The Consumption Levels of Fruits and Vegetables and Antioxidants of College Students

by

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Thesis submitted to the Faculty of the

Virginia Polytechnic Institute and State University

in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

in

Human Nutrition and Foods

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August , 1993

Blacksburg, VA

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(ABSTRACT)

Food guides have been used for many years to aid individuals in food selection. This investigation was conducted in order to assess the compliance of college students with the National Cancer Institute's "Five A Day" recommendation. Three-day average consumption levels of antioxidants vitamin C, vitamin E, and beta carotene and the average number of servings of fruits and vegetables consumed were determined for 217 college students (95 males and 122 females) enrolled in an introductory nutrition class. Nutritional analysis was carried out using the Nutritionist IV software package. Descriptive statistics of the data included means and ranges.

Results indicated that 82% of the students obtained 70% of the RDA for vitamin C and 85% obtained 70% of the RDA for vitamin E; 29% obtained 70% of the level of beta carotene recommended to reduce the risk of developing cancer. College students obtained adequate amounts of of vitamin C but inadequate amounts of vitamin E and beta carotene recommended to reduce the risk of developing certain cancers. Males obtained higher levels of vitamin C and E, while females obtained a higher level of beta carotene. Thirty-four percent of the students consumed at least two servings of fruits daily and 26% consumed at least three servings of vegetables daily. A total of 26% of the students

obtained the recommended five or more servings of fruits and vegetables. Males consumed a slightly greater number of fruits and vegetables compared to females. Consumption of at least five servings of fruits and vegetables, in any combination, provided levels of vitamin C and beta carotene recommended to reduce the risk of developing cancer (52) but a marginal level of vitamin E (contained primarily in foods other than fruits and vegetables).

Because cancer is one of the most common causes of death in the United States and because its risk can be reduced by appropriate diet, produce consumption should be encouraged. The Five A Day program has been developed to do this. Unfortunately, this program has reached only a small sector of the public. Therefore, health practitioners as well as individuals involved in the food industry must concentrate their efforts in educating the public to make wise food choices.

ACKNOWLEDGEMENTS

I would like to thank my committee members for their patience and help during the last ten months. Thank you to Dr. Hertzler, for her drive and encouragement and to Dr. Webb, for your flexible schedule and fun outlook on life. All of you were a great pleasure to work with, and I have learned much more from you than merely how to tackle a thesis.

A special thank you to Ginger Geertsema, my research partner who can turn any stressful situation into a picnic in the park. You are much more than just a fellow graduate student, and I look forward to keeping in touch with you wherever our lives may lead us. A special thank you also to Thresa Vinardi. Without her assistance, these results would still be only #2 pencil dots on #T-10 opscans.

Lastly and most importantly, I would like to acknowledge my parents. Thank you for always being there and loving me no matter what. You instilled in me a thirst for knowledge and life. You are right - in the long run, hard work pays off! Without them, none of this would have been possible. Thank you also to my twin sister, Tracey, who has been through everything with me and still remains my best friend. And thank you to my good friends, although few, are precious.

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CHAPTER I

INTRODUCTION

Food guides have been used for nearly a century to help individuals select foods to meet recommended scientific standards. The most recently developed guides are the Dietary Guidelines and its graphic representation, the Food Guide Pyramid. As an adjunct to the Food Guide Pyramid, the 1988 Five A Day program advocates the daily consumption of at least two servings of fruits and three servings of vegetables. According to a number of nation-wide surveys, the average American consumes only three and a half or fewer servings of fruits and vegetables daily. (1;2;3-8) The consumption of fruits and vegetables and specifically of the antioxidant vitamins C and E and beta carotene has been found to be associated with a decrease in the incidence of cancer; therefore, the Five A Day program has gained much recognition (9-14). Although precise consumption levels of antioxidants necessary to prevent cancer have not yet been ascertained, foods which are good sources of these antioxidants have been recommended. Analysis of dietary records provides information on an individual's average daily intake of certain foods and beverages as well as macronutrients and micronutrients. The purpose of this investigation was to analyze food behavior patterns of a college student population in order to assess their compliance with the Five A Day program recommendations and their intake of antioxidants vitamins C and E and beta carotene.

