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EVALUATION OF THE USDA'S FOOD GUIDE PYRAMID
USING COLLEGE STUDENTS' DIETARY INTAKE DATA

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EVALUATION OF THE USDA'S FOOD GUIDE PYRAMID USING COLLEGE STUDENTS' DIETARY INTAKE DATA

By

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ABSTRACT

EVALUATION OF THE USDA'S FOOD GUIDE PYRAMID USING COLLEGE STUDENTS' DIETARY INTAKE DATA

By

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The purpose of this study was to validate Food Guide Pyramid as a quantitative tool for evaluation of dietary intake of college students. One-day food intake records of 2,489 subjects were evaluated for nutritional adequacy by a Mean Adequacy Ratio based on 6 nutrients (MAR-6: calcium, iron, magnesium, vitamins A, C, and B_6) with a cutoff score of 75, as well as the U.S. Dietary Guidelines for fat and sugar. Food group intake was evaluated for food scores by 2 systems: 1) at least 1 serving from each of the 5 food groups in the Food Guide Pyramid and 2) minimum number of servings from each food group. Although 70% of students obtained a MAR-6 $\geq$75, only 34% of the students consumed $\geq$ 1 serving from each food group and 12% of students consumed the minimum number of servings of Food Guide Pyramid. Less than 1% of diets were nutritionally adequate by the MAR-6 score, by the recommended servings of Food Guide Pyramid, and by the guidelines for fat and sugar. The minimum number of servings of the Food Guide Pyramid provides a nutritionally adequate diet based on MAR-6 score $\geq$ 75 but does not insure minimal fat and sugar intake.

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INTRODUCTION

The new Food Guide Pyramid was developed to assist healthy Americans in making food choices for good health with three major messages: dietary variety, moderation of fats, oils, and sugars, and proportionality (Achterberg, 1992). A diet that is planned following the Food Guide Pyramid is thus expected to provide the appropriate amount of energy to maintain healthy weight, meet the RDA for all nutrients, and contain moderate amounts of fat and sugar. Food guides used in the past such as the Hassle-Free Guide to a Better Guide, Food Wheel, and the Basic Four Food Groups provided the starting point for development of the food groups (Cronin et al, 1987). The appropriate number of servings from each nutrient-bearing food group was then determined by the nutrient content of diets with different number of servings in comparison with the nutritional goals to meet the RDA for all nutrients with moderate amounts of fat and sugar.

The new Food Guide Pyramid offers strengths as a nutrition education tool. The Food Guide Pyramid addresses intake of food groups and foods instead of nutrients, incorporates, for the first time, the U.S. Dietary

Guidelines with a meaningful illustration, and is also more flexible and interesting than previous food guides, such as the Red Cross Food Wheel (Achterberg, 1992). Thus individuals are likely to follow the recommendations.

The Food Guide Pyramid, however, continues to have weaknesses that previous food guides had. 1) It is developed with general U.S. population data of all ages which may or may not be appropriate for certain sub-populations (Achterberg, 1992). Food items that a sub-population selects from each food group may differ from those of the general population, and consequently the expected relationship between food group intakes and nutritional adequacy may vary. 2) The Food Guide Pyramid, similar to all other previous food guides, does not provide guidelines to classify combination dishes (Achterberg, 1992). 3) The recommended number of servings of the Food Guide Pyramid still can provide a wide range of kilocalories, if consumers are not familiar with food composition.

The most commonly used recommendation and quantitative evaluation method for dietary intake of an individual or population has been comparisons to the RDA's which are specific for age and gender (FNB, 1989). The strength of using the RDA's are that they are measurable, age and gender specific, and nutrient allowances are greater than most people require. The limitations of using the RDA's for nutritional education include: 1) inadequate completeness and knowledge of food composition by consumers; 2) multiple computation steps to determine nutritional adequacy; 3) their specificity for age and gender; 4) the necessity for consumers to be able to translate food intake to nutrient content and back to foods; and 5) no RDA's established for fat and other food components that affect health.

Nutrient Adequacy Ratios (NAR), Mean Adequacy Ratios (MAR), and Index of Nutritional Quality (INQ), which are derived from the RDA's, are also frequently used for quantitative assessment of dietary intake. A MAR score is an average of percentages of the RDA's for selected nutrients. An INQ evaluates nutrient density of a diet in relation to nutrient density recommended by the RDA's.

Numerous public health intervention programs and other dietary guidelines are also available for the public based on the relationship of diet to chronic disease (DHHS, 1988; USDA-DHHS 1990; AHA, 1988; NCI, 1987). A review of the available literature by the National Academy of Sciences (1989) concluded that dietary intake is a risk factor for some chronic diseases. A common focus of these recommendations is the alteration of dietary composition by decreasing fat content while increasing complex carbohydrates and the variety of food intake. These dietary guidelines which address food groups as well as nutrient composition are not, however, quantitative tools for assessing nutritional adequacy. The recommendations for moderation of food sources of fat, sugar, sodium, and alcohol do not offer specific cut-off points and are not meant to be followed on a daily basis. Analysis of nationwide nutrition and mortality data supported that diets omitting several food groups were associated with an increased risk of mortality (Kant et al., 1993).

The college student population was selected for this study to evaluate the relationship between food group intake based on the Food Guide Pyramid and nutritional adequacy. While dietary habits are thought to be established in young adulthood, college students' dietary patterns differ from other population groups. College students have been reported to skip meals often, follow extremely low-caloric diets, avoid certain type of nutritious foods, have high fat intakes, and consume inadequate amounts of fruits, vegetables and milk compared to the U.S. Dietary Guidelines (Hernon, 1986; Skinner, 1991; Mitchell, 1990; USDA-DHHS, 1990). Although there is available research on subsets of college students, e.g., students with bulimia, students and weight loss, and athletes, there is limited information on food selection and the general nutritional adequacy of the college student population.

Given current dietary practices, it is questioned how closely a diet conforming to the minimal number of recommended servings of Food Guide Pyramid is within the

U.S. Dietary Guidelines. It is possible for a subject's dietary intake to meet the minimum number of servings of the Food Guide Pyramid but exceed recommended amounts of fat, kilocalories, and sugar or provide inadequate nutrient intake (See dietary examples in Appendix A). Validity and practicality of the Food Guide Pyramid are yet to be tested on the dietary practices of various sub-populations in the U.S. by examination of the relationship between food group intake and nutritional adequacy (Achterberg, 1992). The purpose of this study was to validate the minimal number of servings from the new Food Guide Pyramid as a quantitative tool for assessing nutritional adequacy in the diets of college students.

The specific objectives of this study are:

1). To determine the nutritional adequacy of college students' diet by MAR score for 6 nutrients (MAR-6): iron, calcium, magnesium, vitamins A, C, and B_6.

2). To assess the food group intake of college students by food group scoring systems based on the Food Guide Pyramid.

3). To determine the sensitivity and specificity of the food group scoring systems in identifying nutritional inadequacy as defined by MAR-6 score of less than 75.

4). To identify the differences in food group intake patterns, controlling for the food scores, between the diets which are above and below MAR-6 score of 75.

5). To examine the relationships among selected U.S.

Dietary Guidelines, MAR-6 score, and food score.

Hypotheses

1). College students' diets are nutritionally adequate as determined by MAR-6 score.

2). The three food group scoring systems based on the Food Guide Pyramid provide consistent results with each other.

3). Food group score systems are as specific and sensitive in identifying nutritional inadequacy as are MAR-6 scores.

4). Food group intake patterns of diets differ between those above and below MAR-6 score of 75.

5). The diets that are adequate by the Food Guide Pyramid are also adequate by MAR-6 and selected U.S. Dietary Guidelines.

BACKGROUND AND USAGE OF TERMS

Body Mass Index (BMI) - Body weight in kilograms divided by height in meters squared. (A measure of weight adjusted for height).

Food Guides - Practical plans and guides for food selection by the public without training in nutrition. Food guides are developed based on the professional's scientific knowledge of food composition and nutrient requirements for health (Pennington, 1981).

Food Guide Pyramid - A food guide developed by USDA-DHHS to implement the U.S. Dietary Guidelines (USDA, 1992).

Food Guide Scoring Systems - Methods used to assign food scores based on different number of servings of five food groups of Food Guide Pyramid.

Index of Nutritional Quality (INQ) - Method used to compare the nutritive content of a food or diet in relation to its energy content and the allowances for the specific nutrient and energy (Sorenson, 1976).

INQ-6 - The average of six selected INQs (calcium, magnesium, iron, vitamins B_6, A, and C for this study).

MAR-6 - Mean Adequacy Ratio for 6 selected nutrients (see nutritional adequacy for specific nutrients). The average of six selected NARs. Values above 100% of NAR are truncated at 100% for calculation of MAR.

Nutritional Adequacy - Represented by a comparison of actual nutrient intake to the RDA for that nutrient for the specific population. Nutritional adequacy was assessed by a Mean Adequacy Ratio (MAR) score which represents the average of Nutrient Adequacy Ratio (NAR) of the selected nutrients (Vitamins A, C, and B_6, calcium, iron, and magnesium in this study). These nutrients were selected because they are problem nutrients for college students.

Nutrient Adequacy Ratio (NAR) - Actual nutrient intake divided by the RDA for the nutrient and multiplying by 100.

Problematic Nutrient or Food Group - A nutrient was considered problematic if the mean intake of the entire sample and/or each gender did not meet 75% of the RDA, or if more than 50% of the sample's intake was below 75%. Fat and sugar intakes were considered problematic if more than 30% and more than 10% of kilocalories, respectively, were derived from the food components (USDA-DHHS, 1990; WHO, 1990). Food groups were considered problematic if the mean intake of the entire sample and/or each gender did not meet the minimum number of servings set for different food group scoring systems developed based on Food Guide Pyramid.

RDA - The RDA's were used to calculate NARs and MAR-6 scores which determined nutritional adequacy.

Sensitivity - Used in this study to compare a new evaluation tool (i.e., Food Guide Pyramid) with a reference method (i.e., MAR-6). Sensitivity is defined as the proportion of individuals whose diets were nutritionally inadequate (by MAR-6) and were classified as nutritionally inadequate by food scores based on Food Guide Pyramid.

Specificity - Used in this study to compare a new evaluation tool (i.e., Food Guide Pyramid) with a reference method (i.e., MAR-6). Specificity is defined as the proportion of individuals whose diets were nutritionally adequate (by MAR-6) and were classified as nutritionally adequate by food scores based on Food Guide Pyramid.

LITERATURE REVIEW

METHODS FOR ASSESSING NUTRITIONAL ADEQUACY BY FOOD GUIDE

Food guides readily bridge the gap between nutrients and foods, because food guides present food groups and amounts of each food group that should give a nutritionally adequate diet. Foods are grouped based on unique contributions to the nutritive value of the diet. Examples of food guides used in the U.S. include the Basic Four Food Groups, the Red Cross Food Wheel, and USDA's Food Guide Pyramid (Table 1). These food guides are constructed to be simple, easy to use, and accommodative to diverse food preferences and eating patterns while ensuring desirable levels of nutritional attainment (Light and Cronin, 1981).

Food guides are constructed based on a variety of data sources such as the nutritional status of the population, dietary standards, food consumption practices, food availability, nutritive composition of foods, food costs, and goals and attitudes toward nutrition education. The emphasis of food guides has thus shifted over the years from providing adequate kilocalories; to providing the necessary vitamins, minerals, and protein; and finally to addressing

Table 1. Comparison of Basic Four Food Groups, Food Wheel, and Food Guide Pyramid

Basic Four Food Groups[a]	Food Wheel[b]	Food Guide Pyramid[c]
Food Groups: 4	Food Groups: 6	Food Groups: 6
Fruits/Vegetables 1 medium 1/2 c cooked 1/2 c juice Servings: 4	Fruits 1 medium 1/2 c cooked 2/3 c juice Servings: 2-4	Fruits 1 medium 1/2 c cooked 3/4 c juice Servings: 2-4
	Vegetables 1 c raw 1/2 c cooked Servings: 3-5	Vegetables 1 c raw leafy 1/2 c cooked Servings: 3-5
Meat 2 oz cooked meat, fish, poultry 2 eggs 2 oz cheese 1 c dried beans 4 Tbsp peanut butter Servings: 2	Meat, Fish, Eggs, Poultry, Nuts, Dry Beans 2-4 oz cooked meat, fish, poultry Count as 2 oz lean meat: 2 eggs, 4 Tbsp peanut butter, 1 c cooked beans Servings: 5-7 oz	Meat, Fish, Eggs, Poultry, Nuts, Dry Beans 2-3 oz cooked meat, fish poultry Count as 1 oz lean meat: 1 egg, 2 Tbsp peanut butter, 1/2 c cooked dry beans Servings: 2-3
Milk 1 c milk 1 c yogurt 1 1/2 oz cheese 2 c cottage cheese Servings: 2	Milk, Yogurt, Cheese 1 c milk or yogurt 1 1/2 oz natural cheese, 2 oz American cheese Servings: 3-4	Milk, Yogurt, Cheese 1 c milk or yogurt 1 1/2 oz natural cheese 2 oz Process cheese Servings: 2-3
Grains 1 sl bread 1 oz cereal 1/2 c cooked cereal, rice, or pasta Servings: 4	Grain, Cereal, Bread 1 sl bread 1 oz cereal 1/2 c cooked cereal, rice, or pasta Servings: 6-11	Bread, Rice, Cereal, Pasta 1 sl bread 1 oz cereal 1/2 c cooked cereal, rice, or pasta Servings: 6-11

Table 1 (cont'd)

Basic Four Food Groups	Food Wheel	Food Guide Pyramid
	Fats, Sweets, Alcohol Use in moderation	Fats, Oils, Sweets Use sparingly

a. National Dairy Council, 1991.
b. American National Red Cross, 1984.
c. USDA, Human Nutrition Information Service, 1992.

the dietary issues generally recognized as important for long-term health.

Basic Four Food Groups

The Basic Four Food Groups have been used most commonly since 1957 in the U.S. and is based on nutrition and health issues coming out of the depression and world scarcity. Therefore, the Basic Four Food Groups does not provide guidance for consumption of fat, cholesterol, saturated fat, kilocalories, salt, sugar, or alcohol which are related to diseases of overabundance such as obesity and coronary heart disease.

The basic premise of the Basic Four Food Groups was that consumption of a foundation diet of nutrient-dense foods by specified type and number of servings would provide approximately 1,200 kilocalories with 80% or more of the RDA's of 8 nutrients published in 1953. Nutrients emphasized then were calcium, vitamins A and C, and protein; foods were grouped accordingly (Light and Cronin, 1981).

Guthrie and Scheer (1981) validated the use of a dietary score based on the Basic Four Food Guide. Equal weights were attributed to each of the four food groups. Points were assigned whenever a serving of a food item appeared in the diet within a 24-hour period. Assumptions were that diets providing foods from each of the Basic Four Food Groups provided the foundation of an adequate dietary intake and that each food group has its own unique nutritional composition and makes an equally significant contribution to nutrient adequacy (Guthrie and Scheer, 1981). Guthrie and Scheer evaluated the construct validity of their dietary score by comparing it to a nutrient adequacy score based on the actual nutrient intakes of 212 college students. The 12 nutrients selected for the nutrient adequacy score were protein, calcium, zinc, magnesium, iron, vitamins A, B_6, and B-12, Vitamin C, thiamin, riboflavin, and folacin. Statistical analysis demonstrated that calcium, protein, riboflavin and vitamin B-12 were the nutrients to which the milk group made a major contribution; for the meat group, protein, zinc, iron, and vitamins B_6 and B_{12}; for fruits and vegetables, magnesium, zinc, vitamins A and B_6, Vitamin C, and folate; and for cereals, zinc, thiamin, and vitamin B_6. A potential problem with the nutrients selected for the nutrient adequacy score is multicollinearity between nutrients which can result in a biased index. The authors concluded that using a dietary score based on food groupings was similar to using a nutrient adequacy score and compared actual nutrient intakes to the RDA's.

American Red Cross Food Wheel

The American Red Cross Food Wheel was introduced in 1984. The Food Wheel provides recommendations regarding fats, sweets, alcohol, and vitamins A and C consumption (which the Basic Four Food Groups do not address). In the Food Wheel, foods are divided into 6 groups; the one group of fruits and vegetables in the Basic Four Food Groups was divided into separate groups. The Food Wheel further divides the food groups: 1) the fruit group is divided into Vitamin C fruits and others; 2) the vegetable group, into Vitamin A vegetables, starchy, and others; 3) and the meat, fish poultry, eggs group, into nuts and seeds, lean meats, and dried peas and beans.

USDA's Food Guide Pyramid

The USDA's Food Guide Pyramid, introduced in 1992, addresses many of the weaknesses of the Basic Four Food Groups. The Food Guide Pyramid conveys importance of variety, proportion, and moderation with additional emphasis on overall health. The Food Guide Pyramid was produced in flyer and pamphlet form. The primary emphasis of this study deals with the Food Guide Pyramid in flyer form.

Of the 10 leading causes of death in the U.S. today, five are associated with dietary factors: coronary heart disease, some types of cancer, stroke, noninsulin-dependent diabetes mellitus and atherolscerosis (DHHS, 1988) The primary dietary practice related to these health concerns is the excessive intake of fat accompanied by decreased consumption of complex carbohydrate (DHHS, 1988). The Food Guide Pyramid was designed to address the issues of nutrient adequacy, usability, and overabundance. The Food Guide Pyramid was designed to help implement the U.S. Dietary Guidelines for Americans (USDA-DHHS, 1992) by recommendations to avoid too many kilocalories, fat, and sugar.

The research to develop the Food Guide Pyramid was extensively peer-reviewed. The goals for energy, protein, vitamin, and mineral intake were based on the RDA's while goals for fat and added sugars were based on the U.S. Dietary Guidelines for Americans. While the nutrient content of a food was a primary consideration in the categorization of foods into groups, the usual use of a food in meals and how it was grouped in past food guides was also considered. The factors which were considered in setting the serving size for the food group are: 1) typical serving sizes of foods from food consumption surveys (e.g. 1977-78 NFCS), 2) ease of use, e.g., common household units (cups, ounces) used, 3) nutrient content, and 4) tradition, e.g., 1 slice of bread is traditional serving size in nutrition education materials (Welsh, 1992).

The nutrient profiles are the quantity of nutrients and other food components that one would be expected to obtain on average from a serving of food from each food group. The nutrient profile of a food group reflected the nutrient content of the most frequently consumed foods. In developing the nutrient profile, only foods in their most nutrient-dense forms were used (Cronin et al., 1987).
The recommended number of servings from the five food groups of the Food Guide Pyramid provides 1400 to 3200 kilocalories with 100% of the RDA for 16 vitamins and minerals (Welsh, 1992).

METHODS FOR ASSESSING NUTRITIONAL ADEQUACY BY NUTRIENT COMPOSITION

Recommended Dietary Allowances

The RDA's, which represent a level of intake sufficient to meet the needs of essentially all healthy people, is the major standard to interpret nutrient intake data currently available in the US (Guthrie, 1989). The RDA's are set theoretically at two standard deviations above the mean requirement for a particular age and sex category. For most nutrients, the coefficient of variation of the requirement is assumed to be 15 percent of the mean. Thus, the RDA is set at 130 percent of the mean. The mean requirement if 100/130 or 77 percent of the mean (Guthrie, 1989). Therefore an intake of 77 percent of the RDA meets the needs of one half that particular population.

The RDA's do not represent average requirements; they are intended to cover the needs of practically all members of a group (DHHS, 1979). Since the RDA's are nutritional goals for groups, the failure of an individual to achieve the level of intake might be but is not necessarily indicative of nutritional risk.

Nutrients/1,000 kilocalories

The ratio of the amount of a nutrient/1,000 kilocalories is useful for examining the diet quality of an individual or group. When examining diets in terms of nutrients, it is difficult to compare persons or groups because caloric intake varies widely. In general as one increases caloric intake it is easier to meet the RDA's for individual nutrients. Therefore one could make poor food choices and still meet the RDA's for most nutrients by consuming a large amount of kilocalories. As one consumes fewer kilocalories, choices must be of higher nutrient density to meet the RDA's. The term 'nutrient density' refers to choosing foods that contribute large amounts of needed nutrients relative to the number of kilocalories in the food. Foods that are high in nutrients but relatively low in kilocalories are said to have high nutrient density, while those high in kilocalories but with few nutrients are said to have low nutrient density. Expressing the nutrient composition of the diet in terms of the amount of a nutrient/1,000 kilocalories allow a direct comparison of individual nutrients between diets, thus giving an idea of nutritional quality. This method is suitable when the objective is to examine and compare individual nutrients and assess the quality of food choices.

Index of Nutritional Quality (INQ)

The INQ concept provides a quantitative analysis of the diet using nutrient standards, and also provides a profile of nutritional quality based on a ratio of nutritive to caloric needs. The INQ was developed from the nutrient density concept to compare the nutritive content of a food or diet with its energy content relative to the recommended nutritive to caloric ratio: (Sorenson et al., 1976)

$$INQ = \frac{\text{amount of nutrient in diet/RDA for that nutrient}}{\text{kcal in diet/energy requirement}}$$

The INQ relates the quantity of the nutrient in 1,000 kilocalories of food to the quantity of the nutrient and kilocalories recommended for the maintenance of good health. Foods or diets with INQ values equal or greater than 1 have sufficient nutrients in relation to their kilocalorie content to meet nutrient allowances when consumed at recommended energy level. INQ values less than 1 indicates that the nutrient content of the food or diet in relation to the energy content does not meet recommended standards. An advantage of INQ is the elimination of the correlation between high nutrient intake and high to excessive caloric intake, which is not possible with the Mean Adequacy Ratio (MAR) score.

