05 by Wilcoxon rank-sum test.

Discussion

Nutrient Intakes

Estimated nutrient intakes of the women were similar to those reported through 24 hour recall on women from the USDA's Continuing Survey of Food Intakes by Individuals (CSFII), 1988-1991 (7). Both the overweight and normal/underweight women consumed less than 100% of the RDA for calcium, iron, niacin, vitamin E, zinc, vitamin B6. In addition the normal/underweight group consumed less than 100% of the RDAs for magnesium and thiamin. Women from the CSFII, 1988-1991 consumed less than 100% of the RDA for calcium, iron, vitamin E, zinc, vitamin B6, and magnesium. The only differences in these studies were the HHERO women also consumed less than 100% of the RDA for thiamin and zinc (7). Peterkin (13) used CSFII (1985) data and reported on the diets of women living below 130% of the Federal Poverty Index. Their intakes were below 100% of the RDA for energy, calcium, iron, magnesium, zinc, vitamin B6, folate and vitamin E. The Third

Report on Nutrition Monitoring in the United States (14) reported that the median intakes for vitamin A, vitamin E, vitamin B6, zinc, magnesium and copper were below RDAs for most population subgroups, but women's intakes were also low in iron and calcium. Therefore, nutrient adequacy in this study was similar to that of national studies with the exception of niacin, which was below 100% of the RDA in this study, and thiamin, which was below 100% in the normal/ underweight women in this study.

Moderation of women's dietary intake by limiting fat, saturated fat, cholesterol and sodium was assessed in this study and in CSFII, 1989-1991. The HHERO women had similar intakes to the women in the CSFII for percent of calories from fat, cholesterol and sodium (7).

BMI

Since obesity in this study was determined using the same cut off values as National Health and Nutrition Examination Surveys (NHANES), prevalence of obesity can be compared. National data from NHANES III, 1988-1991, reported 34.9% of women as obese (15). The prevalence of obesity in this study was 52%. Thus this population of women tended to be heavier than women in the general US population.

DSI

The Dietary Status Index, Dietary Adequacy Score, and Dietary Moderation Score were computed in one study (7) previously. Dietary intake data from CSFII, 1989-1991 was utilized to compute all three indices. Overall DSI, DAS and DMS for women in the national study was 46.3, 44.3 and 48.3, respectively (7). The DSI (43.9)

and DAS (38.5) were slightly lower for women at or below 130% of the Federal Poverty Index (7), while the DMS (49.3) was slightly higher. The DSI (44.5), DAS (42.3), and DMS (46.6) were all slightly lower in women with a high school education or less than those with more than a high school education. Since only 6% of the HHERO women had attained an education greater than high school and the women were income eligible for public housing, one would expect DSI, DAS and DMS scores to be similar to the lower income, less educated women in the national study. However, this was not the case. Scores were higher for all three indices (DSI=48.4, DAS=46.5, and DMS=50.2) in this study than all females regardless of income and education in the national study.

Factors that may account for the higher DSI, DAS, and DMS scores are many. Since Dietsys Version 3.0 (16) did not estimate B12 intake, all participants were awarded 6.67 points that contributed to the DAS score. This may have contributed slightly to the higher DSI and DAS scores, but would not have contributed to the higher DMS scores. Of the four nutrient estimates that comprise the DMS, two (percent of calories from fat and percent of calories from saturated fat) were slightly higher for the HHERO women than women in the national study (7), while mean cholesterol and sodium intake were slightly less than the national study. Women on special diets made up 28% of the sample from the HHERO project, whereas women on special diets only made up 18% of the national study group (7). This may explain some of the differences in DMS scores between the two groups. Obesity is a risk

factor for many chronic diseases (17-19). Since the women in this study had a greater prevalence toward obesity than women participating in national studies, these women may be predisposed to chronic disease through obesity. Therefore, a greater prevalence of special diets associated with chronic disease may be seen in this population.

Limitations

Bias can be introduced when using a self selected sample if the people who participated were different in ways that may confound the data than the people who elected not to participate. To decrease sampling bias, every effort was made to elicit at least 50% of all female head of households living in the LaFollette Housing Authority for Phase 1. Phase 3 participants were similar to Phase 1 participants in race and level of educational attainment, but Phase 3 women were younger than Phase 1 women. When responses to questions from the Carter Health Risk Appraisal (20) regarding smoking status, fiber and fat and cholesterol intakes were compared, Phase 1 and Phase 3 women had similar responses to the dietary questions but the Phase 3 women were less likely to smoke. Since smoking status is a confounding factor in obesity (1-3) caution should be taken when applying study results to the larger HHERO population. Also, woman participating in this study would be considered low income, rural, and from an Appalachian culture. Cultural practices that affect eating habits may influence the components comprising the DSI. Therefore, results of this

study could not be extrapolated to populations living outside the Appalachian area or in private sector housing.

Confounding factors to BMI were not controlled in this study (eg, cigarette and alcohol use, socioeconomic status, genetic predisposition to obesity, metabolic abnormalities and level of physical activity). Also, as previously mentioned, the DSI calculation is limiting in and of itself. DSI is based on whether an individual meets or exceeds a standard, but it is not based on the extent to which an individual meets that standard. For example, a person getting 99% of the RDA for vitamin C does not receive the points awarded for vitamin C in the DAS score.

Conclusions

This study shows there is no difference in DSI, DAS, and DMS scores between those women who were categorized as overweight or those categorized as normal/underweight in rural East Tennessee women living in rural housing projects.