CHAPTER II

REVIEW OF LITERATURE

History of Food Guides

For nearly a century, nutrition educators have provided food guidance to the general public. The evolution of this guidance is dependent upon the growth in understanding of nutrient composition of foods, nutrient needs of humans, and the relationship of dietary intake to health (15). A number of different food guides have been published since the early 1900s, all with the same purpose of assisting the public in selecting foods which provide the recommended intake of essential nutrients (16).

Kilocalorie Basis (1890s - 1930s)

In 1894, W.O. Atwater, with the assistance of C.D. Woods, H.B. Gibson, and C.F. Langworthy, published the first tables of food composition and dietary standards for the United States population. Atwater's dietary standards were intended to represent the average requirements of man for protein and total kilocalories; carbohydrate and fat were to provide the balance in kilocalories. Specific vitamins and minerals had not yet been identified. (16;17)

In 1916 Caroline Hunt, a nutrition specialist in the Bureau of Home Economics of the United States Department of Agriculture (USDA), authored the first national food guide. Foods were categorized into five groups: 1) cereals, 2) milk and meat, 3) fruits and vegetables, 4) sugars and sugary foods, and 5) fats and fat foods. The criteria for grouping foods were based on present knowledge of nutritional needs and food composition. Although vitamines A and B were not given special consideration due to insufficient knowledge of their functions, they were known to be distributed throughout the five groups and thus, a varied diet was advocated. Fruits and vegetables were recommended because they were known to contribute sugar, starch, iron, and vitamines

A, B, and C to the diet. Familiar household units were used in defining amounts of foods, and recipes and menus were provided. (16;17)

Dietary recommendations based on these five food groups were published in 1917. Also using these same food groups, a guide for the average family was released in 1921, suggesting the weekly amounts of food to purchase. This guide was slightly modified in 1923 for use by extension workers and teachers in educating housekeepers. Emphasizing the selection of wholesome food, the 1923 Farmer's Bulletin illustrated a week's supply of food for the average American family from each of the five food groups. Food amounts were described by weight, volume, or count and 100-kilocalorie portions to accomodate the knowledge of different food preparers. (16;17)

During the nineteen twenties and thirties, vitamin and mineral standards were proposed. McCollum, Sherman, and Roberts were several researchers who conveyed this beneficial information to the public in practical terms. The focus of food selection was now shifted from the obtainment of adequate kilocalories to the provision of necessary vitamins and minerals. (16)

As early as 1918, McCullom coined the term "protective foods," i.e., foods which are rich sources of calcium, vitamin C, and vitamin A. He stated that dietary patterns should contain a quart of milk and a liberal amount of greens daily and a salad with raw fruits and vegetables twice daily. Sherman stated that protective foods should comprise half of the kilocalorie requirement of one's diet. (16)

In 1933, Hazel Stiebeling, a food economist for the USDA, developed buying guides to aid in food shopping. These family food plans defined the amounts of foods to buy in a week at four different cost levels to meet the nutritional needs of men, women, and children of various ages. Stiebeling emphasized the importance of obtaining a proper balance between "protective foods" and high-energy foods. She described protective foods as those which are nutrient-dense, such as milk, fruits, and vegetables, and high-energy foods as those which supply a large amount of kilocalories but few nutrients, such as fats and sweets. (17)

Recommended Dietary Allowances Basis (1940s - 1980s)

The first Recommended Dietary Allowances (RDAs) were released in 1941 by the Food and Nutrition Board of the National Academy of Sciences. They defined the specific daily intakes of kilocalories, protein, iron, calcium, thiamin, niacin, riboflavin, and vitamins A, D, and C for healthy males and females for seventeen age categories. To aid the lay person in translation of these recommendations into foods, several committees designed similar food guides with the number of food groups ranging from seven to ten. These were the first national guides to incorporate information regarding specific vitamins and minerals and the first to introduce the term "enriched." (16;17)