Using data from the USDA Nationwide Food Consumption Survey (NFCS), 1977-1978, Windham et al. (1983) reported potential nutritional problem areas related to consumption of iron, magnesium, calcium, and vitamin B_6. The nutrients for which average U.S. consumption was below recommended standards on a kilocalorie basis were iron (86%), magnesium (91%), calcium (84%), and vitamin B_6 (79%). Vitamin C (152%) and vitamin A (154%) averaged at least 50% above recommended standards.

Nutrient Adequacy Ratio (NAR) and Mean Adequacy Ratio (MAR)

Another method to assess nutritional adequacy is using Nutrient Adequacy Ratios (NAR) and Mean Adequacy Ratios (MAR). The MAR, an index of the percent of recommended intake consumed for the specified nutrients as compared to the sex and age specific RDA's (FNB, 1989), is the average value of the NAR of all the nutrients of interest. The NAR is calculated by dividing the actual intake of a nutrient by that nutrient's RDA and multiplying by 100.

$$\text{NAR} = \frac{\text{Actual nutrient intake}}{\text{Recommended Dietary Allowance}} \times 100$$

Each NAR score is truncated at 100 prior to the calculation of the MAR to remove the influence of excessive intake of one or more nutrients on the overall score. To determine the overall quality of the diet, Mean Adequacy Ratios (MAR) can be calculate using the following equation:

$$\text{MAR} = \frac{\text{Sum of the NARs for selected nutrients}}{\text{No. of nutrients being assessed}}$$

Krebs-Smith and Clark (1989) used MAR as a method of validating a dietary scoring system based on a food grouping scheme. The purpose of their study was to determine the validity of the scoring system for measuring nutrient adequacy that could be used by maternal and child nutrition programs. Data for the study were obtained from the basic survey portion of USDA's 1977-1978 NFCS. Two MAR's were calculated: one assessed overall nutrient adequacy and another assessed only problem nutrients. The nutrients included in the overall nutrient adequacy were iron, magnesium, phosphorus, thiamin, riboflavin, and vitamins A, B_6, B-12, and C. Problem nutrients were those nutrients with an average NAR below 80 for pregnant and lactating women in a subset of 274 women who participated in the USDA's NFCS. The problem nutrients were calcium, iron, magnesium, and vitamins A and C. Regression analysis was used to assess the relationships between the overall MAR and the simplified food frequency dietary score and between the problem nutrient MAR and the dietary score. Thus the MAR was the "gold standard" used as a measure of diet quality to validate a simplified food frequency diet score.

Worthington-Roberts et al. (1989), studying dietary cravings and aversions of pregnant, lactating and non-lactating women, used NAR for computation of an "Index of Dietary Quality (IDQ). The authors obtained dietary information from four-day food records kept by subjects and analyzed the records to obtain average daily intakes of energy, protein, and 14 micronutrients. Two summary indexes were calculated. First, mean percent RDA was computed for energy, protein, thiamin, riboflavin, niacin, calcium, iron, magnesium, zinc, folate, and vitamins A, D, E, C, B_6 and B_{12}. Second, INQ was computed by counting the number of nutrients for which percent RDA was at least 66.7%. As 16 dietary components were considered, the maximum possible INQ was 16. Results showed that the IDQ ranged form 8.25 to 10.09 for the first year postpartum, indicating diets of less than ideal quality. This use of the NAR as an indicator of diet quality is practical and sound, if it is accepted that an intake greater than 2/3 of the RDA is adequate, and anything less is inadequate. Assigning a score of "one" for nutrients for which intake was greater than 2/3 of the RDA reduces the effect of high intakes for several nutrients.

The studies cited above indicate the major strengths of the MAR and NAR. These scores are easy to calculate and manipulate statistically, and can be used for validating other diet scoring methods. However, much of the research does not offer statistical support or justification for selection of nutrients used in calculating NARs and MARs. If statistical procedures are not used for selecting indicator nutrients, the chances are good that nutrients that are highly interrelated will be used, giving a weighted score not truly representative of diet quality. Also the MAR does not account for nutrient density.

Correlations among nutrients have been reported in a limited number of studies. On the basis of a correlation analysis of the nutrient composition of 202 foods, Pennington (1976) selected seven nutrients - vitamin B_6, pantothenic acid, vitamin A, magnesium, folacin, iron, and calcium as the best combination of index nutrients for judging dietary adequacy. Pennington claimed that if a diet met the recommended intakes for these seven index nutrients, and if a few simple dietary guidelines were followed, there was a high probability that all 45 essential nutrients included in her data base would be present in the diet in adequate amounts.

Jenkins and Guthrie (1984) criticized Pennington's conclusions because they were based on nutrient data composition of equal portions of 202 foods without considering the relative amounts used in a typical diet. Furthermore, data on only three of Pennington's seven nutrients were available and complete. Jenkins and Guthrie identified a set of index nutrients that could be used for dietary assessment. The authors analyzed 3,318 three-day food intake records collected from the adult population surveyed in the 1977-1978 NFCS. The records were analyzed using a data base providing information for 15 nutrients - carbohydrate, protein, calcium, phosphorus, vitamin A, thiamin, riboflavin, niacin, vitamin B_6, vitamin B-12, vitamin C, folacin, iron, magnesium, and zinc. A correlation matrix of the 15 nutrients was generated and then a factor analysis with an orthogonal varimax rotation was performed. Four factors were identified and then index nutrients for each factor were determined. The four index nutrients identified by Jenkins and Guthrie as reflecting adequate intakes of the other 11 nutrients were vitamin B_6, iron, calcium, and vitamin A. These nutrients need to be tested under other circumstances and populations to see if they hold as adequate index nutrients.

U.S. DIETARY GUIDELINES FOR AMERICANS

In response to the increasing concern regarding the relationship between diet and chronic disease, the United States Department of Agriculture, Human Nutrition Information Service set forth U.S. Dietary Guidelines for Americans. The first set of U.S. Dietary Guidelines were published in 1980 and were partially based on the findings of the American Society for Clinical Nutrition (ASCN) published in 1979 in Healthy People: The Surgeon General's Report on Health Promotion and Disease Prevention (Dietary Guidelines Advisory Committee, 1990). Recently the U.S. Dietary Guidelines were revised and published in 1990 (USDA-DHHS, 1990). The guidelines are: 1) eat a variety of foods; 2) maintain healthy weight; 3) choose a diet low in fat, saturated fat, and cholesterol; 4) choose a diet with plenty of vegetables, fruits, and grain products; 5) use sugars only in moderation; 6) use salt and sodium only in moderation; and 7) if you drink alcoholic beverages, do so in moderation.

Current recommendations regarding proportion of caloric intake from macronutrients are 50-55% from carbohydrate, 30% or less from fats, and 15-20% from protein (NAS, 1989 and AHA, 1988). The major public health issues of the day, obesity and chronic diseases such as heart disease, cancer, stroke and hypertension demonstrate the need for guidelines that go beyond minimal intake standards for nutrients which rarely present as clinical deficiencies (Anonymous, 1985). For this reason, the 1990 U.S. Dietary Guidelines also include recommended serving of foods from five primary food groups: 1) breads, cereals and other grain products; 2) fruits; 3) vegetables; 4) meat, poultry, fish, and alternatives; and 5) milk, cheese, and yogurt.

METHODS FOR COLLECTING DIETARY INTAKE DATA

Food intake records

The usefulness of various methods to assess food intake for individuals and population groups varies depending on the research purpose and population groups studied. Food intake records were used for our research as an efficient and accurate method for collecting dietary intake data. Food intake records, however, have been recognized for the following advantages and weaknesses.

A food intake record is a diary of intake recorded immediately after consumption. Food intake records have been promoted because of this direct record and because portion sizes can be measured. But the respondents' burden is increased and subjects may subconsciously improve the dietary intake or provide biased information (Todd, et al., 1983). Subject compliance and accuracy have been known to decrease as the number of recording days increase to more than five days (Gersovitz et al., 1978).

Guthrie and Crocetti (1985) analyzed the extent to which nutrient intake of individuals varied over a three-day period. It was based on a nutrient analysis of the food intake data collected in the 1977-1978 NFCS for three days: a 24-hr recall and food intake records for 2 days. The authors reported that there was considerable variation in nutrient intake from day to day. The authors contended that one-day food intake record may represent the usual intake of a group, and it is necessary to have a large group for nutrients such as vitamin A and C. On any one day as many as 85% of the population had intakes of a specific nutrient that varied by more than 25% from the average for the three-day period. This confirmed that intake of an individual on any one day cannot be considered a sensitive indicator for usual intake of that nutrient. Guthrie and Crocetti found the one-day food intake records to be the least sensitive for vitamins A and C, which was supported by Pao et al. (1985).

When assessing the dietary status of an individual and groups of individuals, the day-to-day variability in food energy and nutrient intake affects the statistical precision or accuracy of estimates of intakes (Basiotis et al., 1987). The level of variability that can be tolerated (i.e., the level of accuracy desired) depends on the intended use of the data and the nutrients studied. The authors used food records of 29 individuals (13 males, ages 21-49, and 16 females, ages 20-53) for 365 consecutive days from a study conducted by the USDA's Beltsville Human Nutrition Research Center. The study was to determine the number of days of food records needed to estimate "true" average nutrient intakes for individuals and groups with a given degree of statistical confidence or precision. For their study, authors defined a "precise" estimate as an X-day average intake being within 10% of the "true average" intake for the individual or the group, for 95% of the time. The true intake was the 365-day's average for an individual or the group. Daily intakes for an individual estimate of energy intake for 14 to 84 days resulted in a 95% degree of accuracy. For estimation of iron intake, the number of days of diet records needed ranged from 18 to 142 days. To estimate vitamin A, a range of 115 to 1724 days was needed. Food sources of vitamin A are concentrated in a small number of foods which accounts for the large variation in intake. To estimate the days required for a group, the males and females were examined as separate groups. To estimate true average food energy intake "accurately" for both groups, an intake of 3 days was needed. For iron, the males required 7 days, and the females required 6 days. The average number of days for vitamin A was 39 for males and 44 for females. To achieve a defined level of statistical precision for groups, one can either increase the number of days of food intake records for a set number of individuals, or increase the number of individuals with a set number of food intake records. Others (Chalmers et al., 1952) suggested that to obtain an estimate of the mean intake for a group with greater precision, it was more efficient to take more subjects, not more days from each subject.

Chalmers et al. (1952) attempted to determine the number of days that a food record should include to estimate dietary intakes of groups and individuals, which days should be included, and how many subjects should be included for a group study. Data were collected from 512 subjects who were from various population groups (high school and college students, pregnant women, and male industrial workers) in the northeastern United States. Using ANOVA, it was found that for all nutrients (kilocalories, protein, calcium, iron, phosphorus, thiamin, riboflavin, niacin, and vitamins A and C) and populations, an one-day food intake record characterized the dietary intake of the group. This answer was based on relative importance of days as compared to number of subjects. To obtain an estimate of the mean intake for a group with greater precision, it was more efficient to take more subjects (approximately 60 subjects), not more days.

The question of which days to use becomes important when food intake records are taken for one day. For the group, there were no significant differences beyond chance occurrence between days for any of the nutrients or any of the population types except college students, who had a distinct decrease in food intake on weekends. In contrast, St Jeor et al. (1983) found no specific day-of-the-week effect in food intake of college students, faculty, and their spouses. Chalmers et al. (1952) contended that it is immaterial which day or days is (are) selected for a diet record, provided no distinct tendency for a specified population has been found.

Todd et al. (1983) assessed the sources of variance in diet records. Eighteen graduate students recorded self-selected food intakes for 30 days. The study was divided into six periods of five days each, in which subjects alternately weighted food intake and recorded it by tape recorder or kept a written record of estimated food intake. Two 24-hour recalls were also obtained and compared to the written estimates of intake for only energy and protein. They found no significant differences in the mean energy and protein intakes between the two recording methods, i.e., taped records or written records. The 95% confidence limits calculated both for the group's and an individual's intake demonstrated that a one-day food intake record gave a reasonable estimate of the group. However, comparing the 24-hour recall and a one-day diet intake with an individual's 30-day record showed that one-day food intake records did not accurately represent an individual's usual diet.

Pao et al. (1985) examined three-day food intake data (a recall for one-day and 2 food records) from the Spring 1977 NFCS to determine if the food intake data collected by a recall differs from the average of the three days. They reported that average daily intakes of three days for kilocalories, fat, protein and carbohydrate and those from one-day recall were within 2% coefficient of variation. The differences in average intakes between the three-day and one-day diets were less than 5% of coefficient of variation for 9 minerals and vitamins except vitamin A and C. The authors concluded that one-day intakes provide as reliable base as three-day intakes for computing mean intakes of most nutrients.

Food group intake patterns

Kant et al. (1991a) examined 24-hour recalls from the second National Health and Nutrition Examination Survey (NHANES II) to identify the extent of diversity in the diets (n=11,658). Two measures were developed for assessing the extent of variety. The first measure, Food Score, assigned one point for each food group consumed for a maximum score of five. The second measure, Serving Score, evaluated each 24-hour recall for the presence of desired number of servings from the five food groups - two servings each from the dairy, meat, fruit, and vegetable groups and four servings from the grain group. Each serving of a food group other than the grain contributed two points to the total score and each serving of grain contributed one point for a maximum score of 20. Failure to consume any foods from the dairy, meat, grain, fruit, and vegetable groups was reported by 24%, 6%, 5%, 46%, and 18%, respectively. The proportion of the population consuming at least the desired number of servings from each of these food groups was 51%, 71%, 29%, 29%, and 61%, respectively. Although 95% of the population consumed at least one food from the grain group, only 29% consumed four or more servings from this group. Only 33% of the US population consumed foods from all five food groups, and the proportion consuming at least the desired number of servings from all of the various food groups was only 2.9%. This result suggests that the typical US diet is not consistent with current food group guidance.

Kant et al. (1991b) examined 24-hour recalls from the second National Health and Nutrition Examination Survey (NHANES II) to identify dietary patterns based on consumption of foods from traditional food groups (n=11,529). All foods reported consumed were assigned to one of five food groups: dairy, meat, grain, fruit, and vegetable. Foods were placed in the five groups on the basis of similarities in nutrient composition and uses in the diet. For each 24-hour recall, the presence or absence of each food group was evaluated. Intakes of energy, cholesterol, dietary fiber, folate, iron, zinc, calcium, potassium, and vitamins A, B_6, C, and E were evaluated. Although the most frequently reported pattern was the one in which respondents consumed foods from all five food groups, this pattern was reported by only 34% of subjects. Omission of fruit was the most commonly reported incomplete pattern, comprising nearly one fourth of all subjects. Only the most frequently reported pattern (i.e., foods from all five food groups) provided mean amounts of all noted vitamins and minerals at levels greater than or equal to the RDA. Vitamin B_6, vitamin E, zinc, and calcium were the nutrients most likely to be consumed at levels below the RDA in all patterns except the leading one.

Kant et al. (1991b) identified several advantages of using broad based food groups to evaluate nutritional adequacy. A food group score is minimally affected by day-to-day variation in food intake or errors in estimation of portion sizes, both of which are notable sources of error in measurement of nutrient intake. For example, although individuals may not consume carotene-rich fruits and vegetables every day, they might be expected to consume some foods from the fruit and vegetable group on a daily basis. Therefore, although information on specific food items from one day is less reliable, the food group estimates may approximate the usual pattern of intake to a greater degree. Because certain food groups are known sources of specific nutrients, these patterns can be used to identify nutrients most likely lacking in the diet. Food group patterns may be used to screen diets in nutrition counseling and education when dietary information available at baseline is minimal.

SENSITIVITY AND SPECIFICITY OF DIETARY ASSESSMENT METHODS

A common purpose of ascertaining nutritional status in both individuals and populations is determining whether some action is required. A diagnostic test to identify and count the nutritionally inadequate classifies persons as nutritionally inadequate or nutritionally adequate in relation to a specific level or cut-off point of a diagnostic indicator (Habicht et al., 1982). Thus, a diagnostic test is composed of both an indicator and a cutoff point for that indicator. Since no diagnostic test exactly reflects the true underlying reality of concern, some misclassification often occurs; i.e., nutritionally inadequate persons are wrongly classified as nutritionally adequate (false negative) and nutritionally adequate persons are classified as nutritionally inadequate (false positive).

The best diagnostic test would be one with the highest proportion of correct diagnoses in the population examined (i.e., least false positives and false negatives) (Habicht et al., 1982). Sensitivity refers to the proportion of those actually nutritionally inadequate who are classified as nutritionally inadequate:

$$\frac{\text{true positive}}{\text{true positive + false negative}}$$

Specificity refers to the proportion of those actually nutritionally adequate who are classified as nutritionally adequate:

$$\frac{\text{true negative}}{\text{false positive + true negative}}$$

For any indicator, sensitivity and specificity are inversely related, so that increasing one (by changing the cutoff point appropriately) will result in decreasing the other.

Krebs-Smith and Clark (1989) determined the sensitivity and specificity of a nutrient adequacy score in a study described earlier in detail in the section on MAR in the literature review. The authors used two cutoff points MAR 66 and MAR 80 to validate the nutrient adequacy score. The nutrient adequacy score appeared more sensitive with regard to MARs for problem nutrients than it did for overall MARs. Also the nutrient adequacy score seemed to be more sensitive toward identifying persons below the MAR 80 cut-off than it was for the MAR 66 cut-off. The nutrient adequacy score was very sensitive for population segments which have a large portion of persons below a particular cut-off. Specificity of the score tended to be greater using a cut-off of MAR 66 than it was using a cut-off of MAR 80 and greater with regard to overall MARs than it was with MARs for problem nutrients. These trends were the opposite of those seen with the sensitivity measure. Generally, it is necessary to balance the goal of sensitivity with that of specificity when choosing cut-off points for indicators of nutritional risk (Habicht et al., 1982).

DIETARY PRACTICES OF COLLEGE STUDENTS

Mitchell (1990) administered a 41-item questionnaire to students in a college basic nutrition course and to students in unrelated general studies classes (control group). To measure construct validity, the questionnaire was administered to 24 seniors majoring in dietetics or minoring in nutrition. Eighty-five percent of the basic nutrition students and eighty-eight percent of the control students consumed fruit, vegetables or juice three or less times per day. Thirty-three percent of the basic nutrition students and thirty-nine percent of the control students drank less than one cup of milk per day. Sixty-one percent of the basic nutrition students and 61% of the control students drank 2 or fewer servings of milk per day.

Skinner (1991) asked students enrolled in an elementary nutrition class to complete three-day food records. A pre/post test was used to evaluate change. The women decreased intakes of kilocalories and fat and increased intakes of calcium, potassium, vitamins A and C. Mean nutrient intakes for women were below the 1980 RDA's pre- and post- instruction for iron and calcium. The mean nutrient intakes of men met the 1980 RDA's. High fat intake was identified as a problem area for both genders.

Marrale et al. (1986) administered a questionnaire to 437 college students who were randomly selected. Marrale reported that many students did not take the time, or have the time to eat properly. Students may not even realize that their diets are nutritional inadequate. Damaging effects of poor dietary habits may result in health problems now or in the future.

Hernon et al. (1986) looked at the food consumption patterns of college students using 3-day food records. The students were divided into subgroups of men and women with mean energy intakes greater than 1,200 kilocalories and women consuming less than 1,200 kcal per day. The students were enrolled in an introductory nutrition course during the winter, spring, summer and fall quarters of 1980. Women with less than 1,200 kcal/day had lower intakes of carbohydrate, protein, fat; ate less frequently; ate less meat and eggs, bread, legumes, cooked starchy vegetables, desserts, milk products, added fat, and added sugar than the men and women who consumed more than 1,200 kcal/day. These women did not meet the RDA's for calcium, iron, thiamin, riboflavin, and niacin. The women who consumed more than 1,200 kcal/day met all the RDA's except for iron while the men met all the RDA's.

O'Leary and Lee (1975) assessed the nutrient intakes of 75 university women in residence and 32 university women living at home. Seven-day records were used for the collection of dietary information. Students consuming kilocalorie-restricted diets tended to have low intakes of calcium and iron. Fifty percent of the low calcium intakes and 90% of the low iron intakes were associated with low kilocalorie intakes. The distribution of kilocalories were protein (16%), fat (38-40%), and carbohydrate (44-46%).

Meal patterns and nutritional adequacy of diets of 100 university students living in residence were studied by Gottschoal, et al. (1977) The students were classified into two categories: those with meal contracts and those without. Students with meal contracts could use their meal card to purchase meals at any cafeteria while students without a meal contract prepared their own meals. Over 90% of all female students had less than desirable intakes of iron. Distribution of kilocalories for the whole group was 14.9% of kilocalories from protein, 36.7% from fat, 44.3% from carbohydrate, and 4.1% from other sources (primarily alcohol).

Jakobovits et al. (1977) looked at 195 food records of junior and senior women students at Cornell University. High intakes of vitamin A, protein, very high intakes of vitamin C, and low iron intakes (69% of the RDA) were found. The majority of students had caloric intakes below the allowance, although 57% had intakes at a level between 60 - 100% of the RDA. Thirty-four percent of the women took at least one type of nutrient supplement, the most widely used being a multivitamin with iron.

Ostrom and Labusa (1977) analyzed seven-day dietary records of 375 students at the University of Minnesota. Kilocalories, protein, calcium, phosphorus, iron, vitamin A, vitamin C, thiamin, riboflavin, and niacin were evaluated. The means for most of the nutrients evaluated were close to or above the established RDA's except for iron intake of females. More than nine out of ten females consumed less than 80% of the RDA for iron. The authors concluded that the apparently low value for female iron intake was due to the fact that although their kilocalorie requirement is only three-fourths of that of the males, the recommended iron intake is almost double at 18 mg per day. Results for vitamins A and C were misleading due to a positive skew. One-third of the students were receiving less than 60% of the RDA for vitamin A and one out of ten students were receiving less than 60% of the RDA for vitamin C. The percent of kilocalories from fat was 35.6, carbohydrate was 48.1, and protein was 16.3.