Implications

From the results of this study, it may be concluded that the women from the HHERO project population have a higher prevalence of obesity than women in the larger US population. Also, DSI, DAS and DMS scores do not appear to differ significantly between women who are categorized as normal/ underweight and those who are categorized as overweight. Thus, factors other than diet may contribute to obesity in this population. HHERO staff should address obesity in this population not only from a dietary standpoint, but also through increased physical activity.

References

1. Miller WC, Niederpruem MG, Wallace JP, Lindeman AK. Dietary fat, sugar and fiber predict body fat content. *J Amer Diet Assoc.* 1994;94:612-615.

2. Romieu I, Willett WC, Stampfer MJ, Colditz GA, Sampson L, Rosner B, Hennekens CH, Speizer FE. Energy intake and other determinants of relative weight. *Am J Clin Nutr.* 1988;47:406-412.

3. Tavani A, Negri E, LaVecchia C. Determinants of body mass index: a study from Northern Italy. *Int J Obesity.* 1994;18:497-501.

4. Lissner L, Heitmann BL. Dietary fat and obesity: evidence from epidemiology. *Eur J Clin Nutr.* 1995;49:79-90.

5. Colditz GA, Willett WC, Stampfer MJ, London SJ, Segal MR, Speizer FE. Patterns of weight change and their relation to diet in a cohort of healthy women. *Amer J Clin Nutr.* 1990;50:1100-1105.

6. Heitmann BL, Lissner L, Sorensen T, Bengtsson C. Dietary fat intake and weight gain in women genetically predisposed for obesity. *Amer J Clin Nutr.* 1995;61:1213-1219.

7. Basiotis PP, Guthrie JF, Bowman SA, Welsh SO. Construction and evaluation of a Diet Status Index. *Family Econ Nutr Rev.* 1995;8:2-13.

8. National Research Council. *Diet and Health: Implications for Reducing Chronic Disease Risk.* Washington DC: National Academy Press; 1989.

9. Food and Nutrition Board. *Recommended Dietary Allowances.* 10th ed. Washington DC: National Academy of Sciences; 1989.

10. *Nutrition and Your Health: Dietary Guidelines for Americans.* 3rd ed. Washington DC: US Depts of Agriculture and Health and Human Services. 1990. Home and Gardens Bulletin no. 232.

11. National Center for Health Statistics. Plan and initial program of the Health Examination Survey. National Center for Health Statistics. *Vital Health Stat 1*(4). 1965.

12. National Center for Health Statistics. Plan and operation of the Health and Nutrition Examination Survey, United States 1971-1973. National Center for Health Statistics. *Vital Health Stat 1* (10a) 1973 and 1(10b) 1977.

13. Peterkin BB. Women's diets: 1977-1985. *J Nutr Ed.* 1986;18:251-257.

14. Life Sciences Research Office, Federation of American Societies for Experimental Biology. *Third Report on Nutrition Monitoring in the United States. Executive Summary.* US Government Printing Office, Washington DC: US Dept of Agriculture and Us Dept of Health and Human Services. 1994.

15. Kuczmarski RJ, Flegal KM, Campbell SM, Johnson CL. Increasing prevalence of overweight among US adults: The National Health and Nutrition Examination Surveys, 1960-1991. *J Amer Med Assoc.* 1994:272:205-211.

16. National Cancer Institute. *Dietsys Version 3.0 User's Guide: Health Habits and History Questionnaire: Diet History and Other Risk Factors.* Beltsville, MD: National Cancer Institute, Information Management Services, Inc; 1994.

17. St Jeor ST. The role of weight management in the health of women. *J Amer Diet Assoc.* 1993;93:1007-1012.

18. Robinson JT, Hoerr SL, Strandmark J, Mavis B. Obesity, weight loss, and health. *J Amer Diet Assoc.* 1993;93:445-449.

19. Kushner RF. Body weight and mortality. *Nutr Rev.* 1993;51:127-136.

20. Healthier People Version 4.0. Health Risk Appraisal Program: Atlanta, GA: Carter Center of Emory University, 1991.

Appendices

Appendix A: Extensive Methodology

Methods

This appendix describes in detail the methodology used in this study. The methods used to determine the variables (BMI, DSI score, and servings per week from the pre-selected food groups) are discussed. This study used secondary data from a larger study, Housing Health Education Rural Outreach (HHERO).

HHERO Project

Participants for this study were chosen from a larger study entitled Housing Health Education Rural Outreach (HHERO). HHERO is a project funded by the US Department of Health and Human Services to the LaFollette Housing Authority, LaFollette, Tennessee. The HHERO grant focuses on primary health care services, health education and disease prevention for primarily women and children living within the LaFollette Housing Projects in the rural counties of East Tennessee where access to health care facilities may be limited. The project period is three years. Assessment of current health care needs was conducted in Year 1. Years 2 and 3 will focus on interventions addressing the needs identified in year 1 (1).

Participant Selection

HHERO Selection. HHERO staff recruited participants through door to door solicitation in each of the housing projects that comprise the housing authority in Campbell, Clairborne, Union, Fentress, Morgan and Scott counties from May to December 1995. The female head of household was identified and her participation