At the time the first RDAs were published, the food guide "Eat the Right Food to Help Keep You Fit," was published by USDA's Bureau of Home Economics. The food groups and the suggested number of servings for both plans were basically the same, but with slightly different representation. Emphasis of certain foods was also the same for both guides; animal protein foods, milk, fruits and vegetables, and enriched or whole grain cereals and breads were stressed with fats and sweets completing a day's energy needs. "Eat the Right Food to Help Keep You Fit" also gave practical suggestions for the selection and preparation of foods within each group. (16)

"A Guide to Good Eating" was also published in 1941. Under the direction of Ethel Austin Martin, the National Dairy Council issued this food guide. The guide contained seven food groups: 1) milk, 2) meat, cheese, fish, and legumes, 3) eggs, 4) fruits, 5) vegetables, 6) cereals and breads, and 7) butter. Developed as part of the Council's nutrition education program, "A Guide to Good Eating" appeared both in handout and poster form. (16)

In 1942, Paul McNutt, Administrator of the Office of Defense Health and Welfare Services, announced a National Industrial Nutrition Program. Designed to reach industry, communities, and homes, this program entailed a new food guide: "U.S. Needs Us Strong-Eat Nutritional Food." The objective of the industrial program was to obtain full health returns from the nation's food resources for, during, and following the war. (16)

The RDAs were the scientific basis for the "U.S. Needs Us Strong-Eat Nutritional Food" guide. The food groups in the 1942 guide were similar to those in "Eat the Right Food to Help Keep You Fit" with the exception of two. The "sweet" and "water" groups were omitted, thus emphasizing the protective foods. In order to reduce food waste, suggestions for meal planning (food examples, cooking methods, and meal patterns) were recommended. Alternative food choices were also listed in view of the food shortages resulting from the war. (16)

Through the efforts of many committees and individuals, the "Basic Seven" food guide was issued in 1943. Several government agencies contributed much to the development of the guide, but committee members of the National Wartime Nutrition Program accomplished its primary coordination. The food guide was based on the first RDAs, published in 1943; eggs were placed with meat, fish, and poultry, thus reducing the number of food groups to seven. As with the 1942 guide, alternative choices were listed for rationed, scarce, or unobtainable foods; however, daily intakes for each food group were not specified. Although no actual document illustrates nutritive contributions, three of the seven food groups were fruits and vegetables (green and yellow vegetables; oranges, tomatoes, and grapefruit; potatoes and other vegetables and fruits), undoubtedly grouped via their vitamin A and C content. The food groups were arranged in a circle to signify that they were equally important. (16)

Following the war, the "Basic Seven" was revised and published as the "National Food Guide" by the USDA. Although recommended daily servings of each food group were included, other information was basically the same as the war-time version. The circular format, sometimes referred to as the "Wheel of Good Eating," remained the key educational device. (16;17)

In 1956, a guide containing four food groups was presented in the USDA publication, "Essentials of an Adequate Diet," written by Louise Page and Esther Phipard. Two years later the guide issued as USDA Leaflet No. 424, "Food for Fitness-A Daily Food Guide," became known as the "Basic Four." It recommended a minimum number of servings from four food groups: two servings of meat, fish, poultry, eggs, dry beans, and nuts; two servings of milk and milk products; four servings of grain products; and four servings of fruits and vegetables. The fruits and vegetable group comprised three subgroups - ascorbic acid-rich, provitamin A-rich, and other fruits and vegetables - with instructions for selecting important sources of ascorbic acid and provitamin A. At least one serving of a vitamin C- rich fruit or vegetable daily and at least one serving of a provitamin A-rich fruit or vegetable every other day was recommended. Four servings of fruits and vegetables allowed for the obtainment of ≥75% of the RDA for vitamins A and C. (16;17)