The studies cited identified several problem areas in the college students' dietary practices. The two nutrients which appear to be consistently inadequate in the female students' diets are iron and calcium. Ostrom and Labusa (1977) concluded vitamins A and C may be inadequate for some students. Mitchell (1990) found that eighty-five to eighty-eight percent of the students consumed fruits, vegetables, or juices three or fewer times per day. Less than one cup of milk was consumed by one-third of the students. The percent of fat from total kilocalories was identified as being above the recommended 30 percent. According to the National Food Consumption Report (USDA, 1977) for females (age 19-22), iron, magnesium, and vitamin B_6 are less than 70% of the RDA while calcium is 70-79% of the RDA. For males (age 19-22), magnesium and vitamin B_6 are 80-89% of the RDA.

METHODS

SUBJECTS

The data for this study included one record from each college student who was non-pregnant, non-lactating, 18 to 24 year old. Each college student analyzed a typical day's intake by 24-hour food intake record with a nutritional analysis computer program, MSU NutriGuide (MSU NutriGuide, 1988) between Fall term, 1988 and Winter term, 1991. Food intake data were collected from one-day food intake records (Appendix B). Nutritional supplementation data were not included in this study.

Approval for the study was obtained from the University Committee on Research Involving Human Subjects. The MSU NutriGuide computer program has been used as part of campus-wide health promotion program in collecting dietary intake data from a large number of college students in three general education or elective courses: Nutrition for Humans (HNF 102), Food and Society (FSC 101) and The Healthy Lifestyle (HCP 270). None of the three courses required a prerequisite course. The subjects are considered fairly representative of the lower level undergraduate student population at Michigan State University (Neid, 1991).

The collected data set was further evaluated to insure that the entered data represented a complete 24-hour intake of a typical day. Multiple records for an individual were present in the database, only the first one day's diet intake was used. Incomplete and multiple records for an individual were eliminated from the raw data.

Several criteria were used to eliminate cases from the data set: pregnancy or lactation; age; and probability that the dietary record represented actual intake due to misinterpretation of the default serving size when the subject entered food consumption (Table 2). Also, cases were eliminated for which the food code, serving size, and meal code variables were in the wrong columns through data process when inspected in SPSS/PC+ after inclusion in the food group intake analysis. Based on the misplacement of the variables, results of food group intake analysis would be in error for these cases.

Table 2. Criteria for exclusion of cases from data set

Description	Number excluded from data set
Pregnant or lactating	5
Age (<18 or >24 years)	124
Incorrect alignment of food code, serving size, and meal code variables	26
Misinterpretation of default serving size	155
TOTAL	310

In order to control for entries in records which would result in under- or overestimation of intake from kilocalories, macronutrients, the six nutrients of interest, five food groups, and sugar; all diets which were more than four standard deviations from the mean for each item were examined individually by two registered dietitians. Records were examined if they contained less than 400 kilocalories. Two hundred fifty-five diets (9.6%) were examined based on the criteria of plus or minus four standard deviations from the mean. One hundred one of these cases recorded intakes that were reasonable. In cases where the recorded intake was reasonable, no change was made and the case was included.

The limit of four standard deviations above the mean was selected to allow variability existing within the group which represents different food behavior. Cases were retained in which several feasible serving sizes contributed to the total intake of one food group. For example, one case provided 15 total servings from the dairy group from a recorded intake of 4 c milk and 8 slices pizza. Cases excluded from the data reported servings which likely were due to errors in recording intake. For example, one case provided 23 total servings from the meat group from a recorded intake of 10 roast beef sandwiches and 16 cups of three-bean salad.

A total of 2,489 records out of the 2,799 records were included in the final data analysis. The distribution of males and females was n=756 (30%) and n=1733 (70%), respectively.

The information saved for each subject included self-reported height (cm) and weight (kg). BMI's were calculated for all subjects by gender.

INSTRUMENTS

Nutrient database

Preparation of the MSU NutriGuide database for analysis is discussed in Appendix C. The MSU NutriGuide nutrient database was examined and updated for accuracy and completeness by two graduate students and three faculty members all of whom were registered dietitians in the Department of Food Science and Human Nutrition, MSU. The completeness of the MSU NutriGuide nutrient database ranges 60-100% for each nutrient included and 90-100% for the six nutrients of interest in this study.

Food group database

Nine hundred fifty-three food items including 338 combination foods in the MSU NutriGuide database were classified by food groups. Of those, forty-two food items, e.g., diet beverages, spices, non-caloric condiments, and flavorings, were not defined for any food groups.

Food group definition and calculation of serving size

The proportion of each standard food group serving size contained in each food item default serving size was calculated by registered dietitians (faculty and graduate students). For food items, identification of appropriate food groups was determined on the basis of ingredients according to established recipe books, e.g., Better Homes and Gardens, manufacturer's labels, and nutrient content of the item. The calculated food group for each item was used to create a food group database in the form of a spreadsheet using the Quattro Pro 3.0 software program (Borland International). Calculations and values entered in the spreadsheet were cross-checked for accuracy by registered dietitians.

Food group classification system

In order to analyze the dietary records collected with MSU NutriGuide, a database was created which listed the food groups, by serving size, contained in each of the 953 food items available in the program. The food groups were classified according to the modified Red Cross Food Wheel Classification System, USDA-Human Nutrition Information Service for American Red Cross (American Red Cross, 1984).

The recommended food groups and serving sizes of the Food Wheel and Food Guide Pyramid are identical with a few exceptions: 2/3 c of fruit juice is one serving in the Food Wheel, while 3/4 c of fruit juice is one serving in the Food Guide Pyramid. The difference in serving sizes for fruit juice is expected to be very small. The data used 2/3c which was counted as one serving.

The database has the capability to separate each food group even further (i.e., garden vegetables, fruit juice, plain fruit, vitamin A rich fruit, vitamin C rich fruit, starchy vegetables, legumes, whole wheat grains, vitamin A rich vegetables). For this study only fruit, vegetable, grain, dairy, and meat categories were used in analysis and are described in Table 3.

Table 3. Food Guide Pyramid food groups and serving sizes

Milk, Yogurt, Cheese 1 c milk or yogurt 1 1/2 oz natural cheese 2 oz processed cheese	Fruits 1 medium 1/2 c cooked 3/4 c juice
Meat, Fish, Eggs, Poultry, Nuts, Dry Beans 2-3 oz cooked meat, fish, poultry Count as 1 oz lean meat: 1 egg, 2 Tbsp peanut butter, 1/2 c cooked dry beans	Vegetables 1 c raw leafy 1/2 c cooked
Bread, Rice, Cereal, Pasta 1 sl bread 1 oz cereal 1/2 c cooked cereal, rice, or pasta	Fats, Oils, Sweets 1 tsp oil, margarine 1 tsp sugar

USDA, 1992

A standard serving of fruit was six ounces of juice, one medium piece, 1/2 cup of prepared or canned fruit or 1/4 cup of dried fruit. Fruit servings not easily converted into a designated serving, such as an ingredient in a mixed dish, were calculated based on a standard portion of 120g, the average weight of one medium piece of fruit (Patterson et al., 1990).

A standard serving of vegetable was 1/2 cup cooked or raw, except for raw leafy vegetables for which one cup was a serving. Vegetable servings not easily identified according to the standard portion, such as an ingredient in a mixed dish, were calculated based on a typical average weight of 75g per serving (Patterson et al., 1990).

The meat group included red meats, poultry, fish, eggs, nuts and seeds. Three ounces of meat, poultry, or fish were considered one serving.

In the dairy group, one cup of milk or yogurt, 1 1/2 ounces of natural cheese and two ounces processed cheese were counted as one serving. Calcium content was used to determine the serving size of other dairy foods, e.g., 2 cups of cottage cheese and 1 1/3 cups of ice cream (which also contains servings of fat and sugar), were considered one serving because they provide about the same amount of calcium. Dairy servings from milk based soups are based on the amount of milk added to the soup.

In the grain group, one serving was equivalent to one slice of bread; one small muffin, roll or biscuit; 1/2 cup of rice, cooked cereal or pasta; or one ounce of ready-to-eat cereal. If a grain product was not easily defined according to the suggested serving sizes, 15 grams of carbohydrate, equivalent to a bread exchange (ADA and ADA, 1989) was used to designate one serving.

The "others" food group was further subdivided to identify fats (1 teaspoon or 5 grams per serving), sweets (5 grams of sugar or approximately one teaspoon in one serving), and alcohol (the amount of a beverage which contained one gram of alcohol was one serving). The serving sizes for fat and sweets were chosen because the teaspoon is a commonly recognized serving size among most lay people and the macronutrient content of a teaspoon of fat is easily converted to the Diabetic Exchange System (ADA and ADA, 1989) Sweets included sugars from sweets (i.e., sucrose or dextrose) but did not include lactose or fructose.

Food group score systems

Three food group score systems were developed based on the Food Guide Pyramid (Table 4). Descriptions of each of these scoring systems follow.

A. Food Group Score System 1. One point was assigned for obtaining a minimum of one serving from each of the five food groups for a food score range: 0 to 5. Kant et al. (1991) reported that this food intake pattern provided mean amounts of key vitamins and minerals at levels greater than or equal to the RDA's. A strength of food group score system 1 is that it is easy to remember (one serving from each of the five food groups), while food group score system 3 is more complex containing various servings from various food groups.

B. Food Group Score System 2. One point was assigned for obtaining a minimum of half the recommended servings from each of the five food groups for a food score range: 0 to 5. Fifty percent of recommended servings are: 3 servings from the bread, cereals, rice, and pasta group; 1.5 servings for the vegetable group; 1 serving from the fruit group; 1 serving from the milk, yogurt, and cheese group;

and 1 serving from the meats, poultry, fish, dry beans and peas, eggs, and nuts group.

C. Food Group Score System 3. One point was assigned for obtaining the minimum number of servings from each of the five food groups for a food score range: 0 to 5. The minimum number of servings are: 6 servings from the bread, cereals, rice, and pasta groups; 3 servings from the vegetable group; 2 servings from the fruit group; 2 servings from the milk, yogurt, and cheese group; and 2 servings from the meats, poultry, fish, dry beans and peas, eggs, and nuts group. The advantage of using food group score system 3 is that it is the minimum number of servings recommended by the Food Guide Pyramid. Only the minimum number of servings from each food group as opposed to the maximum number of servings was evaluated. The assumption was consuming at least the minimum number of servings from each food group ensured nutritional adequacy.

Table 4. Food Group Score Systems

Food Group Score Systems	Dairy	Fruit	Meat	Veg	Grain	Total Food Score
FGSS1[a]	1	1	1	1	1	5
FGSS2[b]	1	1	1	1.5	3	5
FGSS3[c]	2	2	2	3	6	5

a. Requirement for food group score system 1: Consume at least one serving from each of the five food groups.
b. Requirement for food group score system 2: Consume at least 50% of the minimal number of recommended servings of Food Guide Pyramid from each of the five food groups (i.e., 1 serving from dairy group, 1.5 servings from vegetable group, 1 serving from fruit group, 3 servings from grain group, 1 serving from meat group).
c. Requirement for food group score system 3: Consume at least the minimum number of recommended servings of Food Guide Pyramid from each of the five food groups. (i.e., 2 servings from dairy group, 3 servings from vegetable group, 2 servings from fruit group, 6 servings from grain group, and 2 servings from meat group).

PROCEDURES

Nutritional adequacy

Assessment of nutritional adequacy included 1) nutritional adequacy of the diet in meeting the RDA based on a MAR-6 score, 2) nutrient density of the diet based on an Index of Nutritional Quality per 1,000 kilocalories, 3) sugar content of diets measured as percent of kilocalories, and 4) fat content of diets measured as total grams and as percent of kilocalories. A MAR-6 was calculated based on the intake of iron, calcium, magnesium, vitamins A, C, and B_6. These nutrients were selected because they are problematic nutrients for college-age students (Skinner, 1991; Ostrom and Labusa, 1977; USDA, 1977). A combination of four nutrients out of the six nutrients of interest (iron, calcium, vitamins A and B_6) assured comparable intakes of six additional nutrients (magnesium, phosphorus, riboflavin, thiamin, and vitamins C and B_{12}) (Jenkins and Guthrie, 1984). Additionally, vitamins A and C, as well as calcium and iron, are four of the nutrients which are included in nutrient food labels according to the newest Food and Drug Administration regulations (Federal Register, 1993). Magnesium, a trace element, was also chosen because it is found primarily in nuts, legumes, and unmilled grains as well as in green vegetables. There is no clear consensus regarding what MAR-6 score is considered nutritional adequate. A MAR-6 score of 75 was chosen because it is not as conservative as 100% of the RDA but not as liberal as 67% of the RDA (Guthrie, 1989; Hoffman, 1989).

Within each food score, there were various food group intake patterns. For example, a food score of 4 had 5 different food group intake patterns, a food score of 0 had 1 food group intake pattern, and a food score of 2 had 10 different food group intake patterns. Food group intake patterns were developed based on possible food group selection from food scores 2 and 4 from food group score system 1 and food scores 1 and 4 from food group score system 3. The food group intake patterns of students who received a MAR-6 score below 75 were compared to the food group intake patterns of students who received a MAR-6 score of 75 or above to determine if there were any differences if food group selection.

Statistical analysis

Descriptive statistics, including the mean, median, and standard deviation of MAR-6 scores, each nutrient, and each food group were calculated for the entire sample and for each gender. Analysis for associations between macronutrients, nutrients of interest, MAR-6 scores, and food groups were investigated using a correlation matrix.

Sensitivity and specificity of the Food Guide Pyramid were assessed using a cut-off score of 75 for MAR-6. T-tests were used to determine differences in INQ and nutrient intake between students who had a MAR-6 score of 75 or higher and a MAR-6 score of less than 75. Odds ratios were calculated to determine the degree of importance of each food group in attaining nutritional adequacy. A multiple regression equation was calculated to determine if food scores, fat, kilocalories, and gender could predict MAR-6 scores.

RESULTS

SUBJECTS

The mean reported age for all subjects (males and females) was 19.4 (males=19.7 and females=19.3) years (Table 5). The mean reported weight and height of all subjects in the study was 64.5 ± 12.3 kg and 169.7 ± 9.5, respectively. The mean weight and height of males in the sample was 77.0 ± 10.2 and 180.0 ± 6.8 cm, respectively. For females, the mean weight and height was 59.1 ± 8.6 kg and 165.2 ± 6.6 cm, respectively. BMI was strongly correlated with weight among the subjects ($r=.80$), males ($r=.82$), and females ($r=.84$) ($p<.001$).

Table 5. Characteristics of subjects

Characteristic	ALL (n=2489)	MALES (n=756)	FEMALES (n=1733)
Age (yr)	19.4 ± 1.4[a]	19.7 ± 1.4	19.3 ± 1.3
Height (cm)	169.7 ± 9.5	180.0 ± 6.8	165.2 ± 6.6
Weight (kg)	64.5 ± 12.3	77.0 ± 10.2	59.1 ± 8.6
BMI	22.3 ± 2.9	23.7 ± 2.6	21.6 ± 2.8

a. Mean ± standard deviation

NUTRITIONAL ADEQUACY BY NUTRIENT INTAKE

Table 6 summarizes nutrient intake of all subjects by gender. Mean caloric intake for the entire sample was 3,002 $\pm$ 1,712 (males 3,956 $\pm$ 1,818; females 2,586 $\pm$ 1,483).

The percent energy intake from carbohydrate, protein, and fat was 48%, 15%, and 37%, respectively. The percent energy intake from carbohydrate is below and the percent energy from fat is above the U.S. Dietary Guidelines recommendation. Average intake of all nutrients, except calcium for females, exceeded 100% of the RDA for the population. Nutritional supplementation data were not included in this study.

Table 6. Nutrient intakes of college students

% Energy	ALL (n=2489)	MALES (n=756)	FEMALES (n=1733)
Carbohydrate	48 ± 14[a]	47 ± 12	49 ± 15
(sugar)[b]	(10 ± 11)	(10 ± 9)	(10 ± 11)
Protein	15 ± 5	16 ± 5	15 ± 5
Fat	37 ± 15	37 ± 12	37 ± 16
Nutrient			
Energy (Kcal)	3002 ± 1712	3956 ± 1818	2586 ± 1483
Protein (g)	107 ± 61	150 ± 69	88 ± 45
Carbohydrate (g)	345 ± 209	455 ± 231	297 ± 179
Fat (g)	133 ± 112	168 ± 109	118 ± 111
Cholesterol (mg)	393 ± 420	564 ± 521	319 ± 342
Vitamin A (IU)	10943 ± 17179	11295 ± 15567	10790 ± 17839
% RDA	(256 ± 410)	(226 ± 311)	(270 ± 446)
Vitamin D (IU)	445 ± 495	669 ± 634	347 ± 382
% RDA	(111 ± 124)	(167 ± 159)	(87 ± 96)
Vitamin E (mg)	14.7 ± 16.2	17.6 ± 18.4	13.4 ± 15.0
% RDA	(170 ± 186)	(176 ± 184)	(167 ± 187)
Thiamin (mg)	2.13 ± 2.0	2.94 ± 2.2	1.78 ± 1.8
% RDA	(172 ± 163)	(196 ± 149)	(162 ± 166)
Riboflavin (mg)	2.63 ± 1.7	3.72 ± 2.0	2.15 ± 1.2
% RDA	(181 ± 105)	(216 ± 118)	(166 ± 96)
Niacin (mg NE)	29.5 ± 19.5	40.5 ± 22.5	24.5 ± 15.9
% RDA	(179 ± 105)	(211 ± 117)	(164 ± 106)
Vitamin B_6 (mg)	1.95 ± 1.4	2.62 ± 1.7	1.66 ± 1.2
% RDA	(113 ± 78)	(131 ± 83)	(106 ± 75)
Vitamin B_{12} (ug)	6.88 ± 9.5	10.50 ± 13.8	5.30 ± 6.3
% RDA	(343 ± 475)	(525 ± 688)	(265 ± 312)
Folacin (ug)	356 ± 271	465 ± 321	308 ± 232
% RDA	(190 ± 142)	(232 ± 160)	(172 ± 129)
Vitamin C (mg)	140 ± 196	168 ± 212	127 ± 188
% RDA	(232 ± 140)	(281 ± 353)	(212 ± 313)
Iron (mg)	19.7 ± 12.5	26.1 ± 14.0	16.9 ± 10.7
% RDA	(155 ± 116)	(252 ± 137)	(112 ± 71)
Calcium (mg)	1272 ± 880	1768 ± 1064	1056 ± 682
% RDA	(106 ± 73)	(147 ± 89)	(88 ± 57)
Phosphorus (mg)	1776 ± 1033	2444 ± 1206	1470 ± 781
% RDA	(147 ± 86)	(204 ± 101)	(122 ± 65)
Potassium (mg)	3288 ± 1795	4306 ± 2100	2844 ± 1434
% RDA	(164 ± 90)	(215 ± 105)	(142 ± 72)
Magnesium (mg)	342 ± 229	443 ± 251	299 ± 204
% RDA	(110 ± 72)	(123 ± 70)	(104 ± 71)

a. Mean ± standard deviation
b. Sugar: Includes dextrose and sucrose.

Caloric intake was positively associated with protein, carbohydrate, fat, dairy group, and grain group intakes (Table 7). Caloric intake was negatively correlated with percent of total kilocalories from protein and carbohydrate. Total fat was positively correlated with polyunsaturated fat (.62), saturated fat (.89), and cholesterol (.62). Total fat was positively associated with MAR-6 score for all subjects (.35), males (.37), and females (.29).

Table 7. Correlation coefficient (r) between caloric intake versus macronutrients and food groups

	ALL (N=2489)	MALES (n=756)	FEMALES (N=1733)
Protein	.75**	.76**	.67**
% Protein	-.31**	-.31**	-.40**
Carbohydrate	.80**	.84**	.73**
% Carbohydrate	-.26**	-.13**	-.31**
Fat	.84**	.85**	.84**
% Fat	.33**	.26**	.42**
Dairy Group	.43**	.41**	.30**
Fruit Group	.15**	.21**	.07*
Meat Group	.35**	.28**	.22**
Grain Group	.52**	.54**	.40**
Vegetable Group	.24**	.34**	.14**

*p < .01
**p < .001

NUTRITIONAL ADEQUACY BY MAR-6 (Objective 1)

The mean MAR-6 score for all subjects (males and females) was 82 ± 18 (males=89 ± 15 and females=79 ± 18). Over 70% of all subjects received a MAR-6 score of 75 or higher (Table 8). The median MAR-6 score was 87 for all students (males=95, females=83). MAR-6 scores for the study were high with a MAR-6 score of 100 for all males at the third quartile (Table 9).