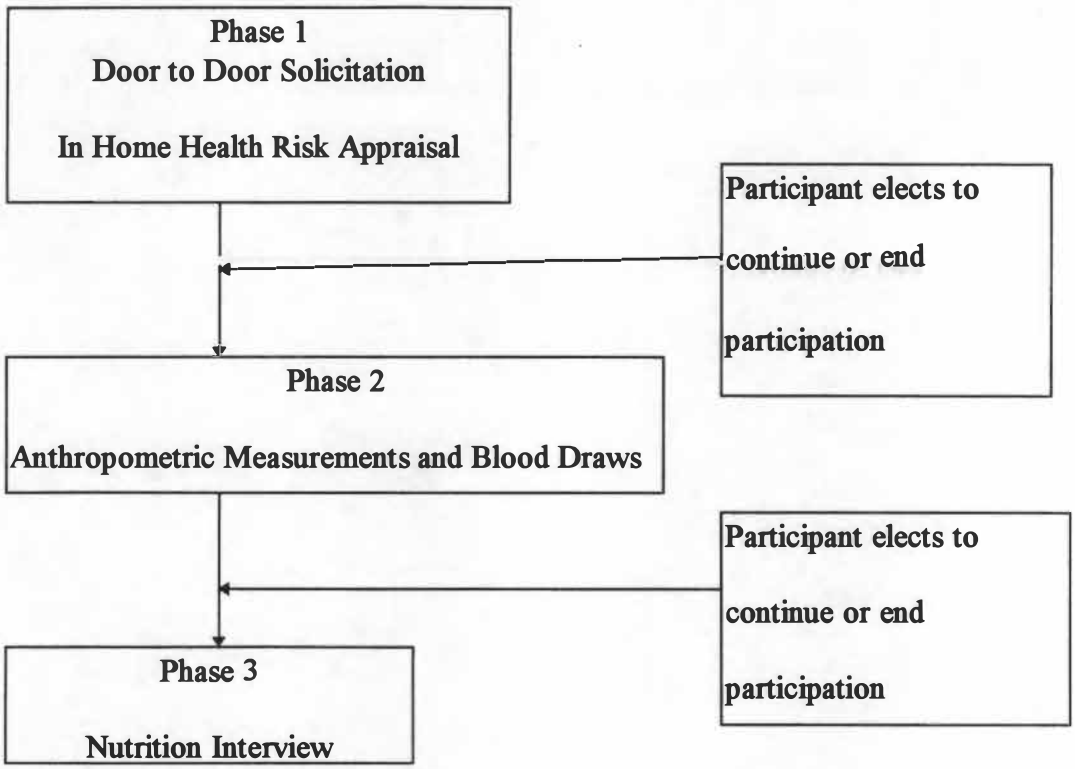

Figure 1: Flow Chart of Participation in HHERO Project

solicited. Once the female head of household agreed to participate, the HHERO staff person administered the Carter Health Risk Appraisal (2) in the home (Phase 1). Since participants were self-selected, staff made an effort to elicit at least a 50% participation rate for the Health Risk Appraisal portion of the study in each county. After the Health Risk Appraisal was completed, continued participation was optional. If the participant continued, she was escorted by one of the HHERO staff to a community room within the housing project where a trained HHERO staff person measured height, weight, and blood pressure and obtained a blood sample (Phase 2).

After completing this step, the participant was asked again to continue by responding to a verbally administered food frequency questionnaire adapted for this study from the HHHQ Brief 87 version (3) (Appendix C) (Phase 3).

Participant Selection for DSI Study. This study used participants from the larger HHERO study that completed the food frequency questionnaire and weight and height measurements. All participants with recorded heights, weights and a completed HHHQ were eligible for this study except women who stated they were pregnant or under the age of 18. Exclusion of pregnant women from the study was based on the premise that a pregnant woman may change her eating practices during pregnancy. All questionnaires deemed invalid were not used. Validity of a questionnaire was established in two ways. First, the interviewer assessed the validity of the participant's responses. If a participant's responses were vague or the participant could not follow instructions, the interviewer reported that questionnaire as invalid. Second, a nutrient analysis computer program assessed the accuracy of nutrient estimates and food frequency data for each questionnaire.

Questionnaire Design

The 60 item HHHQ Brief 87 (3) was selected in the initial HHERO project plan as the means of assessing nutrient intake in this population over the previous year time period. HHHQ Brief 87 is a semi-quantitative food frequency questionnaire. It was selected over other means of dietary assessment for the following reasons:

1. Diet recalls, records or diaries require a highly trained interviewer. Since the HHERO staff conducted the interviews, the HHHQ was selected because it requires little training and can be conducted by persons other than nutritionists and dietitians with ease (3-5).
2. Dietary data were collected at only one time.
3. A trained interviewer can complete the HHHQ Brief 87 in approximately 17 minutes (6). Due to the considerable amount of interview time needed for the Carter Health Appraisal, anthropometric measurements and blood sampling, the HHHQ Brief 87 was chosen over the longer version.
4. HHHQ Brief 87 has been proven reproducible and valid in women of most ages (5).
5. Analysis software is provided with the HHHQ making nutrition intake information easy to estimate.

Features of the standard HHHQ Brief 87 were modified to fit the needs of the HHERO project. For participant confidentiality reasons, questions regarding name, address and telephone number were deleted. Participants were given an identification number to assure confidentiality. Questions relating to birth date, age, gender, years of education completed and race/ethnicity remained in their original format. Questions regarding each participant's height and weight were deleted and replaced with actual measurements. Optional questions regarding smoking habits and vitamin and mineral supplement use were omitted.

The following two questions were added: 1) "Are you on a special diet? If yes, what type?" and 2) "Are you pregnant?" The first question was asked to get an impression of the types of self-prescribed or prescribed diets in this population. The second question was asked to exclude all pregnant women from the DSI study.

The 60 item food category list remained the same as the HHHQ Brief 87. No extra foods or food categories were added. Serving sizes used were small, medium, and large. Frequency of food category consumption was established by day, week, month and year. Time frame used to describe intake was over the past year.