The "Basic Four" was developed to be used as a foundation diet; i.e., it met only one half to two-thirds of the caloric recommendations for adults and provided the major portion of the 1953 RDAs for nutrients. It was assumed that individuals would consume more food than recommended and thus, satisfy their total caloric and nutrient needs. Therefore, one criticism of the "Basic Four" was that little guidance was provided regarding the selection of an appropriate caloric intake as well as selection of sugars and fat. However, because it emphasized obtaining adequate levels of eight vitamins and minerals, the "Basic Four" remained a focal point of nutrition education for the next two decades. (16-18)

The Dietary Guidelines and the Food Guide Pyramid

Dietary Guidelines Basis (1980s - present)

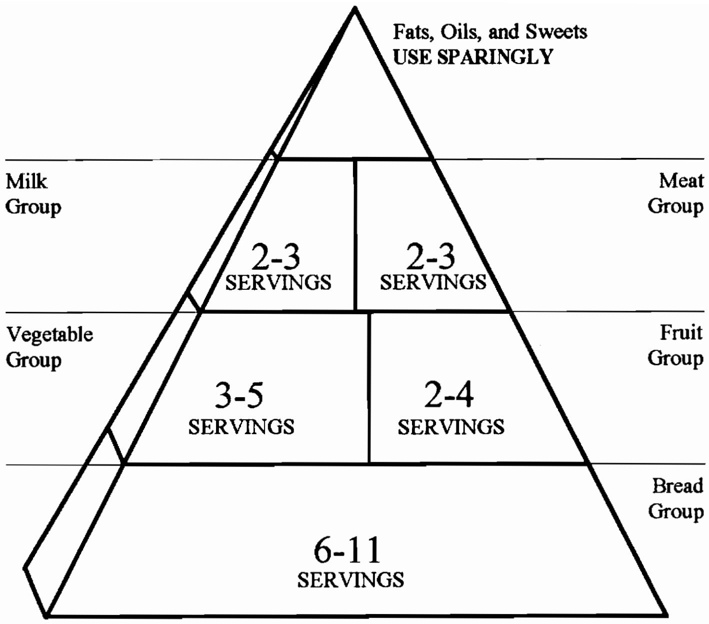
In response to the public's desire for consistent, authoritative guidance on nutrition and health, the Department of Health and Human Services (DHHS) and the USDA issued the first edition of "Nutrition and Your Health: Dietary Guidelines for Americans" in 1980. The Dietary Guidelines were based on the most current information available at the time and were intended for healthy Americans. Since 1980, two federal advisory committees made up of nutrition experts have been established to review the Guidelines and make any recommendations deemed appropriate. Consequently, the Dietary Guidelines were revised and reissued in 1985 and 1990. (17)

The 1990 Guidelines (Table 1) incorporated the findings of two significant reviews of the scientific literature on nutrition and health - "Diet and Health: Implications for Reducing Chronic Disease Risk, " published by the National Research Council of the National Academy of Sciences (NRC-NAS) in 1989 and the "Surgeon General's Report on Nutrition and Health," published by the DHHS in 1988. In the 1990 Guidelines, greater specificity was given to guidance on body weight and intake of saturated and total fat. Although advances in obtaining optimal health were made with the Dietary Guidelines, researchers were finding that people are much more likely to understand a food guide than food guidelines. (17;19)

Table 1. Dietary Guidelines for Americans (19)

♦ Eat a variety of foods
♦ Maintain healthy weight
♦ Choose a diet low in fat, saturated fat, and cholesterol
♦ Choose a diet with plenty of vegetables, fruits, and grain products
♦ Use sugars only in moderation
♦ Use salt and sodium only in moderation
♦ If you drink alcoholic beverages, do so in moderation

Therefore, the Food Guide Pyramid (FGP) was developed (Fig. 1). The FGP is a graphic representation of the Dietary Guidelines; its overall goal is to help people implement the Guidelines by making appropriate food choices. The Pyramid provides a total diet framework which considers both nutrient recommendations as well as constraints for health and wellness. Precise messages of various associations are portrayed: the National Cancer Institute's advice to eat more fruits and vegetables and fiber, the National Cholesterol Education Program's advice to lower saturated fat consumption, and the National High Blood Pressure Education Program's suggestion to reduce salt intake. (15;20;21)



What counts as a serving?