Table 8. Percent and number of students with various MAR-6 score ranges

MAR-6 SCORES[a]	ALL (n=2489) %	(n)	MALES (n=756) %	(n)	FEMALES (n=1733) %	(n)
$0 \leq S < 25$	.6	(15)	.3	(2)	.8	(14)
$25 \leq S < 50$	6.2	(154)	3.0	(23)	7.6	(132)
$50 \leq S < 75$	22.4	(558)	13.8	(104)	26.1	(452)
$75 \leq S \leq 100$	70.8	(1762)	82.9	(627)	65.5	(1135)

a. MAR-6 score = Average NAR scores for 6 nutrients (calcium, magnesium, iron, vitamins B_6, A and C)

Table 9. MAR-6 scores among the quartiles

Quartiles	MAR-6 SCORES[a] ALL (n=2489)	MALES (n=756)	FEMALES (n=1733)
1st	72	83	68
2nd	87	95	83
3rd	97	100	94
4th	100	100	100

a. MAR-6 score = Average NAR scores for 6 nutrients (calcium, iron, magnesium, vitamins B_6, A, and C)

Since MAR $\geq$ 75 was elected as a criteria for nutritional adequacy, the average nutrient intake of students whose MAR-6 scores are $\geq$75 and those whose MAR-6 scores are <75 (Table 10 and 11) were compared. The average intake of all nutrients were above 100% of the RDA for students whose MAR-6 scores are $\geq$75. Students whose MAR-6 scores were below 75 had average intakes of vitamin B_6, magnesium, and calcium below 100% of the RDA. Intakes of vitamin A and iron were below the RDA for males and females, respectively. The difference in intake of all nutrients between students whose MAR-6 score was below and above 75 was statistically significant ($p<.0001$).

The analysis indicates that MAR-6 score $\geq$75 correctly identifies diets that are nutritionally adequate from those that are not as determined by comparison with individual RDA's. The analysis also demonstrates that the MAR-6 score based on the six nutrients selected is representative of the nutrients estimated in this study.

Table 10. Nutrient intakes of students whose MAR-6 scores were greater than or equal to 75

Nutrient	ALL (n=1765)	MALE (n=628)	FEMALE (n=1137)
Energy (Kcal)	3451 ± 1738[a]	4292 ± 1774	2987 ± 1530
Protein (g)	124 ± 61	163 ± 67	103 ± 45
Carbohydrate (g)	396 ± 214	493 ± 227	342 ± 186
Fat (g)	153 ± 118	183 ± 111	135 ± 118
Cholesterol (mg)	452 ± 454	612 ± 545	363 ± 366
Vitamin A (IU)	13388 ± 18981	12944 ± 16554	13633 ± 20200
Vitamin D (IU)	561 ± 529	765 ± 641	449 ± 414
Vitamin E (mg)	16.9 ± 17.5	19.4 ± 19.0	15.5 ± 16.4
Thiamin (mg)	2.50 ± 2.01	3.22 ± 2.29	2.09 ± 1.71
Riboflavin (mg)	3.14 ± 1.69	4.11 ± 1.94	2.61 ± 1.24
Niacin (mg NE)	34.3 ± 20.1	43.6 ± 22.3	29.1 ± 16.6
Vitamin B_6 (mg)	2.36 ± 1.43	2.91 ± 1.62	2.06 ± 1.21
Vitamin B_{12} (ug)	8.13 ± 7.75	11.1 ± 8.17	6.50 ± 7.01
Folacin (ug)	434 ± 279	521 ± 317	386 ± 242
Vitamin C (mg)	167 ± 199	186 ± 219	156 ± 187
Iron (mg)	23.2 ± 12.7	28.4 ± 13.8	20.4 ± 11.2
Calcium (mg)	1539 ± 884	1982 ± 1021	1294 ± 687
Phosphorus (mg)	2091 ± 1026	2706 ± 1140	1752 ± 770
Potassium (mg)	3903 ± 1737	4747 ± 2003	3437 ± 1364
Magnesium (mg)	407 ± 228	491 ± 245	360 ± 204

a. Mean ± standard deviation
MAR-6 score = Average NAR scores for 6 nutrients (calcium, magnesium, iron, vitamins B_6, A and C)

Table 11. Nutrient intakes of students whose MAR-6 scores were less than 75

Nutrient	ALL (n=724)	MALE (n=128)	FEMALE (n=596)
Energy (Kcal)	1909 ± 1016[a]	2307 ± 903	1823 ± 1019
Protein (g)	65.4 ± 33.6	89.7 ± 42.6	60.2 ± 28.8
Carbohydrate (g)	222 ± 132	269 ± 139	212 ± 129
Fat (g)	84.7 ± 79.9	95.9 ± 58.0	82.3 ± 83.7
Cholesterol (mg)	250 ± 274	326 ± 280	234 ± 270
Vitamin A (IU)	4986 ± 9298	3204 ± 2876	5369 ± 10122
Vitamin D (IU)	161 ± 224	193 ± 300	154 ± 203
Vitamin E (mg)	9.28 ± 10.8	8.94 ± 11.9	9.35 ± 10.6
Thiamin (mg)	1.25 ± 1.80	1.57 ± 1.24	1.19 ± 1.90
Riboflavin (mg)	1.38 ± .77	1.80 ± 1.14	1.29 ± .63
Niacin (mg NE)	17.8 ± 11.5	25.1 ± 15.8	16.2 ± 9.71
Vitamin B_6 (mg)	.96 ± .65	1.20 ± .92	.90 ± .57
Vitamin B_{12} (ug)	3.83 ± 12.3	7.66 ± 28.1	3.01 ± 3.45
Folacin (ug)	166 ± 114	186 ± 144	162 ± 107
Vitamin C (mg)	73.2 ± 171	81.2 ± 147	71.5 ± 176
Iron (mg)	11.0 ± 5.96	14.8 ± 8.19	10.2 ± 5.01
Calcium (mg)	622 ± 399	721 ± 503	600 ± 370
Phosphorus (mg)	973 ± 464	1160 ± 484	933 ± 450
Potassium (mg)	1790 ± 744	2145 ± 857	1714 ± 695
Magnesium (mg)	185 ± 137	207 ± 107	181 ± 142

a. Mean ± standard deviation
MAR-6 score = Average NAR scores for 6 nutrients (calcium, magnesium, iron, vitamins B_6, A and C)

NUTRIENT DENSITY

However, caloric intake between the two MAR-6 scores was different. To determine if the differences in nutrient intake were due to the quality of the diet or due to excess caloric intake, nutrient density for each nutrient was calculated (Table 12). Differences in nutrient density between students who had a MAR-6 score greater than or equal to 75 and students who had a MAR-6 score less than 75 were determined for males and females (Appendix D). There was no difference in macronutrient intake between students who had a MAR-6 score greater than or equal to 75 and a MAR-6 score less than 75 except for protein intake. However, there was a difference in micronutrient intakes between students who had a MAR-6 score greater than or equal to 75 and a MAR-6 score less than 75. The differences in nutrient intake were due to the quality of the diet. Students whose MAR-6 score was greater than or equal to 75 consumed foods which were nutrient dense compared to students who have a MAR-6 score below 75.

Table 12. Nutrient density per 1,000 kilocalories of college students' diets with MAR-6 scores above and below 75

Nutrient per 1,000 kcals	MAR-6 score < 75 n = 724	MAR-6 score ≥ 75 n = 1765
Protein (g)	37 ± 14[a]*	38 ± 13
Carbohydrate (g)	121 ± 38	120 ± 34
Fat (g)	41 ± 16	41 ± 16
Cholesterol (mg)	131 ± 123	127 ± 97
Vitamin A (IU)	3315 ± 8907**	4733 ± 8507
Vitamin D (IU)	100 ± 144**	187 ± 177
Vitamin E (mg)	5.63 ± 6.44	5.66 ± 6.54
Thiamin (mg)	.71 ± .71*	.79 ± .56
Riboflavin (mg)	.82 ± .51**	1.01 ± .53
Niacin (mg NE)	10.2 ± 5.75*	11.0 ± 6.01
Vitamin B_6 (mg)	.61 ± .50**	.81 ± .57
Vitamin B_{12} (ug)	2.19 ± 4.47*	2.63 ± 2.67
Folacin (ug)	109 ± 103**	149 ± 121
Vitamin C (mg)	43 ± 65**	56 ± 61
Iron (mg)	6.42 ± 3.45**	7.58 ± 4.63
Calcium (mg)	365 ± 226**	490 ± 247
Phosphorus (mg)	561 ± 219**	653 ± 232
Potassium (mg)	1081 ± 538**	1289 ± 610
Magnesium (mg)	110 ± 83**	131 ± 68

*p<.003 between two groups using t-test
**p<.0001 between two groups
a. MAR-6 score = Average NAR scores for 6 nutrients (calcium, magnesium, iron, vitamins B_6, A and C)
b. Mean ± standard deviation

INQ values for the selected 6 nutrients and the average are reported in Table 13. An INQ of 1 indicates that the amount of food or diet necessary to yield sufficient energy per day to maintain weight will also provide the appropriate allowance for that nutrient. Conversely, an INQ less than 1 identifies nutrients in a food where an excess of kilocalories must be eaten to fulfill the standards for those nutrients if only that food were eaten (Sorenson, 1976). The average INQ's were above or close to 1 except for INQ value of calcium for females.

Table 13. INQ values of college students' diets

INQ[a] of Nutrients	ALL (n=2489)	MALE (n=756)	FEMALE (n=1733)
Vitamin A	2.41 ± 4.78[b]	1.75 ± 2.56	2.70 ± 5.45
Vitamin C	2.08 ± 2.48	2.19 ± 2.64	2.03 ± 2.41
Calcium	.92 ± .52	1.13 ± .57	.82 ± .46
Magnesium	.99 ± .58	.95 ± .39	1.01 ± .64
Iron	1.36 ± .91	2.00 ± 1.04	1.08 ± .68
Vitamin B_6	1.05 ± .78	1.05 ± .68	1.04 ± .82
Average	1.47 ± 1.10	1.51 ± .81	1.45 ± 1.20

a. $\text{INQ} = \dfrac{\text{amount of nutrient in diet/RDA for that nutrient}}{\text{kcal in diet/energy requirement}}$

b. Mean ± standard deviation

To determine the nutrient density between varying kilocalorie levels for females and males, INQ values were obtained for energy intakes below and above recommended energy intakes (Table 14). INQ values for calcium, magnesium, iron, and vitamin B_6 of females consuming more than 2200 kilocalories were below 1. Based on these results, females who consumed above recommended energy intakes consumed less nutrient-dense foods than females who consumed lower energy intakes. These results appear to contradict results from Table 12 where students whose MAR-6 score was above 75, had higher caloric intake and selected foods which were nutrient-dense. A different method was used to categorize students (kilocalorie level versus MAR-6 score). Some of the students whose MAR-6 score were above 75 fell into the lower kilocalorie level and vice versa. This may be a possible explanation for the contradictory results.

Table 14. INQ values of students with varying energy intakes

Average and Individual INQ[a] Values	MALES < 2900 Kcals (n=239)	MALES > 2900 Kcals (n=517)
Average INQ	1.68 ± .94[b]	1.43 ± .73
Vitamin A	1.72 ± 1.81	1.76 ± 2.85
Vitamin C	2.57 ± 3.60	2.01 ± 2.03
Calcium	1.19 ± .65	1.10 ± .53
Magnesium	2.30 ± 1.39	.90 ± .36
Iron	1.04 ± .43	1.87 ± .80
Vitamin B_6	1.25 ± .88	.96 ± .53
	FEMALES < 2200 Kcals (n=882)	FEMALES > 2200 Kcals (n=851)
Average INQ	1.72 ± 1.47	1.17 ± .74
Vitamin A	3.35 ± 7.00	2.02 ± 2.95
Vitamin C	2.37 ± 2.43	1.68 ± 2.33
Calcium	.90 ± .49	.74 ± .42
Magnesium	1.15 ± .73	.86 ± .48
Iron	1.26 ± .79	.89 ± .47
Vitamin B_6	1.27 ± .95	.81 ± .56

a. INQ = $\frac{\text{amount of nutrient in diet/RDA for that nutrient}}{\text{kcal in diet/energy requirement}}$

b. Mean ± standard deviation

FOOD INTAKE BY FOOD GROUPS (Objective 2)

The daily mean and median intake of the five food groups along with the percent and number of subjects who consumed various numbers of servings from the five food groups of the Food Guide Pyramid are reported in Table 15. The medians were below the means for all five food groups implying a small number of students consumed large amounts of certain food groups. For all five food groups, the mean and median intakes were above the recommended minimum number of servings of the Food Guide Pyramid except for the median intake of meat by females (1.7 servings).

Failure to consume any foods from the dairy, meat, grain, fruit, and vegetable groups was reported by 10%, 9%, 1%, 33%, and 8%, respectively. The proportion of students consuming at least the recommended minimum number of servings from dairy, meat, grain, fruit, and vegetable groups was 60%, 45%, 61%, 62%, and 69%, respectively.

Fruit consumption was distributed bimodal. Fifty-five percent of the students consumed less than the minimum recommendation from the meat group with a higher percentage among females (66%) than males (29%). Only 2% of males versus 12% of females did not consume any foods from the meat group, indicating a gender differences in meat group consumption. The large proportion of females who did not

Table 15. Average number of servings consumed from the five food groups, and percentage of students who consumed different number of servings from the five food groups

	ALL (n=2489)		MALE (n=756)		FEMALE (n=1733)	
DAIRY (Recommended Serv: 2-3/day)	Mean ± SD 3.0 ± 2.7 Median = 2.3		Mean ± SD 4.3 ± 3.3 Median = 3.8		Mean ± SD 2.4 ± 2.1 Median = 2.0	
# of Serv (S)	%	(n)	%	(n)	%	(n)
0	9.9	(246)	8.2	(62)	10.6	(184)
0 < S < 1	10.2	(254)	4.0	(30)	12.9	(224)
1 ≤ S < 2	19.6	(488)	10.9	(82)	23.4	(406)
2 ≤ S < 3	18.2	(453)	15.1	(114)	19.6	(340)
3 ≤ S < 4	12.6	(314)	12.1	(92)	12.8	(221)
4+	29.5	(734)	49.7	(376)	20.7	(358)
FRUIT (Recommended Serv: 2-4/day)	Mean ± SD 4.1 ± 4.9 Median = 2.6		Mean ± SD 4.8 ± 5.7 Median = 2.6		Mean ± SD 3.8 ± 4.5 Median = 2.6	
# of Serv (S)	%	(n)	%	(n)	%	(n)
0	32.8	(816)	34.9	(264)	31.9	(552)
0 < S < 1	1.6	(40)	2.0	(15)	1.5	(26)
1 ≤ S < 2	3.9	(97)	2.3	(17)	4.5	(78)
2 ≤ S < 3	14.4	(358)	11.5	(87)	15.7	(272)
3 ≤ S < 4	4.2	(105)	1.5	(11)	5.4	(94)
4 ≤ S < 5	8.4	(209)	4.3	(33)	10.1	(175)
5 ≤ S < 6	7.5	(187)	9.2	(70)	6.8	(118)
6+	27.2	(677)	34.3	(259)	24.1	(418)
MEAT (Recommended Serv: 2-3/day)	Mean ± SD 2.2 ± 2.0 Median = 1.7		Mean ± SD 3.3 ± 2.3 Median = 2.9		Mean ± SD 1.7 ± 1.6 Median = 1.3	
# of Serv (S)	%	(n)	%	(n)	%	(n)
0	9.0	(223)	2.2	(17)	11.9	(206)
0 < S < 1	17.7	(441)	8.5	(64)	21.7	(376)
1 ≤ S < 2	28.3	(704)	18.5	(140)	32.7	(567)
2 ≤ S < 3	18.6	(463)	22.1	(167)	17.0	(295)
3 ≤ S < 4	11.1	(276)	16.8	(127)	8.6	(149)
4+	15.3	(382)	31.9	(241)	8.1	(140)

Table 15 (cont'd)

GRAIN (Recommended Serv: 6-11)	Mean ± SD 8.4 ± 5.8 Median = 7.0		Mean ± SD 11.2 ± 6.8 Median = 10.0		Mean ± SD 7.2 ± 4.9 Median = 6.0	
# of Serv (S)	%	(n)	%	(n)	%	(n)
0	.7	(18)	.7	(5)	.8	(13)
0 < S < 1	.8	(20)	.4	(3)	.9	(16)
1 ≤ S < 3	8.8	(219)	3.0	(23)	11.3	(196)
3 ≤ S < 6	28.9	(719)	15.6	(118)	34.7	(601)
6 ≤ S < 8	17.1	(426)	14.3	(108)	18.3	(317)
8 ≤ S < 10	13.5	(336)	15.1	(114)	12.9	(224)
10 ≤ S < 12	9.1	(226)	12.7	(96)	7.4	(128)
12 ≤ S < 14	6.7	(167)	10.7	(81)	5.0	(87)
14+	14.4	(358)	27.5	(208)	8.7	(151)
VEGETABLE (Recommended Serv: 3-5)	Mean ± SD 5.8 ± 5.0 Median = 4.6		Mean ± SD 6.6 ± 5.4 Median = 5.7		Mean ± SD 5.4 ± 4.7 Median = 4.2	
# of Serv (S)	%	(n)	%	(n)	%	(n)
0	8.3	(207)	7.7	(58)	8.6	(149)
0 < S < 1	4.1	(102)	3.3	(25)	4.4	(76)
1 ≤ S < 2	7.1	(177)	6.5	(49)	7.4	(128)
2 ≤ S < 3	11.9	(296)	8.4	(64)	13.4	(232)
3 ≤ S < 5	20.7	(515)	19.6	(148)	21.2	(367)
5 ≤ S < 7	15.6	(388)	15.1	(114)	15.8	(274)
7 ≤ S < 9	12.5	(311)	13.5	(102)	12.1	(210)
9+	19.8	(493)	25.9	(196)	17.1	(297)

consume foods from the meat group is reflected in their low intake of iron and vitamin B_6.

There appeared to be no nutritional inadequacies when only the mean and median intakes of the various food groups were examined for the population. Yet a large percentage of students consumed less than the recommended minimum number of servings from the various food groups. Based on these findings, information in addition to mean and median values is required to assess nutritional adequacy based on food group selection. The largest percentage of students did not consume any foods from the fruit group. The percentage of students who did not consume the minimum number of servings recommendation were, however, the same for fruit, dairy and grain groups. The number of servings and distribution from the various food groups also needs to be determined to properly assess nutritional adequacy.

RELATIONSHIP BETWEEN FOOD GROUPS AND NUTRIENT INTAKE

To validate that foods were appropriately classified into the various food groups, correlations between nutrients and the food groups eaten by students were determined (Table 16). Expected strong and significant positive associations were confirmed with our data between: dairy and meat groups and protein intake; grain group and carbohydrate; dairy, meat, and grain groups intake and fat; vegetable and fruit groups and vitamin A intake; dairy, meat, and grain groups and vitamin B_6 intake; fruit and vegetable groups and vitamin C intake; dairy, meat, and grain groups and iron intake; dairy and grain groups and magnesium intake; and dairy group and calcium . The relationship between dairy and calcium intake were further supported by the finding that the average intake of calcium for females was 88% of the RDA, and only 53% of females consume at least the minimum number of recommended servings from the dairy group.

Table 16. Correlation coefficient (r) between five food groups and nutrients

Nutrient	D[a]	F[b]	M[c]	G[d]	V[e]
ALL (N=2489)					
Protein (g)	.59**	.13**	.57**	.44**	.28**
Carbohydrate (g)	.35**	.25**	.25**	.55**	.23**
Fat (g)	.29**	.02	.24**	.31**	.17**
Cholesterol (mg)	.31**	.10**	.37**	.17**	.15**
Vitamin A (IU)	.12**	.10**	-.02	.08**	.33**
Vitamin B_6 (mg)	.35**	.21**	.33**	.33**	.29**
Vitamin C (mg)	.07**	.23**	.07**	.09**	.20**
Calcium (mg)	.92**	.12**	.25**	.36**	.24**
Iron (mg)	.31**	.18**	.33**	.44**	.31**
Magnesium (mg)	.37**	.19**	.22**	.39**	.25**
MALES (n=756)					
Protein (g)	.55**	.16**	.50**	.38**	.37**
Carbohydrate (g)	.31**	.29**	.17**	.56**	.31**
Fat (g)	.32**	.08	.22**	.34**	.27**
Cholesterol (mg)	.28**	.16**	.32**	.09*	.18**
Vitamin A (IU)	.22**	.14**	.02	.10*	.35**
Vitamin B_6 (mg)	.34**	.23**	.29**	.27**	.30**
Vitamin C (mg)	.04	.25**	.04	.09*	.20**
Calcium (mg)	.91**	.09*	.11**	.32**	.31**
Iron (mg)	.30**	.25**	.27**	.40**	.34**
Magnesium (mg)	.37**	.21**	.18**	.39**	.31**
FEMALES (n=1733)					
Protein (g)	.50**	.05	.47**	.31**	.18**
Carbohydrate (g)	.23**	.20**	.12**	.44**	.13**
Fat (g)	.21**	.04	.16**	.22**	.09**
Cholesterol (mg)	.20**	.01	.30**	.09**	.09**
Vitamin A (IU)	.07*	.09**	-.05	.07*	.32**
Vitamin B_6 (mg)	.23**	.15**	.18**	.23**	.24**
Vitamin C (mg)	.05	.21**	.03	.05	.19**
Calcium (mg)	.90**	.10**	.13**	.22**	.14**
Iron (mg)	.15**	.09**	.20**	.35**	.27**
Magnesium (mg)	.26**	.14**	.09**	.28**	.17**

*p<.01
** p<.001
a. Dairy group
b. Fruit group
c. Meat group
d. Grain group
e. Vegetable group

FOOD SCORES

Food group score system 1 and 2 produced very similar results (Table 17). Food group score system 1 (FGSS1) was used as a predictor of food group score system 2 (FGSS2) in a multiple regression equation:

$$FGSS2 = .90(FGSS1) + 3x10^{-16} \quad (R^2=.85)$$

The slope was significantly different from 0 (p=.0001). Food group score system 1 was able to predict food group score system 2 (i.e., when FGSS1 is 1, FGSS2 is .9). Only 4% of students met food group score system 1 but did not meet food group score system 2.

Food group score system 1 was used to predict food group score system 3 (FGSS3) in a multiple regression equation:

$$FGSS3 = .33(FGSS1) + 2.5x10^{-16} \quad (R^2=.25)$$

Food group score system 1 was less able to predict results of food group score system 3 than food group score system 2. Therefore, only food group score system 1 and 3 were further evaluated.