Responses to qualifying questions from the HHHQ Brief 87 are used in the analysis software to adjust nutrient values from the original food category list. These questions include: 1) "How often do you eat the skin on chicken?" 2) How often do you eat the fat on meat?" 3) "How often do you add salt to your food?" 4) "How often do you add pepper to your food?" 5) "Not counting salad or potatoes, about how many servings of vegetables do you eat per day or per week?" 6) "Not counting juices, how many servings of fruits do you usually eat per day or per week?" Responses to questions 1 and 2 make adjustments in the nutrient estimates for fat, saturated fat, and percent of calories from fat. When given a long list of fruits and vegetables, it is not uncommon to over report fruit and vegetable consumption. Responses to questions 5 and 6 adjust the overall fruit and vegetable consumption and lower the nutrient estimates associated with these food categories. The modified questionnaire used in the HHERO project used all these qualifying questions except

whether or not the subject used additional salt and pepper, since table salt use would be difficult to estimate and pepper use is not nutritionally significant.

The questionnaire was completed by HHERO staff using face to face interview technique. Staff were asked to initial each questionnaire completed to aid in identifying training needs. Staff also were asked to identify participant questionnaires that the interviewer felt might not be valid secondary to difficulties in conducting the interview (ie, the participant could not follow the directions or gave vague answers [eg, "couple", "few", "sometimes"] to the food frequency portion of the questionnaire).

Training of HHERO Staff

Training of HHERO staff was conducted on a consultant basis by the primary researchers. Training included proper and standardized methods for anthropometry measurements and proper administration of the HHHQ. All staff involved in either the measurements or the HHHQ interviews received training prior to initiation of the study. Staff members were trained in the standard measurement protocol (Appendix B) and allowed to practice until measurements on a single individual could be duplicated. The primary researchers verified that all staff involved in measurements were following the prescribed protocol and accurately recording data.

Staff members involved in the HHHQ interviews were trained on the proper method for conducting the HHHQ interview. The primary researchers first demonstrated the proper method. Then, HHERO staff practiced the technique until

the primary researchers were confident with the staff's ability to perform the interview. Data collected at the first site, LaFollette, were used as a pilot test to allow the HHERO staff to become proficient in the use of the HHHQ. The primary researcher was present at that site for follow up training and questions. After completion of interviews at the first site, the HHERO staff was considered thoroughly trained in the research protocol and the primary researchers were utilized as consultants as needed.

The primary researcher made four announced visits throughout the study to the sites. At these visits, the researcher verified adherence to the standard protocols as a means of quality control.

Height and Weight Measurements

Heights and weights were measured by trained HHERO staff in the designated community room at each site. Standard principles of anthropometry measurement established by Lohman et al (7) were used to ascertain height and weight. Heights were taken using an infant/child/adult height measuring board (Shorr Productions) accurate to 0.1 centimeters. Weights were measured using a digital scale (Seca Scale Model 815) accurate to 0.2 kilograms.

Height was measured in bare or stocking feet, with weight evenly distributed, arms hanging to the sides, and heels together. The subject stood with both heels, buttocks, scapulae and back of head against the measuring board and eyes facing forward. The subject inhaled and stood as erect as possible while the measurement was taken. The measurer, with eyes level to the headboard, brought the headboard

down on the top of the head with sufficient pressure to compress the hair and take the measurement to the nearest 0.1 centimeter. The measurement was recorded immediately (Appendix B).

Standard anthropometric procedures require that a subject's weight be taken while wearing only a standard weight paper gown and slippers (7). Since participants were weighed in a community room in the presence of other participants, this procedure could not be followed. Lohman et al (7) suggests that when this procedure can not be followed the subject should be weighed in the lightest indoor clothing. A deduction for the weight of the clothing or a standard clothing weight deduction is not recommended. To assure the lightest clothing weight, participants were asked to remove all outdoor clothing, shoes, sweaters, and items from their pockets. They then stood on the platform scale and a HHERO staff person obtained their weight to the nearest 0.2 kilograms once the scale stabilized. Weights were recorded immediately by the staff (Appendix C).

Dietary Analysis

All HHHQ questionnaires were coded, entered and analyzed using protocols established by Block et al (3). A software package (Health Habits and History Questionnaire, Dietsys Version 3.0, National Cancer Institute; 1994) was used to analyze questionnaires. A computer configuration file adapted from the original HHHQ Full 87 and altered to fit the needs of this study was used to analyze all subject questionnaires.

Analysis of dietary intake was performed by the primary researcher using the following protocol.

1. Questionnaires will be coded by hand using codes from the Dietsys manual (3).
2. Each questionnaire was entered using the preset configuration file.
3. After all questionnaires were entered, each questionnaire was entered again using the verify mode of the program. This assured accurate data entry.
4. After all questionnaires were verified as correct, the researcher then used the edit check mode of the program. This part of the program flags questionnaires with significant problems that would alter the results of the nutrient analysis. If a questionnaire is flagged as having a severe error (ie, not enough foods eaten in a day or questionably large frequency), then the questionnaire was not used in the study.
5. Nutrient analysis of all questionnaires was completed. The nutrient analysis of those questionnaires with severe errors was not used.
6. Once the nutrient analysis of valid questionnaires was complete, nutrients needed to determine the DSI were converted to percentages of the corresponding age and sex appropriate RDA (8) using the following formula:

$$\text{\% of the RDA} = \frac{\text{nutrient estimate from HHHQ analysis}}{\text{recommended RDA value for gender and age of participant}} \times 100$$

The database for nutrient estimates (DIETPORT.V30 and DIETNUT.V30) used by Dietsys Version 3.0 is the NHANES II database (3). Block et al (3) conclude

that the nutrient database used in Dietsys Version 3.0 is appropriate to describe food intake in the 1990s.