Bread, Cereal, Rice, and Pasta Group:
1 slice of bread; 1 ounce ready-to-eat cereal; 1/2 cup cooked cereal, rice, or pasta

Vegetable Group:
1 cup raw, leafy vegetables; 1/2 cup other vegetables, cooked, or chopped raw; 3/4 cup vegetable juice

Fruit Group:
1 medium apple, banana, orange; 1/2 cup chopped, cooked, or canned fruit; 3/4 cup fruit juice

Milk, Yogurt, and Cheese Group:
1 cup milk or yogurt; 1-1 1/2 ounces natural cheese; 2 ounces process cheese

Meat, Poultry, Fish, Dry Beans, Eggs, and Nuts Group:
2-3 ounces cooked lean meat, poultry, or fish; 1/2 cup cooked dry beans, 1 egg, or 2 tablespoons peanut butter count as 1 ounce lean meat

Sample Diets for Three Calorie Levels

	1600	2200	2800
Bread Group Servings	6	9	11
Vegetable Group Servings	3	4	5
Fruit Group Servings	2	3	4
Milk Group Servings	2-3	2-3	2-3
Meat Group Ounces	5	6	7

Figure 1. The Food Guide Pyramid, Serving Sizes, and Sample Diets (21).

The FGP is based on USDA's research on which foods Americans consume, nutrients contained in these foods, and ways to make the most healthy food selections. The FGP recommends the intake of a variety of foods in order to obtain necessary nutrients and an adequate amount of calories to maintain optimal health and weight. The Pyramid also focuses on fat, since most Americans consume a high amount of fat, especially saturated fat. Reduction of cholesterol, sodium, and sugar is also emphasized. (21)

The FGP comprises six food groups and defines a range of servings for each major food group (Fig. 1). With the exclusion of the "fats, oils, and sweets" group, none of the food groups is viewed as more important than the other, with each contributing some, but not all, of the necessary nutrients. The ranges of number of servings allow for individual needs which are dependent upon age, gender, size, and activity level. At least the minimum number of servings for each food group are recommeded for everyone; this ensures that 70% or more of the 1990 RDA of most nutrients will be met. (21)

According to Cronin (15), fruits and vegetables were separated into two groups because they "are used differently in diets." Those fruits that are good sources of vitamin C were highlighted and special emphasis was placed on certain subgroups within the vegetable group to accomodate for the "problem nutrient" vitamin A. Vegetables are divided into three subgroups based on their nutrient contributions - dark-green and deep-yellow; starchy, including dry beans and peas; and others. The daily consumption of two to four servings of fruits and three to five servings of vegetables is recommended; green leafy vegetables and legumes should be eaten several times a week.

A significant advantage of the FGP over previous food guides is that it is not a rigid diet prescription. Because the FGP offers a range of servings, it can be used as a general guide for individuals with varying needs and lifestyles. In addition, the FGP depicts actual meals based on these recommendations. According to the National Academy of Sciences, 1600 kilocalories (kcal) is adequate for sedentary women and older adults; 2200 kcal is adequate for children, teenage girls, active women, and sedentary men; 2800 kcal is adequate for teenage boys, active men, and very active women. Using these three calorie levels as guidelines, the FGP offers eating patterns for each (Fig. 1), thus further aiding the consumer in food selection. (21)

The development of food guides is an evolutionary process requiring the participation of all nutrition professionals. To refine and extend nutritional concepts, both criticisms of existing designs and ideas for new designs are essential. Food guides are tools for dietary guidance. They are useful only if they reflect current scientific knowledge, educational goals, and practices. As our knowledge expands, we can develop and update useful food guides via an open-minded and participatory process. (22)