Table 17. Percent and number of students who did and did not meet the requirement of three food group score systems

	DID NOT MEET SCORE (score = 0-4)	DID MEET SCORE (score = 5)
Food Group Score System 1[a]	%	%
All (n=2489)	65.3	34.7
Males (n=756)	54.8	45.2
Females (n=1733)	69.9	31.0
Food Group Score System 2[b]	%	%
All (n=2489)	68.8	31.2
Males (n=756)	56.2	43.8
Females (n=1733)	74.3	25.7
Food Group Score System 3[c]	%	%
All (n=2489)	88.5	11.5
Males (n=756)	74.3	25.7
Females (n=1733)	94.7	5.3

a. Requirement for food group score system 1: Consume at least one serving from each of the five food groups.
b. Requirement for food group score system 2: Consume at least 50% of the minimal number of recommended servings of Food Guide Pyramid from each of the five food groups (i.e., 1 serving from dairy group, 1.5 servings from vegetable group, 1 serving from fruit group, 3 servings from grain group, 1 serving from meat group).
c. Requirement for food group score system 3: Consume at least the minimum number of recommended servings of Food Guide Pyramid from each of the five food groups. (i.e., 2 servings from dairy group, 3 servings from vegetable group, 2 servings from fruit group, 6 servings from grain group, and 2 servings from meat group).

Sixty-five percent of students did not meet the criteria (i.e., receive a food score of 5) for food group score system 1 (i.e., consume at least one serving from each of the five food groups) while 88% of students did not meet the criteria (i.e., receive a food score of 5) for food group score system 3 (i.e., consume at least the minimum number of servings from each of the five food groups). Consistent with nutrient intake, a larger percentage of males met the criteria (i.e., received a food score of 5) than females for each of the food group score systems.

The percentage of students consuming less than one serving from dairy, fruit, meat, grain, and vegetables was 20%, 34%, 27%, 2%, and 12%, respectively (Table 15). In contrast, the percentage of students consuming less than the minimum number of recommended servings from dairy, fruit, meat, grain, and vegetables was higher: 40%, 38%, 55%, 39%, and 31%, respectively.

There were similar results when comparing food intake by food groups with food scores. A larger percentage of students were not able to meet a food score of 5 based on food group score system 3 which is to meet the minimum number of recommended servings by food groups than a food score of 5 based on food group score system 1 which is to meet at least one serving from the five food groups.

Average nutrient intakes of students who received a food score of 0-4 and students who received a food score of

5 were compared (Table 18 and 19) for food score systems 1 and 3. For food group score systems 1 and 3, there were differences between the two groups (i.e., food score 0-4 vs 5) for all nutrients ($p<.0001$). However, for both food group score system 1 and 3, average intake of all nutrients for both groups (i.e., food score 0-4 vs 5) was above 100% of the RDA except for calcium intake for students who received a food score of 0-4. The average intake of all nutrients were above 100% of the RDA for students who received a food score of 5 based on food group score system 1 criteria but did not receive a food score of 5 based on food group score system 3 criteria (Appendix E). For food group score system 1, a food score of 5 met 100% of the RDA for all nutrients. For food group score system 3, a food score of 3 and above met 100% of the RDA for all nutrients.

Table 18. Nutrient intakes of students who received a food score 0-4 versus 5 based on food group score system 1

Nutrient	Food Score 0 - 4 n = 1626	Food Score 5 n = 863
Kilocalorie	2687 ± 1582[a]**	3596 ± 1790
Protein (g)	93 ± 54**	134 ± 63
Carbohydrate (g)	309 ± 189**	413 ± 228
Fat (g)	120 ± 108**	158 ± 116
Cholesterol (mg)	328 ± 378**	515 ± 466
Vitamin A (IU)	9688 ± 16355**	13308 ± 18411
Vitamin D (IU)	359 ± 455**	606 ± 529
Vitamin E (mg)	12.6 ± 13.8**	18.4 ± 19.4
Thiamin (mg)	1.93 ± 2.12**	2.52 ± 1.79
Riboflavin (mg)	2.27 ± 1.56**	3.30 ± 1.70
Niacin (mg NE)	26.3 ± 18.4**	35.5 ± 20.2
Vitamin B_6 (mg)	1.68 ± 1.26**	2.47 ± 1.52
Vitamin B_{12} (ug)	5.80 ± 7.37**	8.91 ± 12.3
Folacin (ug)	310 ± 241**	444 ± 303
Vitamin C (mg)	116 ± 161**	185 ± 243
Iron (mg)	17.5 ± 11.5**	23.6 ± 13.3
Calcium (mg)	1070 ± 802**	1652 ± 895
Phosphorus (mg)	1520 ± 919**	2230 ± 1075
Potassium (mg)	2821 ± 1573**	4169 ± 1857
Magnesium (mg)	302 ± 219**	418 ± 228

**p<.0001 between two groups
Requirement for food group score system 1: Consume at least one serving from each of the five food groups.
b. Mean ± standard deviation

Table 19. Nutrient intakes of students who received a food score 0-4 versus 5 based on food group score system 3

Nutrient	Food Score 0 - 4 n = 2204	Food Score 5 n = 285
Kilocalorie	2792 ± 1579[a]**	4627 ± 1825
Protein (g)	98 ± 54**	175 ± 67
Carbohydrate (g)	322 ± 194**	528 ± 231
Fat (g)	124 ± 108**	203 ± 118
Cholesterol (mg)	357 ± 388**	674 ± 535
Vitamin A (IU)	10265 ± 16489**	16187 ± 21103
Vitamin D (IU)	407 ± 474**	737 ± 562
Vitamin E (mg)	13.5 ± 15.1**	23.6 ± 20.7
Thiamin (mg)	1.98 ± 2.01**	3.28 ± 1.79
Riboflavin (mg)	2.41 ± 1.56**	4.28 ± 1.68
Niacin (mg NE)	27.3 ± 18.1**	46.4 ± 21.7
Vitamin B_6 (mg)	1.80 ± 1.28**	3.17 ± 1.75
Vitamin B_{12} (ug)	6.30 ± 9.62**	11.3 ± 7.18
Folacin (ug)	328 ± 250**	576 ± 324
Vitamin C (mg)	131 ± 189**	209 ± 237
Iron (mg)	18.2 ± 11.6**	30.9 ± 13.7
Calcium (mg)	1165 ± 818**	2100 ± 904
Phosphorus (mg)	1621 ± 919**	2885 ± 1173
Potassium (mg)	3039 ± 1603**	5218 ± 2022
Magnesium (mg)	318 ± 213**	530 ± 259

**p<.0001 between two groups
Requirement for food group score system 3: Consume at least the minimum number of recommended servings of Food Guide Pyramid from each of the five food groups.
(i.e., 2 servings from dairy group, 3 servings from vegetable group, 2 servings from fruit group, 6 servings from grain group, and 2 servings from meat group).
a. Mean ± standard deviation

SENSITIVITY AND SPECIFICITY (Objective 3)

Sensitivity and specificity are diagnostic tests to identify the proportion of individuals actually nutritionally adequate who are classified as nutritionally adequate (specificity) and the proportion of individuals actually nutritionally inadequate who are classified as nutritionally inadequate (sensitivity). As shown in Table 20, when the cut-off point was MAR-6 greater than or equal to 75, the two food group score systems have a high sensitivity and a moderate or low specificity. That is, the Food Guide Pyramid scoring systems 1 and 3 classify students who are nutritionally inadequate as nutritionally inadequate 88 and 99% of the time, respectively, but classify students who are nutritionally adequate as nutritionally adequate 45 and 16% of the time, respectively. Both food group score system 1 and 3 have a high sensitivity. On the other hand, food group score system 1 classifies subjects who are not at nutritional risk only 45% of the time while food group score system 3 classifies subjects who are not at nutritional risk only 16% of the time.

If the goal is preventive medicine, a high sensitivity is required to accurately classify subjects at nutritional risk. Food group score system 1 and 3 obtain similar results but food group score system 3 has a higher sensitivity (99%) versus food group score system 1 (88%) However, food group score system 1 is less complex to

Table 20. Sensitivity and specificity of the food group score systems for determining nutritional adequacy using cut-off point MAR-6 greater than or equal to 75

Cut-off point: MAR-6 ≥75	Sensitivity	Specificity
Food Group Score System 1[a]		
All (n=2489)	88	45
Male (n=756)	87	52
Female (n=1733)	88	40
Food Group Score System 3[b]		
All (n=2489)	99	16
Male (n=756)	97	30
Female (n=1733)	99	8

a. Requirement for food group score system 1: consume at least one serving from each of the five food groups.
b. Requirement for food group score system 3: consume at least the minimum number of servings of Food Guide Pyramid from each of the five food groups. (i.e., 2 servings from dairy group, 3 servings from vegetable group, 2 servings from fruit group, 6 servings from grain group, and 2 servings from meat group).

remember and to use in nutrition education messages than food group score system 3 (i.e., consume at least one serving from each food group versus various number of servings from each food group). Therefore, food group score system 1 would be the best method to use in nutrition education messages/programs.

FOOD SCORES OF STUDENTS WHOSE INTAKE IS ABOVE AND BELOW MAR-6 SCORES OF 75

Students were categorized for various food scores based on the number of food groups they consumed (Table 21). For food group score system 1, students who obtained a MAR-6 score below 75 generally received a food score of 1 or 2 while students who obtained a MAR-6 $\geq$75 received a food score of 4 or 5. The number of students receiving a MAR-6 score below and above 75 appears to be equal for food score of 3 which is the critical score for meeting adequate nutrition by MAR-6 scores.

For food group score system 3, students who obtained a MAR-6 score below 75 generally received a food score of 0 or 1 while students who obtained a MAR-6 above 75 received a food score of 3 or above. The number of students receiving a MAR-6 score below 75 or greater than or equal to 75 appears to be equal for food score of 2 which is the critical score for meeting adequate nutrition as determined by MAR-6. The results were supported by data on the average

Table 21. Percent of students with different MAR-6 scores and food scores

Food Score System 1[a]	MAR-6 SCORE <75 %	≥75 %
Food Score 0 (n=0)	0	0
Food Score 1 (n=15)	87	13
Food Score 2 (n=108)	85	15
Food Score 3 (n=482)	50	50
Food Score 4 (n=1021)	29	71
Food Score 5 (n=863)	10	90
Food Score System 3[b]		
Food Score 0 (n=54)	85	15
Food Score 1 (n=251)	75	25
Food Score 2 (n=578)	46	54
Food Score 3 (n=739)	21	79
Food Score 4 (n=582)	10	90
Food Score 5 (n=285)	2	98

a. Requirement for food group score system 1: consume at least one serving from each of the five food groups.
b. Requirement for food group score system 3: consume at least the minimum number of servings of Food Guide Pyramid from each of the five food groups. (i.e., 2 servings from dairy group, 3 servings from vegetable group, 2 servings from fruit group, 6 servings from grain group, and 2 servings from meat group).

nutrient intakes of students receiving different food scores (Appendix F). The average intake of all nutrients were above 100% of the RDA for students who received a food score of 3 and above.

For food group score system 3, very few students (2%) received a food score of 5 who did not meet a MAR-6 score of 75. For food group score system 1, only 10% of students received a food score of 5 who did not meet a MAR-6 score of 75. By obtaining a food score of 5 for either of the food group score systems, the dietary intake will almost always be adequate in nutrients. It is also easier to meet the nutrient requirements than it is to meet the food group requirements.

FOOD GROUP INTAKE PATTERNS (Objective 4)

Food scores can range from 0 to 5 with various number of students who meet each score. Within each score, there are 2 groups of students, i.e., students whose MAR-6 score is less than 75 and students whose MAR-6 score is greater than or equal to 75. Food group intake patterns were determined to identify differences in food group selection between students who met MAR-6 and did not meet MAR-6 (Table 22). The percentage of students who did not consume foods from the dairy group and had a MAR-6 score less than 75 were consistently higher than the percentage of students who did

Table 22. Food group intake patterns of the percentage of students whose MAR-6 scores are less than 75 and greater than or equal to 75

	ALL <75 (%)	ALL ≥75 (%)	MALE <75 (%)	MALE ≥75 (%)	FEMALE <75 (%)	FEMALE ≥75 (%)
FGSS1[a] (Food Score 2)						
DFMGV	n=92	n=16	n=17	n=0	n=75	n=16
11000	1	0	0	0	1	0
10100	1	0	6	0	0	0
10010	20	38	18	0	20	38
10001	1	0	0	0	1	0
01100	1	0	0	0	1	0
01010	21	6	12	0	23	6
01001	0	6	0	0	0	6
00110	21	19	35	0	17	19
00101	3	0	12	0	1	0
00011	32	31	18	0	35	31
FGSS1 (Food Score 4)						
DFMGV	n=292	n=729	n=53	n=249	n=239	n=480
01111	26	14	30	11	26	16
10111	37	46	47	64	35	36
11011	27	30	9	13	31	39
11101	1	1	0	0	1	0
11110	9	9	13	12	8	8
FGSS3[b] (Food Score 1)						
DFMGV	n=189	n=62	n=22	n=6	n=167	n=56
20000	12	18	14	33	12	16
02000	31	29	27	17	32	30
00200	12	2	23	0	10	2
00060	19	24	18	33	19	23
00003	26	27	18	17	28	29
FGSS3 (Food Score 4)						
DFMGV	n=59	n=523	n=17	n=236	n=42	n=287
02263	25	13	29	11	24	15
20263	29	26	29	39	29	15
22063	15	35	12	22	17	45
22203	10	13	6	11	12	15
22260	20	13	24	17	19	10

a. DFMGV=dairy, fruit, meat, grain, vegetable groups
Requirement for food group score system 1: consume at least one serving from each of the five food groups.
(cont'd)

Table 22 (cont'd)

0=less than 1 serving from food group
1=1 or more servings from food group
e.g. DFMVG=11100 indicates that $\geq$1 servings of dairy, fruit, and meat; and <1 serving from grain, vegetable.
b. Requirement for food group score system 3: consume at least the minimum number of servings of Food Guide Pyramid from each of the five food groups. (i.e., 2 servings from dairy group, 3 servings from vegetable group, 2 servings from fruit group, 6 servings from grain group, and 2 servings from meat group).
0=less than minimum number of recommended servings from each food group
1=greater than or equal to minimum number of servings from food group
e.g. DFMGV=02263 indicates that <2 servings of dairy, $\geq$2 servings of fruit, $\geq$2 servings of meat, $\geq$6 servings of grain, and $\geq$3 servings of vegetables.

not consume foods from the dairy group and had a MAR-6 score greater than or equal to 75. Further information regarding mean intake and distribution of servings is in Appendix G. While there was some variation in the odds ratios between the food scores and systems (Table 23), dairy group consumption consistently had the most impact on nutrient adequacy while meat group consumption had the least impact on nutrient adequacy. The odds ratios indicate that by not consuming foods from the dairy group, the chances of eating a nutritionally inadequate diet is 8 times higher than chances of eating an nutritionally inadequate diet when consuming foods from the dairy group. On the other hand, by not consuming foods from the meat group, the chances of eating a nutritionally inadequate diet is 2 times higher than chances of eating an nutritionally inadequate diet when consuming foods from the meat group. The dairy group may have the largest impact on nutrient adequacy since average intake of calcium was below 100% of the RDA for females.

Table 23. Odds ratios of receiving MAR-6 score greater than or equal to 75 by including defined servings of respective food groups

Food group	FGSS 3[a] Score 4 vs 5	FGSS 1[b] Score 4 vs 5
Dairy	8.4	4.2
Grain	3.9	3.3
Veg	7.1	2.9
Fruit	5.3	2.5
Meat	2.3	2.6

a. Requirement for food group score system 3 (FGSS 3): consume at least the minimum number of servings of Food Guide Pyramid from each of the five food groups. (i.e., 2 servings from dairy group, 3 servings from vegetable group, 2 servings from fruit group, 6 servings from grain group, and 2 servings from meat group).
b. Requirement for food group score system 1 (FGSS 1): consume at least one serving from each of the five food groups.

RELATIONSHIP AMONG SELECTED U.S. DIETARY GUIDELINES, MAR-6 SCORES, AND FOOD SCORES (Objective 5)

Percent of students whose intake met U.S. dietary Guidelines for fat and sugar are reported in Table 24. Only 31% of students met the guideline for percent of kilocalories from fat. Sixty-one percent of students met the guideline for percent of kilocalories from sugar.

Table 24. Percent of students who did and did not meet U.S. Dietary Guidelines for fat and sugar

	% kcal fat		% kcal sugar	
	Not Meet <30% % (n)	Meet[a] ≤30% % (n)	Not Meet <30% % (n)	Meet[b] ≥30% % (n)
All	69 (1724)	31 (765)	39 (961)	61 (1528)
Male	74 (561)	25 (195)	44 (329)	57 (427)
Female	67 (1165)	33 (568)	37 (633)	64 (1100)

a. Consume ≤ 30% kcal from fat to meet guideline.
b. Consume ≤ 10 % kcal from sugar to meet guideline.

When looking at group averages, 70% of students had a MAR-6 score greater than or equal to 75, 31% of students consumed less than or equal to 30% of total kilocalories from fat, 61% of students consumed less than or equal to 10% of total kilocalories from sugar, and 12% of students consumed at least the minimal number of servings from each of the five food groups of the Food Guide Pyramid. However, the percentages decrease when the criteria are combined. The association was weak between the food scores and avoidance of consumption of sugar and fat (Table 25). Only 2% of students met the percent kilocalories from fat and a food score of 5 and 8% of students met the percent kilocalories from sugar and food score of 5. Attainment of food score 5 versus 4 or below did not increase the chance of achieving less than 30% and less than 10% of total kilocalories from fat and sugar, respectively, (32% of food score 0-4 vs 18% of food score 5 had less than 30% of kilocalories from fat; 61% of food score 0-4 versus 67% of kilocalories from sugar).

Twenty-two percent of students met percent kilocalories from fat and MAR-6 score of greater than or equal to 75 while over 46% met percent kilocalories from sugar and MAR-6 score of greater than or equal to 75 (Table 26). The proportion of students whose caloric intake from fat was below 30% of total kilocalories did not differ between those whose MAR-6 score was below and above 75.

Table 25. Percent of students who meet the U.S. Dietary Guidelines for fat and sugar intake as well as food score 5

	ALL (n=2489) Food Group Score System 3 Food Scores[a]		MALE (n=756) Food Group Score System 3 Food Scores		FEMALE (n=1733) Food Group Score System 3 Food Scores	
	0-4 (%)	5 (%)	0-4 (%)	5 (%)	0-4 (%)	5 (%)
% Kcal Fat						
Not Meet	60.0	9.4	53.8	20.4	62.6	4.6
Meet[b]	28.6	2.1	20.5	5.3	32.1	.7
% Kcal Sugar						
Not Meet	34.8	3.8	34.0	9.5	35.1	1.3
Meet[c]	53.8	7.6	40.3	16.1	59.6	3.9

a. Food Score System 3: Consume at least the minimum number of servings from each of the five food groups
b. Consume ≤ 30% kcal from fat to meet guideline.
c. Consume ≤ 10% kcal from fat to meet guideline.

Table 26. Percent of students who did and did not meet guidelines for fat and sugar compared to MAR-6 scores

	ALL (n=2489) MAR-6 Score[a]		MALE (n=756) MAR-6 Score		FEMALE (n=1733) MAR-6 Score	
	<75 (%)	≥75 (%)	<75 (%)	≥75 (%)	<75 (%)	≥75 (%)
% Kcal Fat[b]						
Not Meet	20.5	48.9	12.6	61.6	23.9	43.2
Meet	8.6	22.1	4.3	21.4	10.4	22.3
% Kcal Sugar[c]						
Not Meet	14.1	24.5	9.0	34.5	16.3	20.2
Meet	15.0	46.4	7.9	48.5	18.1	45.4

a. MAR-6 score = Average NAR scores for 6 nutrients (calcium, magnesium, iron, vitamins B_6, A and C)
b. Consume ≤ 30% kcal from fat to meet guideline.
c. Consume ≤ 10% kcal from fat to meet guideline.

The percent of students who met the U.S. Dietary Guidelines for fat and sugar compared to MAR-6 scores, food group score system 3, and combination of both MAR-6 score and food group score system 3 were computed (Table 27). Less than 1% of students were able to meet all categories. The major dietary problems with the subjects included in the study were meeting a food score of 5 based on food group score system 3 and avoidance of fat and sugar.