BMI

BMI was calculated by using the equation:

$$\text{weight (kg)/height (m)}^2.$$

The subjects were divided into two groups using the National Center of Health Statistics (NCHS) established cut off points for overweight. All study participants with BMIs that were below 27.3 kg/m^2 were categorized into the normal/underweight group. Those participants with BMIs are ≥ 27.3 kg/m^2 were categorized into the overweight/ severely overweight group (9-10). The NCHS cut off points have been used to describe overweight in the US population since NHANES II (9-10). These cut off points have been used to describe obesity in women over the age of 20 years (9-10). Thus, NCHS cut off points could describe obesity in this population of rural East Tennessee women.

Food Groupings

The food grouping system that was used in this study was established previously by Subar et al (6). This system was utilized with the HHHQ Brief 87 in the National Health Interview Survey (6). It will be referred to as the Subar food groups from here forward and the items in the food list of the HHHQ will be referred to as food categories. Food categories from the HHHQ were divided into 27 Subar food groups based on nutritional content, function of the food in the diet and botanical

composition (6,11). Dietary Guidelines for Americans (12) and the American Cancer Society recommendations (6) are the basis on which the Subar food groups were formed. The Subar food groups are listed in Table 1.

Servings per week for each Subar food group were tabulated as follows:

1. Servings from each food category were stated by the study participants during the interview as servings per day, week, month or year. Serving size was stipulated by study participants as small, medium or large. Servings per week for each food category of the HHHQ were tabulated by multiplying daily servings by 7 and weekly servings by 1; or dividing monthly servings by 4 and yearly servings by 52. This number was multiplied by the serving size coefficient: 0.5 for small serving, 1.0 for a medium serving, and 1.5 for a large serving. The product was the servings per week for each food category.

2. To determine servings per Subar food group, the researcher added the number of servings per week from each food category within that food group. For example, if the Subar food group to be calculated was alcoholic beverages, the servings per week was added for the following food categories: beer, wine, and other alcoholic beverages. The sum of these three food categories equals the servings per week for that Subar food group.

Dietary Status Index

The Diet Status Index provides a single measure that addresses both adequacy

Table 1: Food groups and their corresponding food categories from the HHHQ	
1. Alcoholic beverages	beer; wine; liquor
2. All breads	white bread, rolls, crackers; dark breads; cornbread, corn muffins, corn tortilla, grits
3. All meat	hamburgers, cheeseburgers, meatloaf; beef, beef stew/potpie; liver; pork; fried chicken; chicken, turkey (baked, stewed or broiled); fried fish, fish sandwiches; bacon; sausage; hot dogs; ham, lunch meats
4. All vegetables	carrots, mixed vegetables with carrots; tomatoes; green salad; broccoli; spinach; mustard greens, turnip greens, collards; coleslaw, cabbage, sauerkraut; french fries, fried potatoes; potatoes (baked, boiled, mashed); sweet potatoes, yams; beans (baked, pinto, kidney, chili)
5. Citrus fruit	orange juice, grapefruit juice; oranges; grapefruit
6. Dairy products	whole milk; 2% milk; skim milk; 1% milk, buttermilk; cheese, cheese spreads
7. Desserts	ice cream; pie; doughnuts, cookies, cake, pastry; chocolate candy
8. Eggs	eggs
9. Fish/ Chicken	fried chicken; chicken, turkey (baked, stewed or broiled); fried fish, fish sandwiches
10. Fried potatoes	french fries, fried potatoes; potatoes; potatoes (baked, boiled, mashed)
11. Fruits and juice	orange juice, grapefruit juice; oranges; grapefruit; cantaloupe; apples, applesauce
12. Fruits and vegetables	orange juice, grapefruit juice; oranges; grapefruit; cantaloupe; apples, applesauce; carrots, mixed vegetables containing carrots; tomatoes; green salad; broccoli; spinach; mustard greens, turnip greens, collards; coleslaw, cabbage, sauerkraut; sweet potatoes, yams
13. Garden vegetables	carrots, mixed vegetables containing carrots; tomatoes; broccoli; spinach; mustard greens, turnip greens, collards; coleslaw, cabbage, sauerkraut
14. High fiber bread and cereal	high fiber cereals; dark breads
15. Low fat milk	2% milk, skim milk, 1% milk, buttermilk
16. Non-fried potatoes	potatoes (baked, boiled, mashed)
17. Peanuts	peanuts, peanut butter
18. Processed meats	bacon; sausage; hot dogs; ham, lunch meat
19. Ready to eat cereal	high fiber cereals; highly fortified cereals; other cold cereals
20. Red meat	hamburgers, cheeseburgers, meatloaf; beef; beef stew/ pot pie; pork
21. Salads	green salad; tomatoes; coleslaw, cabbage, sauerkraut
22. Salty snacks	chips, popcorn
23. Soft drinks	soda/soft drinks with sugar
24. Soup and stew	vegetable, vegetable beef, minestrone, tomato soups; beef stew/pot pie
25. Starches	rice; beans (baked, pinto, kidney, chili); french fries, fried potatoes (baked, boiled, mashed); spaghetti, lasagna, pasta
26. Table fats	salad dressing, mayonnaise; butter; margarine
27. Whole milk and cheese	whole milk; cheese, cheese spreads

Source: Subar AF, Ziegler RG, Patterson BH, Ursin G, Graubard B. US dietary Patterns Associated with Fat Intake: The 1987 National Health Interview Survey. Am J Public Health. 1994: 84; 359-366.
Subar AF. Personal Communication. Bethesda, MD: March 1995.

and excess of nutrients (13). The DSI is an average of the Dietary Adequacy Score (DAS) and the Dietary Moderation Score (DMS).