The Five A Day Program

The Five A Day program originated in 1988, with an NCI grant awarded to the California Department of Health Services for the development of a cooperative program between private industry and public health groups. Seventeen major California supermarket chains, totaling more than 1800 stores, participated in the program. In 1991, the Five A Day program became a nationwide collaboration between NCI and the produce industry. Today, more than 200 food retailer organizations representing over 30,000 supermarkets have joined the program. (1)

Recently, much research has been conducted on the effect of fruit and vegetable consumption on health. Studies by the USDA, the National Academy of Sciences (NAS), and the Department of Health and Human Services (DHHS) each concluded that diets low in total fat or saturated fat, cholesterol, and plentiful in whole grains, fruits, and vegetables decrease the risk of heart disease and many types of cancers. Therefore, the Five A Day program was founded as the first national health promotion program to focus on the positive role of fruit and vegetable consumption in the reduction of the risk of cancer and other chronic diseases. (1)

Sponsored by the National Cancer Institute (NCI), the Five A Day program is the largest ever industry/government joint nutrition education program. To effectively coordinate this program with NCI, produce industry leaders created the Produce for Better Health Foundation (PBH) to serve as the industry co-sponsor. NCI has granted PBH a license for use of its program and materials and for sublicensure of all industry participants. PBH is a non-profit consumer education organization funded by contributions from the produce industry. The Five A Day program consists of extensive retail promotion of the goal, consumer education, promotional efforts by produce organizations and firms, communications programs, and federal grants to local and state health authorities to conduct Five A Day program activities. (2;23)

The goal of the Five A Day program is to increase the consumption of fruits and vegetables to at least five servings a day by the year 2000. Six specific guidelines are provided:

1. Eat a variety of fruits and vegetables.
2. Eat at least one vitamin A-rich source daily.
3. Eat at least one vitamin C-rich source daily.
4. Eat at least one high fiber source daily.
5. Eat cruciferous (cabbage family) vegetables several times a week.
6. Do not substitute vitamin supplements for fresh fruits and vegetables.

Long-range goals include disseminating the message to school-aged populations, underserved populations, foodservice, and the health community. By the year 2001, the Five A Day vision is to have:

♦ Educated the consumer about the importance of consuming at least five servings of fruits and vegetables a day;

♦ Aided the mass media to place fruits and vegetables on the public agenda as an important and positive health issue and created programs at the retail level to help consumers select a wider variety of produce items;

♦ Implemented a variety of programs to promote increased produce consumption among children;

♦ Diversified programs pertaining to all ethnic, demographic, and socioeconomic populations;

♦ Secured diverse and successful partnerships for the promotion of Five A Day and achieved sufficient funding from both industry and government;

♦ Established the Five A Day goal as a component of the recommendations or promotions of other influential organizations;

♦ Implemented evaluation systems to monitor program progress and make necessary changes and measured the program's impact at appropriate intervals. (2;23;24)

Because of the scientific evidence supporting the need for increased consumption of fruits and vegetables, other agencies have joined in this effort. In 1989, the NAS published "Diet and Health Implications for Reducing Chronic Disease Risk (29)." In this report, the NAS recommended the following: 'Every day, eat five or more servings of a combination of vegetables and fruits, especially green and yellow vegetables and citrus fruits.' The 1990 USDA/DHHS "Dietary Guidelines for Americans (17)" recommends: 'Eat at least three servings of vegetables and two servings of fruits daily.' One of the "Healthy People 2000 National Health Promotion and Disease Prevention Objectives (25)" is for Americans to increase the consumption of fruits and vegetables (including legumes) to five or more daily servings. The new Food Guide Pyramid also endorses the daily consumption of at least five servings of fruits and vegetables. "Improving America's Diet and Health: From Recommendations to Action (17)," published in1991, suggested that at least five servings of fruits and vegetables be eaten per day, with an emphasis on green and yellow vegetables.