Table 27. Percent of students who did and did not meet the U.S. Dietary Guidelines for fat and sugar

	ALL (n=2489) Fat[a] & Sugar[b]		MALE (n=756) Fat & Sugar		FEMALE (n=1733) Fat & Sugar	
	Not Meet (%)	Meet (%)	Not Meet (%)	Meet (%)	Not Meet (%)	Meet (%)
MAR-6 Score[c]						
<75	29.0	.1	16.9	0	34.2	.2
≥75	66.9	4.0	79.1	4.0	61.6	4.0
Food Group Score System 3[d]						
Not Meet	85.1	3.5	71.8	2.5	90.8	3.9
Meet	10.8	.6	24.2	1.5	5.0	.2
MAR-6 Score and Food Group Score System 3						
Not Meet	85.3	3.5	72.4	2.5	91.0	3.9
Meet	10.6	.6	23.7	1.5	4.9	.2

a. Consume ≤ 30% kcal from fat to meet guideline.
b. Consume ≤ 10% kcal from fat to meet guideline.
c. MAR-6 score = Average NAR scores for 6 nutrients (calcium, magnesium, iron, vitamins B_6, A and C)
d. Food Group Score System 3: Consume at least the minimum number of recommended servings from each of the five food groups

Stepwise regression was determined to show associations between the dependent variable (i.e., MAR-6) and independent variables (i.e., food group score system 3 (FGSS3), kilocalorie intake, fat intake, and gender). These independent variables were selected because they were based on the Food Guide Pyramid, U.S. Dietary Guidelines, and/or differences observed between the genders. First, food scores were used to predict MAR-6 scores. The regression equation was:

$$\text{MAR-6 score} = 8.95(\text{FGSS3}) + 56 \quad (R^2 = .38)$$

Next, kilocalorie (Kcal) intake was added to the regression equation.

$$\text{MAR-6 score} = 6.98(\text{FGSS3}) + .003(\text{Kcal}) + 53 \quad (R^2 = .44)$$

Then, fat intake was added to the regression equation.

$$\text{MAR-6 score} = 6.72(\text{FGSS3}) + .004(\text{Kcal}) - .02(\text{fat}) + 52 \quad (R^2 = .45)$$

Finally, gender (G) was added to the regression equation. Males were coded "0" and females were coded "1".

$$\text{MAR-6} = 6.9(\text{FGSS3}) + .004(\text{kcals}) - .02(\text{fat}) + 2.3(\text{G}) + 49.8 \quad (R^2 = .45)$$

Regression analysis with all the independent variables indicate that all the independent variables were significant (Table 28).

Table 28. Regression analysis for food scores, kilocalories, fat, and gender to predict MAR-6 score

Variable	b[a]	Beta[b]	t	Sign of t
FGSS 3	6.888	.476	26.946	.00001
Kcals	.005	.436	13.842	.00001
Fat	-.025	-.157	-5.537	.00001
Gender	2.273	.059	3.530	.0004
Constant	49.788		47.991	.00001

a. b=regression coefficient
b. Beta=standardized regression coefficient

FGSS3 accounted for 38% of the variance in MAR-6 score, when FGSS3 was the only independent variable. Adding kilocalorie intake as an independent variable to the equation increased R^2 to .44. Adding fat intake and gender to the equation increased R^2 to .45. When all independent variables were added, food group score system 3 contributed more to the prediction of MAR-6 than the other variables, based on the Beta values. The R^2 for this equation was .45. Even though the addition of gender to the equation did not increase R^2, the slope for gender was significant. Therefore the variables food group score system 3, kilocalories, fat, and gender accounted for 45% of the variance in MAR-6 scores.

DISCUSSION

The majority of the dietary intake data for our study was collected from a large number of college students in three general education or elective courses which did not require a prerequisite course. The subjects are considered fairly representative of the lower level undergraduate student population at Michigan State University. The sample size of this study was large (N=2489) which will increase the validity (Chalmers, 1952). To assign equal weight for each subject, only the first one-day food intake record was used although some students had 3 day food intake records. For 100 students, one-day food intake records were compared to 3 day food intake records. Nutrient intakes were comparable for 1 and 3 day food intake records (data not presented).

Heights (64 in.) of females were comparable to other studies of college students (Hernon et al., 1986; Vickery et al., 1985) while weights of females tended to be slightly higher (132 lb vs 125 lb) (Hernon et al., 1986). Heights (70 in.) and weights (170 lb) for males were similar to other studies (Ostrom and Labusa, 1977). Mean age for all subjects (19.4 years) was slightly below the mean age of other studies (20 - 21 years) (Vickery, 1985; Skinner;

1991). The BMI's of subjects in this study (23.7 and 21.6 for males and females) are similar to the 50th percentile BMI of 23.0 for 18 - 24 year old males and 21.6 for 18-24 year old females from NHANES II (Rowland, 1989). Although some of the characteristics of our subjects vary from other studies, there were not major differences.

In other studies on college students, kilocalories ranged from 2,700 - 2,900 kilocalories for males and from 1,700 - 1,900 kilocalories for females which are lower than our study (Skinner, 1991; Gottschalk, 1977). In our study, students were responsible for putting their own data into the computer which provides more confidentiality. Students also receive immediate feedback on the nutritional adequacy of their diet from the MSU NutriGuide computer program.

In the present study, percent kilocalories from carbohydrate, protein, and fat were similar to those reported by Ostrom and Labusa (1977) who found college students received 48.1% of kilocalories from carbohydrate, 16.3% from protein, and 35.6% from fat. Percent kilocalories from fat was similar to the national average of 37% (DHHS, 1998). Although the percent kilocalories from fat were similar to other studies, the importance of lowering fat consumption needs to be emphasized, because the percentage of kilocalories from fat is above the recommended guideline (USDA-DHHS, 1990).

In contrast to several studies (O'Leary and Lee, 1975;

Gottschoal et al., 1977; Jakobovits et al., 1977; Ostrom and Labusa, 1977), mean iron intake for males and females in our study was above 100% of the RDA. Similar to several studies (O'Leary and Lee, 1975; Skinner, 1991), mean calcium intake for females in our study was below 100% of the RDA. Mean calcium intake for females might have increased if nutritional supplementation was included.

There is no clear consensus among studies (Krebs-Smith and Clark, 1989; Worthington-Roberts et al., 1989) regarding which nutrients to use or what the MAR value should be to evaluate dietary intake. In our study, a MAR score based on 6 nutrients (calcium, iron, magnesium, and vitamins A, C, and B_6) with a cut-off value of greater than or equal to 75 correctly identified diets that were nutritionally adequate from diets that were not as determined by comparison with individual RDA's. It was also demonstrated that the MAR-6 score based on the six nutrients selected was representative of the nutrients estimated in our study. The MAR-6 score used in our study is a valid dietary evaluation method to assess nutrient intake.

Krebs-Smith et al. (1990) examined the effect of using the two different methods for categorizing food mixtures. Using method 1, each food mixture was classified as a single item and assigned to a food group according to its main ingredient. Using method 2, a food mixture was separated into ingredients and each ingredient assigned to its appropriate food group. In the present study, method 2 was used. Three food groups emerged as important sources of energy in the diets of 1,032 women: grain; meat, fish, and poultry; and dairy products. Percentage of energy from both the meat, fish, and poultry group and the grain group was lower and the proportion of energy from the dairy group was higher when food mixtures were separated into their constituent ingredients.

There are few studies which have reported food group intake of college students. Mitchell (1990) administered a questionnaire to 279 college students (82 males and 196 females) whose mean age was less than 23 years. Mitchell reported that 85% of college students consumed fruit, vegetables, and juice three or fewer times per day although how fruits, vegetables, and juices were classified was not reported. Mitchell combined intakes of fruits and vegetables. In the present study, fruit and vegetable intakes were separated with 53% and 31% of students consuming less than 3 servings from fruit and vegetables, respectively. Adding fruit and vegetable consumption together results in 84% of students consuming less than 3 servings per day but this is under the assumption that students did not consume both fruits and vegetables.

The twelve percent of students who did not consume milk in the Mitchell study is similar to the results reported in this study in which only 10% of students did not consume any dairy products. On the other hand, Mitchell found that 61% of students drank less than 2 cups per day which contrasts to the 40% of students who did not consume at least 2 servings from the dairy group in this study. Mitchell only addressed milk consumption; while in our study, dairy group consumption was measured. The percentage of students who do not consume milk in Mitchell's study may actually consume other foods from the dairy group hence lowering the reported percentage.

Using data from NHANESII, Patterson et al. (1990) reported on fruit and vegetable intake of adults ages 19 to 74. The number of grams reported for each fruit and vegetable was converted into number of servings using the suggested serving sizes given by a food guidance system developed to implement the U.S. Dietary Guidelines. Forty-five percent of subjects consumed no fruit and 22% consumed no vegetables. In our study, 33% of students did not consume any fruits while 8% consumed no vegetables. Patterson et al. (1990) reported that the mean numbers of servings of fruits and vegetables were 1.08 and 1.77 servings, respectively. The mean numbers of servings of fruits (4.1) and vegetables (5.8) from our study were much higher than results reported by Patterson et al. (1990) Twenty-seven percent of subjects consumed at least 3 servings from the vegetable group and 29% consumed at least 2 servings from the fruit group (Patterson et al., 1990), both lower than our study where 69% of students consumed at least three servings from the vegetable group and 62% of students consumed at least two servings from the fruit group. Patterson et al. (1990) defined a serving in terms of the number of grams eaten per meal, as opposed to within a 24-hour period. Small portions (weighing less than an ounce) were not counted as a serving, while upper limits were used to avoid overestimating the number of servings of big eaters. This procedure likely resulted in Patterson et al. underestimating fruit and vegetable consumption. The differences in intake may also be due to different methods of classifying food mixtures. In this study, combination foods were separated into their ingredients, and each ingredient was assigned to its appropriate food group. Patterson et al. (1990) classified food mixtures according to the major ingredient only.

Kant et al. (1991a) evaluated 24-hour dietary recalls of 11,658 subjects ages 19 to 74 years obtained in NHANESII. The percent of all subjects who failed to consume a food from the dairy, meat, grain, fruit, and vegetable groups was reported by 24%, 6%, 5%, 46%, and 18%, respectively, (Kant et al., 1991a). In our study, percent of students who failed to consume a food from each group was lower with 10%, 9%, 1%, 33%, and 8% from the dairy, meat, grain, fruit, and vegetable groups.

The differences between the two studies in the percent of subjects who did not consume a food from each food group could be explained by the difference in the desired number of servings from each of the five food groups. The desired number of servings from each food group in our study were the lower end of Food Guide Pyramid recommendations: two from the dairy, meat, and fruit groups, three servings from vegetable group, and six servings from grain group. The desired number of servings of Kant et al. (1991a) were: two from the dairy, meat, fruit, and vegetable groups and four servings from the grain group. In the study of Kant et al. (1991a), the proportion of the population consuming at least the desired number of servings from dairy, meat, grain, fruit, and vegetable groups was 51%, 71%, 29%, 29%, and 61%, respectively. In our study, the percent of students consuming at least the desired number of servings was higher with 60%, 45%, 61%, 62%, and 69%, respectively, from the dairy, meat, grain, fruit, and vegetable groups.

Kant et al. (1991a) also reported that only 33% of the U.S. population consumed at least one food item from all five food groups, and 2.9% of the proportion consumed at least the desired number of servings from all food groups. A higher percentage of students in this study consumed the variety of foods than that in Kant et al. (1991a). Thirty-five percent of subjects consumed at least one serving for all five food groups (food score 5 of food group score system 1), and 12% of the subjects consumed at least the desired number of servings from all of the food groups (food score 5 of food group score system 3), although the number of desired servings of vegetable and grain group in this study were higher than those of Kant et al. (1991a), i.e., 3 and 6 servings from vegetable and grain groups in this study versus 2 and 4 servings from vegetable and grain groups, respectively, in the study of Kant et al. (1991a). Although a higher percentage of college students consumed the desired number of servings from each food group than in the general U.S. population, college students' diets are far from the recommendations of the Food Guide Pyramid.

To our best knowledge, no research data has been reported on sensitivity and specificity of Food Guide Pyramid recommendations in identifying nutritional inadequacies and adequacies. The Food Guide Pyramid food group score systems 1 and 3 classify students who are nutritionally inadequate as nutritionally inadequate 88 and 99% of the time, respectively, but classify students who are nutritionally adequate as nutritionally adequate 45 and 16% of the time, respectively. Both food group score system 1 and 3 have a high sensitivity.

If the goal is preventive medicine, a high sensitivity is required to accurately classify subjects at nutritional risk. The findings support that students who consumed at least one serving from each of the five food groups are just as likely to consume nutritionally adequate diets as those students who consumed the minimal number of recommended servings from each of the five food groups (i.e., 2 servings from each dairy, meat, fruit; 3 servings from vegetable; and 6 servings from grain).

Limited information is available on the relationship between food group intake patterns and nutrient intake. Kant et al. (1991b) examined the relationship of food group intake patterns to nutrient intake using 24-hour dietary recalls from NHANES II. The evaluation method evaluated each recall for the presence or omission of five food groups (dairy, meat, fruit, vegetable, and grain). Diets consisted of at least one food from each food group provided mean amounts of all key nutrients at levels greater than or equal to the RDA's. Although the authors did not use the minimum number of servings from the Food Guide Pyramid as a criteria, their findings are consistent with ours. Diets consisting of at least one serving from each food group provided adequate nutrients and is comparable to consuming the minimal number of recommended servings from each food group.

In our study, the differences in MAR-6 score within various food scores were evaluated to determine if different food group intake combinations contributed to nutritional adequacy. Within food scores of 1 and 4 of both food group score systems, the difference in food group intake patterns between those whose MAR-6 score is above 75 and below 75 were in meat and dairy group consumption. A diet which did not contain the minimum number of recommended servings of Food Guide Pyramid for the meat group was likely to meet nutrient adequacy (i.e., an individual did not need to meet the minimum number of servings from the meat group to meet MAR-6 score, whereas a diet which did not contain the minimal number of dairy food group of Food Guide Pyramid was more likely to result in a score below 75 for MAR-6 score. Based on these results regarding food group intake patterns and nutritional adequacy, increase in consumption of meat group may not need to be emphasized for the college student population, while emphasis on adequate consumption of dairy group may make a positive impact on improving nutritional adequacies of this population.

For many years, the emphasis of food guides has been on nutritional inadequacies. Many chronic diseases are due to excess consumption of various foods. One of the major messages of the Food Guide Pyramid is moderation of fats, oils, and sugars (Achterberg, 1992). In this study, 31% of students consumed less than 30% of total kilocalories from fat. Only 2% of the students consumed less than 30% percent kilocalories from fat and food group score system 3 and 8% of students consumed less than 10% percent kilocalories from sugar and food group score system 3. In sum, less than 1% of the students in our study consumed diets that would be considered adequate by the recommendation of the Food Guide

Pyramid and U.S. Dietary Guidelines for fat and sugar.

Our findings in a collegiate population present challenges to the nutrition educators for using the minimal number of servings of Food Guide Pyramid along with the U.S. Dietary Guidelines for fat and sugar and adequate nutritional intake based on the RDA's. Nutrition education messages need to emphasize the importance of adequate minimum number of servings of Food Guide Pyramid in addition to wise food selections within each food group.

SUMMARY AND CONCLUSION

1) Average nutrient intake of college students in this study was adequate compared to RDA's, except for calcium intake by female students (88% of the RDA).

2) MAR-6 score greater than or equal to 75 identified correctly nutritionally adequate diets from those that were not. The six selected nutrients were representative in estimating nutritional adequacy in this study.

3) Mean and median intake from five food groups, except for median intake of meat by females, were above the minimal recommended number of servings of Food Guide Pyramid. While mean and median intakes of the five food groups are useful to determine nutritional adequacy, the distribution of the various food groups also need to be determined. Failure to consume any foods from the dairy, meat, grain, fruit, and vegetable groups by our study population was 10, 9%, 1%, 33%, and 8%, respectively. The percentages of students consuming at least the minimal number of servings by Food Guide Pyramid from dairy, meat, grain, fruit, and vegetable groups were 60%, 45%, 61%, 62%, and 69%, respectively. Only 12% of students consumed the desired number of servings from all five food groups.

4) Food group score systems 1 and 3 did not differ in sensitivity. Consuming at least one serving from each food group also approximated the same nutritional adequacy as consuming the minimum number of servings suggested by the Food Guide Pyramid.

5) Based on food group intake patterns of the college population in this study, meat group consumption had the least impact on nutritional adequacy, while dairy group consumption had the greatest impact.

6) Very few students (2%) consumed at least the minimal number of recommended servings of the Food Guide Pyramid while also obtaining less than 30% of total kilocalories from fat.

7) Consumption of the at least the minimum number of servings of the Food Guide Pyramid provided a nutritional adequate diet based on MAR-6 score greater than or equal to 75 but does not insure minimal fat and sugar intake.

8) The Food Guide Pyramid should be used carefully with emphasis on moderation addressing fat and sugar as well as on variety. There should be continuing emphasis on food selection of nutrient dense foods within each food group.

ASSUMPTIONS

Several assumptions were made in this study based on the findings from previous studies:

1) The students recorded honestly all food and beverage items consumed accurately. It was stressed in the courses that the students would not be graded on the basis of the adequacy of their diet, and that the assignment would be more meaningful and informative for them if they were honest and accurate in recording their intake. Guthrie (1984) reported, however, that students ages 18 to 30 had difficulties estimating portion sizes, with errors greater than 50% for many food items. Minimal errors are expected to be made when entering foods into the diet analysis program because foods did not have to be entered by code numbers.

2) Appropriate substitutions were made when consumed food items were not in the database of the diet analysis program.

3) The nutrient database is complete and accurate with current information.

LIMITATIONS

This study has a few limitations which should be addressed and considered in planning future studies. The validity and reliability of one-day food intake records depends on honesty and accuracy of self-reported food consumption, ability to correctly record amounts consumed, and ability to correctly identify foods for substitutions from the available nutrient database. One-day food intake records were used in this study since a large sample size was included and one-day food intake records have been shown to evaluate adequately the group intake for large groups. Previous research has shown that one-day food intake records are not an accurate representation of individual dietary intakes. A three-day food intake record would have been more appropriate for individual intake. Guthrie and Crocetti (1985) found the one-day food intake records to be the least sensitive for vitamins A and C for estimating an individual's diet but represent the usual intake of a group. Chalmers (1952) also reported that for all nutrients and populations, a food intake record of one day characterized the dietary intake of the group.

RECOMMENDATIONS FOR FUTURE STUDIES

Based on the findings of this study the following recommendations are made for future studies:

1) Although dietary intake of most students met MAR-6 score of 75, only a few students consumed the minimum number of recommended servings from the various food groups of the Food Guide Pyramid. The extent to which fortified foods (e.g., cereals) and nutritional supplementation contributed to daily nutrient intake in the U.S. or in a sub-population is an important question to be answered. The differences in specific foods between diets which meet and do not meet overall nutrient allowances needs to be identified.

2) This study found that 1 in 50 students consumed food that meet the Food Guide Pyramid's recommended minimum number of servings along with those for fat and sugar.

2a) Similar studies need to be done on other campuses or in other population groups.

2b) A nutrition intervention program could emphasize the Food Guide Pyramid's messages of moderation, dietary variety, and proportionality. A pre- and post- dietary intake record could be used to determine if there were any dietary changes made based on the nutrition education message. A post-dietary intake record at least six to 12 months after the program could be used to determine long term changes in adopting "moderation, proportionality, and variety" behavior.

3) Our study objectives could be evaluated using 3-day food intake records to determine if there are any differences in findings.

APPENDIX A

APPENDIX A

DIETARY INTAKE EXAMPLES

False Negative Case:

Example of a diet which meets the minimum number of recommended servings from each of the five food groups of Food Guide Pyramid but does not meet a MAR-6 score of 75.

List of foods consumed

Food	Amount	Number of servings and food group
Apple juice	3/4 c	1 - fruit
Banana	1 medium	1 - fruit
Bread (Italian)	6 slices	6 - grain
Green beans, frozen	1 1/2 c	3 - vegetable
Milk (2%)	2 c	2 - dairy
Chicken leg	1 each	1 - meat
Egg (poached)	2 large	1 - meat

Nutrient	% RDA
Vitamin A	64
Vitamin C	68
Vitamin B_6	94
Calcium	65
Iron	60
Magnesium	75

MAR-6 score = 71

Example of a diet which meets the minimum number of recommended servings from each of the five food groups but exceeds guidelines for fat and sugar.

List of foods	Amounts	Number of servings and food group
Egg	2 large	1 - meat
Hamburger patty	3 oz	1 - meat
Bread, whole wheat	2 slices	2 - grain
Bun, hamburger	2 buns	4 - grain
Milk, whole	2 c	2 - dairy
Banana	1 medium	1 - fruit
Orange juice	3/4 c	1 - fruit
Broccoli	1 1/2 c	3 - vegetable
Jelly	2 Tbsp	6 - sugar[a]
Butter	3 tsp	3 - fat [b]
Pepsi	12 oz	8 - sugar

41% of total kilocalories from fat
15% of total kilocalories from sugar

a. 1 tsp of sugar equals 1 sugar
b. 1 tsp of fat equals 1 fat

APPENDIX B

APPENDIX B

HNF 102
Bond (SN)

ONE-DAY FOOD INTAKE RECORD
ASSIGNMENT

This assignment is intended to increase your awareness of the adequacy of your diet. Take this sheet home with you. Select a weekday (not Saturday or Sunday) and record all the food and drink you consume for that day. List foods as completely and accurately as possible. You will NOT be graded on the adequacy of your diet.

Be sure to include:

a) beverages: water, milk, soft drinks, juice, tea, coffee, alcoholic beverages, etc.
b) condiments: butter, margarine, mayonnaise, catsup, mustard, pickle, relish, cream, sugar, jelly, sauces, etc.
c) method of preparation: fried, baked, boiled, broiled, etc.
d) anything added during preparation: oil, milk, wine, etc.
e) for combination foods, list all ingredients as accurately as possible

Be sure to note estimated quantity of food. Describe portion sizes by ounces, cups, tablespoons, etc. For example, rather than "1 glass of milk," estimate ounces as close as possible.

1 cup = 8 ounces (fluid)
1 tablespoon = 3 teaspoons
1/4 pound = 4 ounces (weight)

After you have completed your food intake record, you will run a computerized diet analysis program for assessment of your diet. Bring your food intake record sheet with you to the Student Union computer lab, Human Ecology computer lab, or Bessey Hall computer labs. Hours will be reserved for HNF 102 students at the times listed on the computer lab instruction sheets, and open hours are also available.

The computerized diet analysis program, MSU NutriGuide, will be available from the assistants in the Human Ecology lab and the Student Union lab. Bessey Hall computer labs will have the program on the mainframe, but you will need to get a bootdisk and NutriGuide A disk from the monitor in Rm 210. Follow the attached instructions for the lab you are attending and proceed through the program. The computer will automatically print 2 copies of your analysis. Turn one copy in to the instructor or teaching assistants before or after class and keep the second copy for your own use. Turn in this food intake record sheet along with your computer printout.