Dietary Adequacy Score (DAS). DAS is based on RDA for the following nutrients: protein, vitamin A, thiamin, riboflavin, niacin, vitamin B6, vitamin B12, folate, vitamin C, vitamin E, iron, zinc, calcium, phosphorus, and magnesium. The DAS is calculated by giving a participant one point for each nutrient on the list that is greater than or equal to 100% of the RDA for that person. This allows a participant to have a score of 0 to 15. This score then is multiplied by 6 2/3 so DAS can be represented on a 100 point scale (13). The nutrient analysis program used in this study does not analyze for Vitamin B12 intake. Two vegetarians were identified through the special diet question. When their HHHQ was reviewed, they were found to consume both eggs and dairy products. Therefore, the researcher believed no one would be at high risk for B12 deficiency and all participants were given one point for this nutrient.

Dietary Moderation Score (DMS). This calculation is based on the following dietary intake criteria:

1. ≤ 30% calories from fat.
2. ≤ 10% of calories from saturated fat.
3. ≤ 300 milligrams of cholesterol.
4. ≤ 2400 milligrams of sodium (13).

The DMS is calculated by giving each participant one point for each nutrient intake falling at or below each of the above criteria. A participant can have a score of 0 to 4.

This score then is multiplied by 25, so DMS can be represented on a 100 point scale (13).

Dietary Status Index (DSI). To obtain the DSI, the arithmetic average of the DAS and the DMS is calculated (13). No established standard exists to describe the results of DSI at present (13). Therefore, participant DSI scores were rank ordered and expressed on a tertile basis. Tertiles were classified as HIGH (upper third), MID (middle third) and LOW(lower third). Tertiles were utilized rather than quartiles to allow for a large enough number of participants to fall within each group so as to be able to show statistical significance.

Statistics

All data were entered and verified for analysis using Statistical Analysis System (version 5, 1985, SAS Institute, Cary, NC). Statistics to describe the population by demographics were calculated. Mean and standard deviation was calculated for age. Frequencies were determined for race or ethnicity and educational attainment. The number of persons and percent of the population with eighth grade or less education level were calculated. The number of persons and percent of the study population for each special diet listed on the questionnaire were calculated. Mean and standard deviations for the following 16 micronutrients and 3 macronutrients were calculated: protein, fat, carbohydrate, calcium, phosphorous, iron, sodium, potassium, thiamin, riboflavin, niacin, vitamin C, saturated fat, cholesterol, folate, vitamin E. Mean percent of calories from protein, carbohydrate, and fat were also calculated.

A discussion of the statistics used to determine the answers to the two research questions follows.

1) For which of the 27 groups delineated by Subar et al are there significant differences in consumption (servings/ week) between DSI categories (based on tertile distribution) in a population of low income women living in rural public housing in East Tennessee?

2) Are there statistical differences in the DSI score between overweight women and normal or underweight women based on BMI from this population?

Variables for the first question were: servings per week for each Subar food grouping and DSI category. Servings per week (x +/- SD) for each Subar food group were calculated for each DSI category. Since DSI was not normally distributed even after a log transformation was performed, the Kruskal-Wallis test was performed ($p \leq 0.001$) for each food group. This procedure was repeated for each compressed food group.

The variables for the second question were DSI score and BMI group (overweight or normal/underweight). The mean and standard deviation for DSI were calculated for each of the two BMI groups. Assumptions of normality were not met for DSI. Therefore Wilcoxon Rank-Sum test was performed ($p \leq 0.05$).

References

1. Levin B. The Rural Housing Authority Health Outreach Project for Housing Health Education Rural Outreach (HHERO). Project funded by LaFollette Housing Authority through Dept of Health and Human Services, Office of Rural Health Policy. Grant no. CSD000213-01-0. 1995.
2. Healthier People Version 4.0. *Health Risk Appraisal Program*: Atlanta, GA: Carter Center of Emory University, 1991.
3. National Cancer Institute. *Dietsys Version 3.0 User's Guide: Health Habits and History Questionnaire: Diet History and Other Risk Factors.* Beltsville, MD: National Cancer Institute, Information Management Services, Inc; 1994.
4. Lee RD, Nieman DC. *Nutritional Assessment.* Madison, WI: Brown and Benchmark Publishers; 1993.
5. Block G, Hartman AM, Naughton D. A reduced dietary questionnaire: development and validation. *Epidemiol* 1990;1:58-64.
6. Subar, AF, Ziegler RG, Patterson BH, Ursin G, Graubard B. US dietary patterns associated with fat intake: The 1987 National Health Interview Survey. *Amer J Public Health.* 1994;84:359-366.
7. Lohman TG, Roche AF, Martorell R. *Anthropometric Standardization Reference Manual.* Champaign, IL: Human Kinetics Books; 1988.
8. Food and Nutrition Board. *Recommended Dietary Allowances.* 10th ed. Washington DC: National Academy of Sciences; 1989.

9. National Center for Health Statistics. Plan and initial program of the Health Examination Survey. National Center for Health Statistics. *Vital Health Stat 1*(4). 1965.

10. National Center for Health Statistics. Plan and operation of the Health and Nutrition Examination Survey, United States 1971-1973. National Center for Health Statistics. *Vital Health Stat 1* (10a) 1973 and 1(10b) 1977.

11. Subar, AF. Personal Correspondence. Bethesda, MD: March 1995.

12. *Nutrition and Your Health: Dietary Guidelines for Americans.* 3rd ed. Washington DC: US Depts of Agriculture and Health and Human Services. 1990. Home and Gardens Bulletin no. 232.

13. Basiotis PP, Guthrie JF, Bowman SA, Welsh SO. Construction and evaluation of a Diet Status Index. *Family Econ Nutr Rev.* 1995;8:2-13.