ONE-DAY FOOD INTAKE RECORD

NAME:______________________________ I.D.#______________________

ITEM AND DESCRIPTION	PORTION
Meal 1	
Snack(s)	
Meal 2	
Snack(s)	
Meal 3	
Snack(s)	

Vitamin/Mineral Supplement(s)______________________________

Is this a complete one-day intake? _____ Yes _____ No

Was this a TYPICAL day? _____ Yes _____ No

APPENDIX C

APPENDIX C

PREPARATION OF A DATA SET FOR ANALYSIS

The data file of dietary records was reanalyzed for nutrient content with an updated MSU NutriGuide (Version 1.5) nutrient data file to create a nutrient intake data file. Multiple and incomplete dietary records were eliminated from MSU NutriGuide nutrient intake data file. The MSU NutriGuide data file of dietary records in American Standard Code for Information Interchange (ASCII) was reformatted from multiple rows in a text format to a single row in a spreadsheet format (Borland International, Quattro Pro version 3.0). The first step in this conversion process was to import the reanalyzed nutrient intake data file to the Quattro Pro spreadsheet program and convert it to .wk1 format by saving it under a file name with ".wk1" as the extension. This format is commonly used for data translation between computer applications.

Each variable was assigned a specified location in a row with spaces between each variable. The nutrient intake data file formed a block matrix (256 columns by 8,162 rows), called "parsing cells". The nutrient intake data file was visually inspected for irregularities and the resulting nutrient intake data file was divided and saved as four separate .wk1 files for use on a computer which did not have the capacity to analyze the file as a whole.

At the same time as the work on the nutrient intake data file was completed, the food group database for MSU NutriGuide was created by three registered dietitians by the following procedure: 1) food group content by category and serving size of each food item was determined and cross validated by other nutrition experts and 2) food group content was entered in a spreadsheet format (Quattro Pro) and checked for accuracy. The food group classification systems were described in detail in the "Instrument" section.

The MSU NutriGuide diet intake records in spreadsheet form were analyzed for food group content with the food group spreadsheet via the table look-up function in Quattro Pro. In order to accomplish this cross-referencing function, four spreadsheets of formulas were created to analyze each of the 44 food variables in the diet records of the data file. Four formula spreadsheets were required due to space limitations in the Quattro Pro format. (The first formula spreadsheet analyzed foods one through eleven, the second analyzed foods twelve through twenty-two, the third analyzed foods twenty-three through thirty-three and the fourth analyzed foods thirty-four through forty-four.) Each cell of a formula spreadsheet represented one of 23 food groups for each food variable. The cells contained calculations which referenced the appropriate cells of the MSU NutriGuide data file (a food code and its' corresponding serving size) and the food group database. When activated the computer would "look-up" the food code entered by the subject in the food group database and multiply the calculated number of food group servings contained per default serving by the serving size associated with the food code. The result of the calculation was placed in the corresponding cell in the formula spreadsheet and saved as a .wk1 file.

The results of each of the food group analysis (number of servings of food group intake from each food item consumed) underwent the following procedures.

1) The files were transformed into SPSS/PC+ system files.

2) Similar food groups contained in each of the eleven foods analyzed by each formula spreadsheet were combined.

3) In SPSS/PC+ the files were joined together in sequential order by case. It was crucial to maintain the original order of the cases so the correct data would match the correct case when the food group intake data was matched with the MSU NutriGuide data at the end of the process. Each of the four files contained the results calculated by one formula spreadsheet for all cases.

4) The SPSS/PC+ program was used to create variables which represented the total number of servings consumed from each dairy, fruit, vegetable, grain, and meat food group for each subject in each of the four files. The combined food

group intakes from each of three files were concatenated into one file and like food groups were added together again to calculate the daily food group intake for each subject. The fourth file which represented data from foods 34 through 44 was eliminate from this process, because the file contained data for only two cases which would be eliminated due to incorrect alignment of food codes and serving sizes in the MSU NutriGuide data. The variables which represented the total daily intake of each food group were saved and joined with the MSU NutriGuide nutrient intake data file.

The four MSU NutriGuide nutrient intake data files were transformed into SPSS/PC+ system files and joined together in sequential order according to case to match the original order. The resulting nutrient intake data file was limited only to those variables required for analysis and joined with the food group intake results to create the data set used in statistical analysis by SPSS/PC+.

APPENDIX D

APPENDIX D

NUTRIENT DENSITY

Table 29. Nutrient density per 1,000 kilocalories of college students' diets with MAR-6 scores above and below 75 for males and females

Nutrient per 1,000 kcals	MALE MAR-6 <75 n=128	MALE MAR-6 ≥75 n=628	FEMALE MAR-6 <75 n=596	FEMALE MAR-6 ≥75 n=1137
Protein (g)	39	38	33	35
Carbohydrate (g)	117	115	116	114
Fat (g)	42	43	45	45
Cholesterol (mg)	141	143	128	122
Vitamin A (IU)	1389	3015	2945	4564
Vitamin D (IU)	84	178	84	150
Vitamin E (mg)	3.88	4.5	5.13	5.2
Thiamin (mg)	.68	.75	.65	.70
Riboflavin (mg)	.78	.96	.71	.87
Niacin (mg NE)	10.9	10.2	8.9	9.7
Vitamin B_6 (mg)	.52	.68	.49	.69
Vitamin B_{12} (ug)	3.32	2.59	1.65	2.18
Folacin (ug)	81	121	89	129
Vitamin C (mg)	35	43	39	52
Iron (mg)	6.4	6.6	5.6	6.8
Calcium (mg)	313	462	329	433
Phosphorus (mg)	503	630	512	587
Potassium (mg)	930	1106	940	1151
Magnesium (mg)	90	114	99	121

MAR-6 score = Average NAR scores for 6 nutrients (calcium, magnesium, iron, vitamins B_6, A and C)

APPENDIX E

APPENDIX E

NUTRIENT INTAKES OF STUDENTS WHO MET FOOD GROUP SCORE SYSTEM 1 CRITERIA BUT DID NOT MEET FOOD GROUP SCORE SYSTEM 3 CRITERIA

Number of Valid Observations (Listwise) = 578.00

Variable	Mean	Std Dev	Minimum	Maximum	N
CALORIE	3087.78	1537.06	864.0	10953.0	578
PROTEIN	114.27	49.37	31.7	397.8	578
CARBO	357.04	204.26	74.9	1624.6	578
FAT	135.59	108.45	10.7	659.6	578
CHOL	436.25	405.62	6.1	3055.5	578
VITA	11889.73	16766.47	479.0	270478.0	578
ARDA	283.38	412.22	9.6	6761.9	578
VITD	541.10	499.87	.0	2941.8	578
DRDA	135.27	124.96	.0	735.5	578
VITE	15.88	18.10	.1	141.5	578
ERDA	187.58	211.45	.0	1737.5	578
B1	2.14	1.67	.2	22.2	578
B1RDA	177.19	138.00	18.2	2018.2	578
B2	2.82	1.49	.5	10.7	578
B2RDA	198.90	96.87	35.3	723.1	578
NIACIN	30.16	17.05	6.3	111.3	578
NIARDA	187.10	102.24	40.0	633.3	578
B6	2.12	1.26	.2	10.4	578
B6RDA	126.28	73.09	13.3	613.3	578
B12	7.73	14.06	.2	301.7	578
B12RDA	386.54	703.00	10.0	15085.0	578
FOLACIN	378.81	269.45	47.8	2311.6	578
FOLRDA	203.81	142.89	26.7	1284.4	578
VITC	173.82	245.15	6.3	2668.7	578
VCRDA	289.69	408.58	10.0	4448.3	578
IRON	20.07	11.56	4.3	83.3	578
FERDA	153.20	101.55	26.7	830.0	578
CALCIUM	1431.29	802.07	374.0	5241.0	578
CALRDA	119.27	66.84	31.2	436.7	578
PHOSPHOR	1906.52	856.56	515.0	5413.0	578
PHOSRDA	158.87	71.38	42.9	451.1	578
POTASS	3651.23	1526.63	860.0	9350.0	578
POTRDA	182.54	76.33	43.0	467.5	578
MAGNES	363.40	188.88	88.0	1532.0	578
MAGRDA	118.87	60.33	27.4	510.7	578

APPENDIX F

APPENDIX F

NUTRIENT INTAKES OF STUDENTS WITH VARIOUS FOOD SCORES BASED ON FOOD GROUP SCORE SYSTEM 3

Food Score = 0

Number of Valid Observations (Listwise) = 54.00

Variable	Mean	Std Dev	Minimum	Maximum	N
CALORIE	1466.69	834.74	475.0	5327.0	54
PROTEIN	46.24	29.32	8.4	182.1	54
CARBO	176.08	101.81	37.1	565.3	54
FAT	62.41	49.15	12.4	274.7	54
CHOL	153.93	167.57	11.8	1120.2	54
VITA	2400.43	2153.02	.0	10428.0	54
ARDA	58.54	53.61	.0	260.7	54
VITD	119.39	131.02	.0	411.1	54
DRDA	29.84	32.73	.0	102.7	54
VITE	5.69	7.38	.0	30.9	54
ERDA	70.14	91.95	.0	387.5	54
B1	.92	.57	.1	3.2	54
B1RDA	80.78	51.87	9.1	290.9	54
B2	1.07	.56	.3	3.1	54
B2RDA	79.97	43.96	23.1	230.8	54
NIACIN	14.61	9.56	1.1	47.8	54
NIARDA	94.68	64.33	6.7	320.0	54
B6	.84	.62	.0	2.8	54
B6RDA	51.90	39.71	.0	175.0	54
B12	2.81	1.98	.0	9.7	54
B12RDA	140.00	99.22	.0	485.0	54
FOLACIN	137.17	122.52	2.2	468.5	54
FOLRDA	75.47	67.99	1.1	260.0	54
VITC	39.51	43.53	.0	258.8	54
VCRDA	65.93	72.55	.0	431.7	54
IRON	10.21	7.14	2.4	42.2	54
FERDA	72.25	49.30	13.3	280.0	54
CALCIUM	413.09	228.79	28.0	887.0	54
CALRDA	34.42	19.06	2.3	73.9	54
PHOSPHOR	752.15	482.34	189.0	3073.0	54
PHOSRDA	62.68	40.20	15.7	256.1	54
POTASS	1246.00	754.17	219.0	4141.0	54
POTRDA	62.27	37.71	10.9	207.0	54
MAGNES	190.59	233.10	26.0	1309.0	54
MAGRDA	65.19	82.19	9.3	467.5	54

Units of nutrients correspond to Table 6.

Food Score = 1

Number of Valid Observations (Listwise) = 251.00

Variable	Mean	Std Dev	Minimum	Maximum	N
CALORIE	1897.06	1132.60	409.0	8012.0	251
PROTEIN	61.42	33.84	8.4	242.7	251
CARBO	216.24	148.45	1.8	1543.9	251
FAT	88.98	88.23	1.0	537.9	251
CHOL	229.86	277.75	.0	1462.3	251
VITA	6950.57	17890.66	.0	223200.0	251
ARDA	171.43	447.29	.0	5580.0	251
VITD	173.74	225.35	.0	1424.9	251
DRDA	43.43	56.32	.0	356.3	251
VITE	8.40	9.01	.0	81.6	251
ERDA	103.29	112.01	.0	1025.0	251
B1	1.42	2.67	.1	39.4	251
B1RDA	125.61	242.58	9.1	3581.8	251
B2	1.47	1.15	.1	9.2	251
B2RDA	109.89	85.79	7.7	707.7	251
NIACIN	19.84	15.15	1.5	77.5	251
NIARDA	128.32	96.44	6.7	513.3	251
B6	1.13	.95	.0	6.3	251
B6RDA	70.16	58.01	.0	393.8	251
B12	3.60	3.76	.0	22.2	251
B12RDA	180.16	187.98	.0	1110.0	251
FOLACIN	212.53	196.44	.2	1276.1	251
FOLRDA	116.65	107.94	.0	708.9	251
VITC	95.91	196.75	.0	2785.1	251
VCRDA	159.85	327.89	.0	4641.7	251
IRON	12.14	8.88	1.7	56.4	251
FERDA	86.27	69.18	13.3	560.0	251
CALCIUM	585.47	410.02	38.0	2777.0	251
CALRDA	48.79	34.17	3.2	231.4	251
PHOSPHOR	972.17	538.58	78.0	3380.0	251
PHOSRDA	81.01	44.88	6.5	281.7	251
POTASS	1840.86	1012.99	273.0	8802.0	251
POTRDA	92.02	50.65	13.6	440.1	251
MAGNES	212.61	195.18	15.0	1453.0	251
MAGRDA	72.45	66.59	5.4	518.9	251

Food Score = 2

Number of Valid Observations (Listwise) = 578.00

Variable Label	Mean	Std Dev	Minimum	Maximum	N
CALORIE	2276.13	1314.39	381.0	9104.0	578
PROTEIN	75.19	36.63	13.0	314.3	578
CARBO	263.61	154.36	44.0	1618.2	578
FAT	103.61	107.58	3.3	644.2	578
CHOL	279.90	318.95	.0	1983.1	578
VITA	8797.60	11858.85	63.0	112223.0	578
ARDA	215.47	295.30	1.6	2805.6	578
VITD	283.38	372.25	.0	3811.4	578
DRDA	70.84	93.05	.0	952.7	578
VITE	10.87	11.26	.1	106.8	578
ERDA	131.73	137.15	.0	1337.5	578
B1	1.53	1.37	.2	20.6	578
B1RDA	132.56	119.99	18.2	1872.7	578
B2	1.86	1.10	.4	9.2	578
B2RDA	136.08	76.97	23.5	592.3	578
NIACIN	21.94	14.72	1.4	125.7	578
NIARDA	140.21	93.46	6.7	840.0	578
B6	1.44	.98	.1	8.6	578
B6RDA	88.75	59.48	6.3	537.5	578
B12	4.69	6.88	.0	111.5	578
B12RDA	234.46	344.18	.0	5575.0	578
FOLACIN	267.41	208.45	22.7	2311.6	578
FOLRDA	146.16	114.22	12.0	1284.4	578
VITC	108.39	162.54	2.4	2582.9	578
VCRDA	180.65	270.90	3.3	4305.0	578
IRON	15.20	9.72	2.8	77.3	578
FERDA	110.01	77.86	20.0	520.0	578
CALCIUM	860.20	563.03	55.0	4839.0	578
CALRDA	71.68	46.92	4.6	403.2	578
PHOSPHOR	1261.88	651.39	266.0	6182.0	578
PHOSRDA	105.15	54.28	22.2	515.2	578
POTASS	2475.17	1151.86	283.0	8392.0	578
POTRDA	123.73	57.59	14.1	419.6	578
MAGNES	266.59	175.38	44.0	1555.0	578
MAGRDA	89.83	58.61	15.7	458.2	578

Food Score = 3

Number of Valid Observations (Listwise) = 739.00

Variable	Mean	Std Dev	Minimum	Maximum	N
CALORIE	2872.90	1462.44	939.0	9046.0	739
PROTEIN	101.34	44.12	22.2	313.6	739
CARBO	334.97	184.34	67.1	1624.6	739
FAT	126.21	107.20	8.7	645.7	739
CHOL	350.51	346.58	.0	2803.5	739
VITA	11879.86	19682.13	265.0	221088.0	739
ARDA	285.32	483.31	6.6	5527.2	739
VITD	438.70	452.25	.0	2946.7	739
DRDA	109.66	113.05	.0	736.7	739
VITE	14.02	14.35	.0	135.4	739
ERDA	165.88	171.20	.0	1687.5	739
B1	2.03	1.83	.3	21.2	739
B1RDA	169.66	153.41	27.3	1718.2	739
B2	2.49	1.32	.4	10.1	739
B2RDA	176.94	88.98	23.5	707.7	739
NIACIN	27.41	16.03	2.7	121.0	739
NIARDA	170.78	99.02	15.8	806.7	739
B6	1.89	1.21	.0	10.1	739
B6RDA	113.78	73.22	.0	673.3	739
B12	6.33	6.74	.0	83.5	739
B12RDA	316.37	337.14	.0	4175.0	739
FOLACIN	338.03	224.67	4.2	1637.2	739
FOLRDA	182.77	121.31	2.2	909.4	739
VITC	142.62	196.87	4.9	2668.7	739
VCRDA	237.71	328.12	8.3	4448.3	739
IRON	18.81	11.26	4.3	84.1	739
FERDA	142.29	94.86	26.7	750.0	739
CALCIUM	1232.84	720.19	137.0	4123.0	739
CALRDA	102.73	60.02	11.4	343.6	739
PHOSPHOR	1685.26	769.74	373.0	5077.0	739
PHOSRDA	140.43	64.14	31.1	423.1	739
POTASS	3195.83	1357.21	543.0	11614.0	739
POTRDA	159.77	67.86	27.1	580.7	739
MAGNES	331.46	204.72	41.0	1620.0	739
MAGRDA	108.98	67.90	11.7	578.6	739

Food Score = 4

Number of Valid Observations (Listwise) = 582.00

Variable	Mean	Std Dev	Minimum	Maximum	N
CALORIE	3711.69	1668.79	1028.0	10953.0	582
PROTEIN	137.81	60.24	40.4	397.8	582
CARBO	421.86	212.21	90.9	1509.9	582
FAT	163.21	109.67	20.5	659.6	582
CHOL	514.37	490.00	10.7	3568.5	582
VITA	11833.70	15575.03	376.0	270478.0	582
ARDA	271.50	379.16	9.4	6761.9	582
VITD	617.40	580.88	.0	3372.3	582
DRDA	154.34	145.22	.0	843.0	582
VITE	18.34	19.86	.1	141.5	582
ERDA	208.95	227.83	.0	1737.5	582
B1	2.71	2.27	.6	23.1	582
B1RDA	210.91	168.25	46.7	2018.2	582
B2	3.40	1.84	.8	19.2	582
B2RDA	228.02	111.76	52.9	1129.4	582
NIACIN	36.79	20.88	4.7	149.7	582
NIARDA	216.82	114.80	33.3	789.5	582
B6	2.39	1.47	.1	10.4	582
B6RDA	135.83	81.46	6.3	613.3	582
B12	9.37	14.95	.0	301.7	582
B12RDA	468.23	747.31	.0	15085.0	582
FOLACIN	442.17	293.97	14.2	1997.7	582
FOLRDA	233.26	151.86	7.8	999.0	582
VITC	161.81	199.46	.0	2617.3	582
VCRDA	269.67	332.43	.0	4361.7	582
IRON	23.76	12.40	5.9	83.3	582
FERDA	194.82	120.72	40.0	830.0	582
CALCIUM	1701.16	948.71	172.0	5241.0	582
CALRDA	141.75	79.06	14.3	436.7	582
PHOSPHOR	2257.66	1043.94	45.0	6908.0	582
PHOSRDA	188.13	86.99	3.8	575.7	582
POTASS	4082.56	1796.99	772.0	18912.0	582
POTRDA	204.10	89.85	38.6	945.6	582
MAGNES	409.92	222.33	11.0	1532.0	582
MAGRDA	129.07	69.45	3.9	510.7	582

Food Score = 5

Number of Valid Observations (Listwise) = 285.00

Variable	Mean	Std Dev	Minimum	Maximum	N
CALORIE	4627.32	1824.92	1550.0	10650.0	285
PROTEIN	174.62	66.92	53.3	400.5	285
CARBO	527.65	231.31	124.2	1363.8	285
FAT	202.60	118.07	30.6	626.6	285
CHOL	673.99	535.04	49.8	3347.4	285
VITA	16187.29	21103.74	1735.0	216002.0	285
ARDA	346.19	437.43	34.7	4320.0	285
VITD	737.00	562.17	.0	3380.8	285
DRDA	184.23	140.53	.0	845.2	285
VITE	23.60	20.75	1.1	142.1	285
ERDA	254.51	225.94	10.0	1775.0	285
B1	3.28	1.79	1.0	20.2	285
B1RDA	237.99	121.57	73.3	1346.7	285
B2	4.28	1.68	1.2	10.8	285
B2RDA	268.22	96.76	76.5	635.3	285
NIACIN	46.44	21.71	10.9	123.9	285
NIARDA	258.14	116.32	73.3	700.0	285
B6	3.18	1.75	.4	10.3	285
B6RDA	169.92	90.06	20.0	540.0	285
B12	11.31	7.18	.6	55.2	285
B12RDA	565.42	359.13	30.0	2760.0	285
FOLACIN	575.51	323.94	79.5	1745.8	285
FOLRDA	295.85	163.52	40.0	970.0	285
VITC	208.88	236.87	13.2	2036.8	285
VCRDA	348.10	394.83	21.7	3395.0	285
IRON	30.90	13.74	7.1	83.5	285
FERDA	272.79	139.68	66.7	840.0	285
CALCIUM	2100.34	906.44	465.0	5354.0	285
CALRDA	175.02	75.53	38.8	446.2	285
PHOSPHOR	2884.95	1172.59	740.0	6808.0	285
PHOSRDA	240.41	97.71	61.7	567.3	285
POTASS	5217.65	2021.84	1087.0	16609.0	285
POTRDA	260.86	101.09	54.3	830.4	285
MAGNES	529.89	258.66	145.0	1701.0	285
MAGRDA	156.72	73.49	45.1	486.0	285

APPENDIX G

APPENDIX G

MEANS AND DISTRIBUTION OF SERVINGS OF VARIOUS FOOD SCORES BASED ON FOOD GROUP SCORE SYSTEM 3

Table 30a. Mean and standard deviations of the five food groups for food score 5

Food Score = 5	ALL <75 (n=6)	ALL ≥75 (n=279)
Dairy	4.4 ± 2.4[a]	5.2 ± 2.5
Fruit	5.0 ± 2.9	7.6 ± 4.9
Meat	3.5 ± .6	4.1 ± 1.8
Grain	13.5 ± 2.9	13.6 ± 6.7
Vegetable	5.1 ± 1.8	9.2 ± 5.6
MAR Score	68.5 ± 4.5	97.3 ± 4.9

a. Mean ± standard deviation

Table 30b. Mean and standard deviations of the five food groups for food score 5 for males

Food Score = 5	MALE <75 (n=4)	MALE ≥75 (n=190)
Dairy	4.9 ± 2.9[a]	5.6 ± 2.6
Fruit	4.9 ± 3.6	8.0 ± 5.2
Meat	3.6 ± .8	4.3 ± 1.9
Grain	13.7 ± 3.0	14.6 ± 7.2
Vegetable	5.3 ± 2.2	9.7 ± 5.9
MAR Score	67.4 ± 4.9	97.6 ± 4.6

a. Mean ± standard deviation

Table 30c. Mean and standard deviations of the five food groups for food score 5 for females

Food Score = 5	FEMALE <75 (n=2)	FEMALE ≥75 (n=89)
Dairy	3.3 ± .5[a]	4.3 ± 2.1
Fruit	5.4 ± 1.1	6.6 ± 4.2
Meat	3.5 ± 0	3.6 ± 1.2
Grain	13.0 ± 3.5	11.5 ± 4.8
Vegetable	4.6 ± .9	8.0 ± 4.7
MAR Score	70.8 ± 3.7	96.6 ± 5.6

a. Mean ± standard deviation

Table 31. Average number of servings consumed from the five food groups, and percent of students who consumed different number of servings from the five food groups with food score 5

	ALL <75 n=6 (%)	ALL ≥75 n=279 (%)	MALE <75 n=4 (%)	MALE ≥75 n=190 (%)	FEMALE <75 n=2 (%)	FEMALE ≥75 n=89 (%)
DAIRY						
# of Serv						
0 < S < 2	0	0	0	0	0	0
2 ≤ S < 3	17	22	25	17	0	33
3 ≤ S < 4	50	13	25	9	100	19
4+	33	65	50	73	0	48
FRUIT						
# of Serv						
0 < S < 2	0	0	0	0	0	0
2 ≤ S < 3	17	18	50	18	0	19
3 ≤ S < 4	17	5	0	3	0	9
4 ≤ S < 5	16	8	0	3	50	17
5 ≤ S < 6	17	17	25	19	0	12
6+	33	53	25	57	50	43
MEAT						
# of Serv						
0 < S < 2	0	0	0	0	0	0
2 ≤ S < 3	0	30	0	26	0	37
3 ≤ S < 4	83	23	75	23	100	25
4+	17	47	25	57	0	38
GRAIN						
# of Serv						
0 < S < 6	0	0	0	0	0	0
6 ≤ S < 9	0	24	0	16	0	37
9 ≤ S <11	33	15	25	15	50	15
11+	67	61	75	67	50	48

Table 31. (cont'd)

VEGETABLE						
# of Serv						
0 < S < 3	0	0	0	0	0	0
3 ≤ S < 5	50	20	50	20	50	21
5 ≤ S < 7	33	26	25	21	50	35
7 ≤ S < 9	17	17	25	17	0	16
9+	0	37	0	42	0	28

Numbers may not add to 100 due to rounding.

Table 32a. Mean and standard deviations of the five food groups for food score 4

Food Score = 4	ALL <75 (n=59)	ALL ≥75 (n=523)
Dairy	2.5 ± 1.9[a]	4.4 ± 3.0
Fruit	4.1 ± 3.9	5.3 ± 5.1
Meat	3.0 ± 1.8	2.9 ± 2.2
Grain	9.6 ± 4.5	11.1 ± 6.2
Vegetable	4.4 ± 2.9	7.3 ± 4.9
MAR Score	64.7 ± 8.4	94.3 ± 6.6

a. Mean ± standard deviation

Table 32b. Mean and standard deviations of the five food groups for food score 4 for males

Food Score = 4	MALE	
	<75 (n=17)	≥75 (n=236)
Dairy	3.3 ± 3.0[a]	5.3 ± 3.5
Fruit	4.8 ± 5.0	4.9 ± 5.8
Meat	3.6 ± 2.2	3.5 ± 2.3
Grain	11.3 ± 5.0	12.3 ± 6.8
Vegetable	5.4 ± 4.0	7.3 ± 5.2
MAR Score	67.8 ± 4.6	94.6 ± 6.7

a. Mean ± standard deviation

Table 32c. Mean and standard deviations of the five food groups for food score 4 for females

Food Score = 4	FEMALE	
	<75 (n=42)	≥75 (n=287)
Dairy	2.1 ± 1.1[a]	3.7 ± 2.3
Fruit	3.9 ± 3.5	5.6 ± 4.4
Meat	2.8 ± 1.6	2.3 ± 1.8
Grain	8.9 ± 4.1	10.1 ± 5.5
Vegetable	4.0 ± 2.3	7.3 ± 4.7
MAR Score	63.4 ± 9.2	94.0 ± 6.5

a. Mean ± standard deviation

Table 33. Average number of servings consumed from the five food groups, and percent of students who consumed different number of servings from the five food groups with food score 4

	ALL		MALE		FEMALE	
	<75 n=59 (%)	≥75 n=523 (%)	<75 n=17 (%)	≥75 n=236 (%)	<75 n=42 (%)	≥75 n=287 (%)
DAIRY						
# of Serv						
0	7	4	6	4	7	4
0 < S < 1	7	2	6	3	7	2
1 ≤ S < 2	12	7	18	5	10	9
2 ≤ S < 3	44	21	18	15	52	27
3 ≤ S < 4	19	15	29	11	17	18
4+	12	51	24	63	7	40
FRUIT						
# of Serv						
0	27	22	24	36	29	12
0 < S < 1	0	1	6	2	0	0
1 ≤ S < 2	2	3	18	2	0	3
2 ≤ S < 3	20	15	12	11	21	17
3 ≤ S < 4	8	4	6	2	7	6
4+	42	55	35	48	43	61
MEAT						
# of Serv						
0	5	4	0	2	7	5
0 < S < 1	5	11	12	7	2	14
1 ≤ S < 2	5	20	0	13	7	27
2 ≤ S < 3	37	26	29	25	40	27
3 ≤ S < 4	22	17	24	18	22	15
4+	25	23	35	35	21	13
GRAIN						
# of Serv						
0	0	0	0	0	0	0
0 < S < 1	2	0	0	0	2	0
1 ≤ S < 3	3	2	0	2	5	2
3 ≤ S < 6	5	11	6	9	5	13
6 ≤ S < 9	41	32	35	27	43	36
9 ≤ S <11	19	17	12	17	21	17
11+	31	38	47	46	24	32

Table 33. (cont'd)

VEGETABLE # of Serv						
0	10	3	12	3	10	2
0 < S < 1	3	2	6	3	2	1
1 ≤ S < 3	7	9	6	10	7	7
3 ≤ S < 5	46	21	29	20	52	23
5 ≤ S < 7	17	19	24	17	14	21
7+	17	47	24	47	14	46

Numbers may not add 100 due to rounding.

Table 34a. Mean and standard deviations of the five food groups for food score 3

Food Score = 3	ALL <75 (n=186)	ALL ≥75 (n=583)
Dairy	1.9 ± 1.8[a]	3.2 ± 2.5
Fruit	3.5 ± 3.9	4.0 ± 4.7
Meat	2.0 ± 1.6	1.9 ± 1.9
Grain	7.2 ± 4.5	8.1 ± 5.2
Vegetable	4.1 ± 2.9	5.8 ± 4.7
MAR Score	63.8 ± 9.1	90.3 ± 7.5

a. Mean ± standard deviation

Table 34b. Mean and standard deviations of the five food groups for food score 3 for males

Food Score = 3	MALE <75 (n=37)	MALE ≥75 (n=250)
Dairy	1.9 ± 2.4[a]	3.9 ± 2.9
Fruit	3.5 ± 3.8	3.5 ± 5.7
Meat	3.1 ± 2.9	2.6 ± 2.4
Grain	7.7 ± 4.7	10.1 ± 5.7
Vegetable	3.9 ± 3.4	5.0 ± 4.5
MAR Score	63.2 ± 9.1	91.2 ± 7.5

a. Mean ± standard deviation

Table 34c. Mean and standard deviations of the five food groups for food score 3 for females

Food Score = 3	FEMALE	
	<75 (n=119)	≥75 (n=433)
Dairy	1.9 ± 1.6[a]	2.9 ± 2.2
Fruit	3.5 ± 3.9	4.2 ± 4.3
Meat	1.7 ± 1.3	1.7 ± 1.7
Grain	7.0 ± 4.4	7.5 ± 4.9
Vegetable	4.1 ± 2.8	6.1 ± 4.8
MAR Score	64.0 ± 9.1	89.9 ± 7.5

a. Mean ± standard deviation

Table 35. Average number of servings consumed from the five food groups, and percent of students who consumed different number of servings from the five food groups with food score 3

	ALL		MALE		FEMALE	
	MAR <75 n=156 (%)	MAR ≥75 n=583 (%)	MAR <75 n=37 (%)	MAR ≥75 n=150 (%)	MAR <75 n=119 (%)	MAR ≥75 n=433 (%)
DAIRY						
# of Serv						
0	20	6	30	8	17	6
0 < S < 1	15	9	16	3	15	10
1 ≤ S < 2	14	19	11	16	15	20
2 ≤ S < 3	24	17	22	13	24	18
3 ≤ S < 4	18	17	8	21		
4+	9	33	14	39	21	16
					8	30
FRUIT						
# of Serv						
0	34	31	46	49	30	24
0 < S < 1	2	1	0	3	3	1
1 ≤ S < 2	1	4	0	5	2	4
2 ≤ S < 3	17	15	8	9	28	17
3 ≤ S < 4	6	4	3	0	38	5
4+	39	45	43	33	0	49

Table 35. (cont'd)

MEAT						
# of Serv						
0	10	9	5	3	12	12
$0 < S < 1$	15	21	3	14	19	23
$1 \leq S < 2$	21	32	11	33	24	32
$2 \leq S < 3$	32	17	41	16	29	18
$3 \leq S < 4$	12	9	16	15	11	8
4+	10	11	24	19	6	8
GRAIN						
# of Serv						
0	3	1	3	1	3	1
$0 < S < 1$	1	0	0	0	1	0
$1 \leq S < 3$	11	7	11	2	11	8
$3 \leq S < 6$	24	30	24	21	24	34
$6 \leq S < 9$	33	30	22	27	36	30
$9 \leq S < 11$	13	11	16	13	12	11
11+	16	22	24	36	13	17
VEGETABLE						
# of Serv						
0	12	8	19	10	9	7
$0 < S < 1$	5	4	0	7	6	3
$1 \leq S < 3$	14	19	14	25	11	17
$3 \leq S < 5$	40	20	41	18	42	21
$5 \leq S < 7$	17	15	11	11	19	16
7+	14	35	16	29	13	37

Numbers may not add to 100 due to rounding.

Table 36a. Mean and standard deviations of the five food groups for food score 2

Food Score = 2	ALL <75 (n=268)	ALL ≥75 (n=310)
Dairy	1.3 ± 1.2[a]	2.3 ± 2.2
Fruit	3.3 ± 4.7	2.9 ± 4.6
Meat	1.3 ± 1.4	1.3 ± 1.3
Grain	5.6 ± 3.8	6.1 ± 4.3
Vegetable	3.9 ± 4.1	5.8 ± 5.1
MAR Score	60.7 ± 11.3	86.8 ± 7.3

a. Mean ± standard deviation

Table 36b. Mean and standard deviations of the five food groups for food score 2 for males

Food Score = 2	MALE <75 (n=40)	MALE ≥75 (n=46)
Dairy	1.3 ± 1.6[a]	3.3 ± 3.6
Fruit	2.6 ± 5.0	1.6 ± 4.7
Meat	2.8 ± 2.2	1.7 ± 1.7
Grain	6.8 ± 4.5	7.3 ± 5.1
Vegetable	3.0 ± 2.9	5.5 ± 4.8
MAR Score	62.0 ± 11.4	88.2 ± 7.9

a. Mean ± standard deviation

Table 36c. Mean and standard deviations of the five food groups for food score 2 for females

Food Score = 2	FEMALE <75 (n=228)	 $\geq$75 (n=264)
Dairy	1.3 ± 1.2[a]	2.2 ± 1.8
Fruit	3.4 ± 4.6	3.4 ± 4.6
Meat	1.1 ± 1.0	1.3 ± 1.2
Grain	5.3 ± 3.6	5.9 ± 4.1
Vegetable	4.1 ± 4.3	5.9 ± 5.1
MAR Score	60.4 ± 11.3	86.5 ± 7.2

a. Mean ± standard deviation

Table 37. Average number of servings consumed from the five food groups, and percent of students who consumed different number of servings from the five food groups with food score 2

	ALL		MALE		FEMALE	
	MAR <75 n=268 (%)	MAR ≥75 n=310 (%)	MAR <75 n=40 (%)	MAR ≥75 n=46 (%)	MAR <75 n=228 (%)	MAR ≥75 n=264 (%)
DAIRY						
# of Serv						
0	18	7	33	11	16	8
0 < S < 1	24	11	13	2	26	13
1 ≤ S < 2	28	35	30	31	28	36
2 ≤ S < 3	19	17	10	17	21	16
3 ≤ S < 4	8	11	8	9	8	11
4+	3	18	8	30	2	16
FRUIT						
# of Serv						
0	41	47	65	65	37	44
0 < S < 1	1	4	0	15	1	2
1 ≤ S < 2	4	7	5	2	4	7
2 ≤ S < 3	16	11	3	4	18	12
3 ≤ S < 4	6	3	0	0	8	4
4+	32	28	28	13	33	30
MEAT						
# of Serv						
0	18	12	5	7	20	13
0 < S < 1	23	25	10	20	25	27
1 ≤ S < 2	35	47	30	54	36	45
2 ≤ S < 3	13	7	23	4	12	7
3+	11	9	33	15	8	8
GRAIN						
# of Serv						
0	2	1	5	2	1	1
0 < S < 1	3	1	5	2	2	1
1 ≤ S < 3	20	12	5	9	23	13
3 ≤ S < 6	38	50	35	37	39	53
6 ≤ S < 9	21	18	20	17	21	18
9 ≤ S <11	7	6	13	13	6	4
11+	10	13	18	20	9	11

Table 37. (cont'd)

<u>VEGETABLE</u>						
<u># of Serv</u>						
0	13	9	20	13	11	9
0 < S < 1	7	2	8	0	8	2
1 ≤ S < 3	26	28	33	31	25	27
3 ≤ S < 5	27	12	23	9	28	13
5 ≤ S < 7	12	16	5	13	14	16
7+	15	34	13	35	15	33

Numbers may not add to 100 due to rounding.

Table 38a. Mean and standard deviations of the five food groups for food score 1

Food Score = 1	<u>ALL</u> <75 (n=189)	≥75 (n=62)
Dairy	1.0 ± 1.0[a]	1.6 ± 1.6
Fruit	1.8 ± 3.4	2.3 ± 4.2
Meat	1.1 ± 1.5	1.0 ± .7
Grain	4.6 ± 3.1	5.7 ± 3.7
Vegetable	2.4 ± 2.9	3.9 ± 5.2
MAR Score	53.3 ± 14.1	85.0 ± 6.5

a. Mean ± standard deviation

Table 38b. Mean and standard deviations of the five food groups for food score 1 for males

Food Score = 1	MALE <75 (n=22)	MALE ≥75 (n=6)
Dairy	.8 ± .8[a]	2.8 ± 2.6
Fruit	1.4 ± 2.6	1.7 ± 4.3
Meat	1.5 ± 1.2	1.2 ± .4
Grain	4.8 ± 2.4	7.1 ± 4.3
Vegetable	1.6 ± 1.4	2.0 ± 2.9
MAR Score	54.8 ± 13.5	90.4 ± 8.6

a. Mean ± standard deviation

Table 38c. Mean and standard deviations of the five food groups for food score 1 for females

Food Score = 1	FEMALE <75 (n=167)	FEMALE ≥75 (n=56)
Dairy	1.0 ± 1.0[a]	1.4 ± 1.4
Fruit	1.9 ± 3.6	2.4 ± 4.2
Meat	1.1 ± 1.6	.9 ± .7
Grain	4.6 ± 3.2	5.5 ± 3.6
Vegetable	2.6 ± 3.1	3.9 ± 5.1
MAR Score	53.1 ± 14.3	84.4 ± 6.0

a. Mean ± standard deviation

Table 39. Average number of servings consumed from the five food groups, and percent of students who consumed different number of servings from the five food groups with food score 1

	ALL		MALE		FEMALE	
	MAR <75 n=189 (%)	MAR ≥75 n=62 (%)	MAR <75 n=22 (%)	MAR ≥75 n=6 (%)	MAR <75 n=167 (%)	MAR ≥75 n=56 (%)
DAIRY						
# of Serv						
0	27	11	36	0	26	13
0 < S < 1	21	16	9	0	23	18
1 ≤ S < 2	40	55	41	67	40	54
2 ≤ S < 3	7	6	14	0	7	7
3 ≤ S < 4	2	0	0	0	2	0
4+	3	11	0	33	3	9
FRUIT						
# of Serv						
0	59	63	73	83	58	61
0 < S < 1	3	2	0	0	4	2
1 ≤ S < 2	6	7	0	0	7	7
2 ≤ S < 3	13	3	9	0	13	4
3 ≤ S < 4	2	2	0	0	2	2
4+	16	24	18	17	16	25
MEAT						
# of Serv						
0	16	11	5	0	18	13
0 < S < 1	30	31	36	17	29	32
1 ≤ S < 2	42	57	36	83	43	54
2 ≤ S < 3	7	0	9	0	7	0
3+	5	2	14	0	4	2
GRAIN						
# of Serv						
0	2	0	0	0	2	0
0 < S < 1	2	2	0	0	2	2
1 ≤ S < 3	21	10	18	0	21	11
3 ≤ S < 6	57	65	64	67	56	64
6 ≤ S < 9	12	10	14	0	11	11
9 ≤ S <11	2	15	0	0	2	5
11+	5	10	5	33	5	7

Table 39. (cont'd)

VEGETABLE						
# of Serv						
0	18	19	32	17	16	20
0 < S < 1	14	5	9	33	15	2
1 ≤ S < 2	16	18	9	17	17	18
2 ≤ S < 3	25	31	32	17	25	32
3 ≤ S < 5	13	5	18	0	13	5
5 ≤ S< 7	5	2	0	0	6	2
7+	8	21	0	17	9	21

Numbers may not add to 100 due to rounding.

Table 40a. Mean and standard deviations of the five food groups for food score 0

Food Score = 0	ALL <75 (n=46)	ALL ≥75 (n=8)
Dairy	.6 ± .6[a]	1.2 ± .6
Fruit	.2 ± .4	.3 ± .5
Meat	.8 ± .6	.8 ± .6
Grain	3.6 ± 1.5	4.4 ± 1.6
Vegetable	1.2 ± 1.0	.8 ± .8
MAR Score	43.1 ± 16.7	81.5 ± 4.3

a. Mean ± standard deviation

Table 40b. Mean and standard deviations of the five food groups for food score 0 for males

Food Score = 0	MALE <75 (n=8)	MALE ≥75 (n=0)
Dairy	.5 ± .5[a]	
Fruit	0	
Meat	1.3 ± .6	
Grain	4.1 ± 1.3	
Vegetable	1.0 ± 1.1	
MAR Score	45.2 ± 19.4	

a. Mean ± standard deviation

Table 40c. Mean and standard deviations of the five food groups for food score 0 for females

Food Score = 0	FEMALE <75 (n=38)	FEMALE ≥75 (n=8)
Dairy	.6 ± .6[a]	1.2 ± .6
Fruit	.2 ± .5	.3 ± .5
Meat	.7 ± .5	.8 ± .6
Grain	3.5 ± 1.5	4.4 ± 1.6
Vegetable	1.2 ± 1.0	.8 ± .8
MAR Score	42.7 ± 16.3	81.5 ± 4.3

a. Mean ± standard deviation

Table 41. Average number of servings consumed from the five food groups, and percent of students who consumed different number of servings from the five food groups with food score 0

	ALL		MALE		FEMALE	
	MAR <75 n=46 (%)	MAR ≥75 n=8 (%)	MAR <75 n=8 (%)	MAR ≥75 n=0 (%)	MAR <75 n=38 (%)	MAR ≥75 n=8 (%)
DAIRY						
# of Serv						
0	41	0	38		42	0
0 < S < 1	26	38	50		21	38
1 ≤ S < 2	33	63	13		37	63
FRUIT						
# of Serv						
0	83	75	100		79	75
0 < S < 1	7	0	0		8	0
1 ≤ S < 2	11	25	0		13	25
MEAT						
# of Serv						
0	15	13	0		18	13
0 < S < 1	37	50	25		40	50
1 ≤ S < 2	48	38	75		42	38
GRAIN						
# of Serv						
0	0	0	0		0	0
0 < S < 1	0	0	0		3	0
1 ≤ S < 3	31	13	25		32	13
3 ≤ S < 6	67	88	75		66	88
VEGETABLE						
# of Serv						
0	28	38	50		24	38
0 < S < 1	11	25	0		13	25
1 ≤ S < 2	33	13	25		34	13
2 ≤ S < 3	28	25	25		29	25

Numbers may not add to 100 due to rounding.

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