Appendix B Standardized Anthropometric Measurement Instructions

Measuring Height

The Subject

- Barefoot or in stocking feet
- Have weight evenly distributed on both feet
- Arms should hang freely at sides with palms facing in
- Stand with heels together
- Subject should stand with both heels, buttocks, scapulae and back of head against the measuring board (See Diagram below)
- Subject should inhale and stand as erect as possible while being measured

The Person Measuring

- Should bring the headboard down on the top of the head with sufficient pressure to compress the hair
- Measure while subject is inhaling
- Should have their eyes level with the headboard
- Should measure to nearest .1 centimeter and record immediately

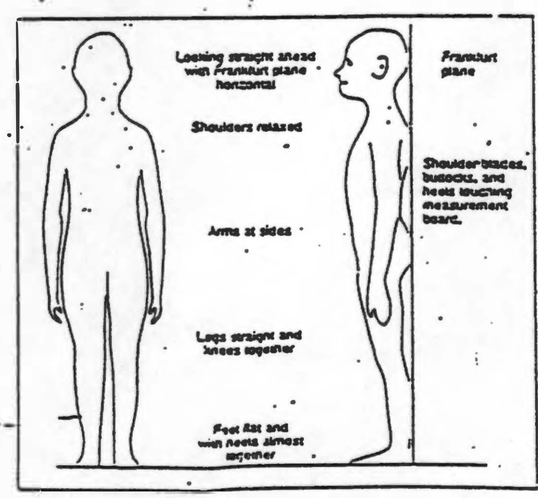

Figure 10.4: Positioning of subject for height measurement. Horizontal line is the Frankfurt plane, which should be in a horizontal position when height is measured. Reproduced from Robbins GE, Trowbridge FL. In: Nutrition Assessment: A Comprehensive Guide for Planning Intervention by M.D. Simko, C. Cowell, and J.A. Gilbride, p.77, with permission of Aspen Publishers, Inc. © 198-.

Taken from: Gibson RS. Principles of Nutritional Assessment. New York, New York: Oxford University Press; 1990.

Measuring Weight

The Subject

- Stand in center of platform of scale
- Stand with body weight evenly distributed between both feet
- Have on light indoor clothing-no shoes, sweaters or outdoor clothing
- Remove all items from pockets
- Be relaxed
- Stand still

The Person Measuring

- Make sure scale is on an even surface
- Stand in front of scale
- Weigh person to nearest .2 kilogram and record immediately

Standards for weight and height measurement adopted from:
Lohman TG, Roche AF, Martorell R. Anthropometric Standardization Reference Manual. Champaign IL: Human Kinetics Books; 1988.

Appendix C Adapted Version of Health Habits and History Questionnaire

Health Habits and Diet Questionnaire

1. Today's date ___/___/___

2. Respondent's ID number ___ ___ ___ ___ ___ ___ ___ ___ ___

3. Height ___ ___ ___ . ___ centimeters

   Reminder: Height is recorded to the nearest .1 centimeter

4. Weight ___ ___ ___ . ___ kilograms

   Reminder: Weight is recorded to the nearest .2 kilograms

5. Measurer's initials ___ ___ ___

6. Are you pregnant? ☐ yes ☐ no

7. When were you born? __/__/__

8. How old are you? ______ years

9. Sex ______ 1. male ______ 2. female

10. Race or ethnic background: (check one)

____ 1. White, not Hispanic
____ 2. Black, not Hispanic
____ 3. Hispanic
____ 4. American Indian/Alaska native
____ 5. Asian
____ 6. Pacific Islander

11. What is the highest grade in school you have completed? (circle one)

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17+

12. Are you on a special diet? (may check up to two)

____ 1. no
____ 2. weight loss
____ 3. for medical conditions
____ 4. vegetarian
____ 5. low salt
____ 6. low cholesterol
____ 7. weight gain

13. This section is about your usual eating habits. Thinking back over the past year, how often do you usually eat the following foods?
First, I will ask you about your usual serving size. I will tell you what a medium serving is. If your usual serving is one-half the medium serving then your serving is a small serving. If your usual serving is one and one-half times the size of a medium serving, then your usual serving is a large serving.
Next, I will ask you about HOW OFTEN, on the average, you eat the food. You can report this to me as servings per day, servings per week, servings per month or servings per year. If you never or rarely eat this food, then let me know.
Reminders to the interviewer:
Please DO NOT SKIP foods. And please BE CAREFUL which column you put your answer in. It will make a big difference if you check "Hamburger once a day" when you mean "hamburger once a week." MAKE SURE TO USE NUMBERS IN THE HOW OFTEN COLUMNS.
Some items say "in season." Indicate how often your participant eats these foods just in the 2-3 months when that food is in season. (Be careful about overestimating here.)
Please look at the example below. This person
1) eats a medium serving of cantaloupe once a week, in season.
2) has 1/2 grapefruit about twice a month.
3) has a small serving of sweet potatoes about 3 times a year.
4) has a large hamburger or cheeseburger or meat loaf about 4 times a week.
5) never eats liver.

EXAMPLE:

	Medium Serving	Your Serving Size S	M	L	How often? Day	Week	Month	Year	Rarely/Never
Cantaloupe (in season)	¼ medium		✓			1			
Grapefruit	(½)		✓				2		
Sweet potatoes, yams	½ cup	✓						3	
Hamburger, cheeseburger, meat loaf	1 medium			✓		4			
Liver	4 oz.								✓

	Serving	Size			Day	Week	Month	Year	Rarely/Never	
FRUITS & VEGETABLES		S	M	L						
EXAMPLE – Apples, applesauce, pears	(1) or ½ cup		✓			4				
Apples, applesauce, pears	(1) or ½ cup									11 ___
Cantaloupe (in season)	¼ medium									15 ___
Oranges	1 medium									19 ___
Orange juice or grapefruit juice	6 oz. glass									23 ___
Grapefruit	(½)									27 ___
Other fruit juices, fortified fruit drinks	6 oz. glass									31 ___
Beans such as baked beans, pintos, kidney, limas, or in chili	¾ cup									35 ___
Tomatoes, tomato juice	(1) or 6 oz.									39 ___
Broccoli	½ cup									43 ___
Spinach	½ cup									47 ___
Mustard greens, turnip greens, collards	½ cup									51 ___
Cole slaw, cabbage, sauerkraut	½ cup									55 ___
Carrots, or mixed vegetables containing carrots	½ cup									59 ___
Green salad	1 med. bowl									63 ___
Salad dressing, mayonnaise (including on sandwiches)	2 Tblsp.									67 ___
French fries and fried potatoes	¾ cup									71 ___
Sweet potatoes, yams	½ cup									75 ___
Other potatoes, incl. boiled, baked, potato salad, mashed	(1) or ½ cup									11 ___
Rice	¾ cup									15 ___
MEAT, MIXED DISHES, LUNCH ITEMS		S	M	L	Dy	Wk	Mo	Yr	Nv	
Hamburgers, cheeseburgers, meat loaf	1 medium									19 ___
Beef—steaks, roasts	4 oz.									23 ___
Beef stew or pot pie with carrots, other vegetables	1 cup									27 ___
Liver, including chicken livers	4 oz.									31 ___
Pork, including chops, roasts	2 chops or 4 oz.									35 ___
Fried chicken	2 sm. or 1 lg. piece									39 ___
Chicken or turkey, roasted, stewed or broiled	2 sm. or 1 lg. piece									43 ___
Fried fish or fish sandwich	4 oz. or 1 sand.									47 ___
Other fish, broiled, baked	4 oz.									51 ___
Spaghetti, lasagna, other pasta with tomato sauce	1 cup									55 ___
Hot dogs	2 dogs.									59 ___
Ham, lunch meats	2 slices									63 ___
Vegetable soup, vegetable beef, minestrone, tomato soup	1 med. bowl									67 ___
BREADS / SALTY SNACKS / SPREADS		S	M	L	Dy	Wk	Mo	Yr	Nv	
White bread (including sandwiches), bagels, etc., crackers	2 slices, 3 cracks									71 ___
Dark bread, including whole wheat, rye, pumpernickel	2 slices									75 ___
Corn bread, corn muffins, corn tortillas	1 med. piece									11 ___
Salty snacks (such as chips, popcorn)	2 handfuls									15 ___
Peanuts, peanut butter	2 Tblsp.									19 ___
Margarine on bread or rolls	2 pats									23 ___
Butter on bread or rolls	2 pats									27 ___
BREAKFAST FOODS		S	M	L	Dy	Wk	Mo	Yr	Nv	
High fiber, bran or granola cereals, shredded wheat	1 med. bowl									31 ___
Highly fortified cereals, such as Product 19, Total, or Most	1 med. bowl									35 ___
Other cold cereals, such as Corn Flakes, Rice Krispies	1 med. bowl									39 ___
Cooked cereals	1 med. bowl									43 ___
Eggs (1 egg = small, 2 eggs = medium)										47 ___
Bacon	2 slices									51 ___
Sausage	2 patties or links									55 ___

	Medium Serving	Serving Size			Day	Week	Month	Year	Rarely/ Never	Office Use
SWEETS		S	M	L						
Ice cream	1 scoop									59 ____
Doughnuts, cookies, cakes, pastry	1 oz. or 3 cookies									63 ____
Pies	1 med. slice									67 ____
Chocolate candy	small bar, 1 oz.									71 ____
DAIRY PRODUCTS, BEVERAGES		S	M	L	Da	Wk	Mo	Yr	Nv	
Cheeses and cheese spreads, not including cottage	2 slices or 2 oz.									75 ____
Whole milk and bevs. with whole milk (not incl. on cereal)	8 oz. glass									11 ____
2% milk and bevs. with 2% milk (not incl. on cereal)	8 oz. glass									15 ____
Skim milk, 1% milk or buttermilk (not incl. on cereal)	8 oz. glass									19 ____
Regular soft drinks (not diet)	12 oz. can or bottle									23 ____
Beer	12 oz. can or bottle									27 ____
Wine	1 med. glass									31 ____
Liquor	1 shot									35 ____
Milk or cream in coffee or tea	1 Tblsp.									39 ____
Sugar in coffee or tea, or on cereal	2 teaspn.									43 ____

14. How often do you eat the skin on chicken?

____1. Seldom/ never
____2. Sometimes
____3. Often/ Always

15. How often do you eat the fat on meat?

____1. Seldom/ Never
____2. Sometimes
____3. Often/ Always

16. Not counting salad or potatoes, about how many servings of vegetables do you eat per day or per week?

__________ per __________
(number) (write in day or week)

17. Not counting juices, how many servings of fruits do you usually eat per day or per week?

__________ per __________
(number) (write in day or week)

18. Interviewer's initials __________

19. Question to the interviewer: Do you think the information given was valid information? _____yes _____no

If no, why?____

VITA

Linda Lou Knol was born in Des Plaines, Illinois many moons ago. She worked very hard for many years trying to make a place for herself in corporate America. Finally, she decided to go back to school. She attended Johnson & Wales University and got an associate degree in Culinary Arts, after which she received a bachelor's degree in Dietetics from the University of Rhode Island. She followed her Dietetics degree with an AP4 program in dietetics, which enabled her to take the national dietetic examination to become a Registered Dietitian. She moved once more to attend the University of Tennessee in Knoxville. She currently works as a Registered Dietitian with a special emphasis in public health. If she could do it all over again, she would not change a thing.