Fruit and Vegetable Consumption of Americans

The USDA has long recommended that fruits and vegetables be consumed daily because of their vitamin, mineral, and fiber content. Developed in 1957, "Food for Fitness-A Daily Food Plan" suggested at least four servings daily as essential to an adequate diet. The 1979 version of this "Hassle-Free Guide to a Better Diet" contained the same recommendations of four or more servings of fruits and vegetables daily, but added a fifth group focusing on chiefly kilocalorie sources. Based on the current Food Guide Pyramid (21), Americans should include at least two servings of fruits and three servings of vegetables in their daily diets. How many servings of fruits and vegetables does the average American consume?

Data from the Second National Health and Nutrition Examination Survey (NHANES II) are used to assess the nutrient intake of the American population. The NHANES II survey was conducted by the National Center for Health Statistics (NCHS) between 1976 and 1980. To obtain a representative sample of the civilian noninstitutionalized population six months to 74 years, a highly stratified multi-stage probability design was used. Those interviewed were 10,313 white and 1335 black adults aged 19 to 74 years. Dietary interviews included both a brief food frequency questionnaire and a 24-hour recall. (3)

According to the NHANES II, approximately 11% of the population ate neither fruits nor vegetables, 45% of the population had no servings of fruit or fruit juice, and 22% had no servings of vegetables on the recall day. About one quarter of the population consumed one serving of fruit or fruit juice and one serving of vegetables. Twenty-six percent had two servings of vegetables on the recall day. Only 29% ate the two or more servings of fruit or fruit juice and 27% consumed the three or more servings of vegetables recommended by the USDA; nine percent obtained both. Consumption of fruits and vegetables was lower among blacks than whites and among those with a lower socioeconomic level. Average fruit and fruit juice intake was somewhat higher for females than males; the opposite was true for vegetables. Although these data are ten years old, recent surveys such as the Continuing Survey of Food Intakes by Individuals (CSFII) conducted in 1985 and 1986 by the USDA and the National Health Interview Survey (HIS) conducted in 1987 by the NCHS, have shown very similar results. (3)

One of the most recent nutrient intake surveys was conducted in 1991 by the NCI and PBH. The "Five A Day Baseline Study of Americans' Fruit and Vegetable Consumption" was a nationally representative telephone survey of 2837 Americans 18 years and older. It assessed the current fruit and vegetable consumption of Americans, as well as their awareness of and attitudes toward various nutrition issues. The survey showed that the typical American eats only 3.5 servings of fruits and vegetables a day and that only 23% ate the recommended five servings or more. More alarming was the finding that 42% consumed two servings or fewer. (1;2;4-8)

In demographic breakdowns, women scored slightly higher than average in their produce consumption, at nearly four servings, with men consuming only three servings. In general, Hispanic Americans tended to eat about three servings of fruits and vegetables, compared to 3.5 for black and white Americans. Fewer servings were also eaten by less-educated consumers and those with lower incomes. Older adults (65 years and older) were found to consume nearly four servings of produce a day, while younger adults (18 to 34 years) consumed about three servings a day. (1;2;4-8)

The survey also revealed that few Americans acknowledge the significance of fruits and vegetables as part of their daily diets. Thirty-three percent of those interviewed believe that just one serving of fruit and vegetables is adequate for maintaining good health. Thirty-one percent indicated that two servings is adequate, and 25% responded that three or four servings were adequate. Only eight percent of American adults are aware that they should be consuming at least five servings of fruits and vegetables daily. (1;2;4-8)

Fruits, Vegetables, and Cancer

For several decades, it has become increasingly evident that most cancer is caused or promoted by environmental and lifestyle factors and that genetics play a very small role. In fact, current research supports the estimate that 90% of cancer incidence is related to environmental and lifestyle factors and, therefore, that most cancer is preventable. Although tobacco use is the most well-known lifestyle cause of cancer mortality, accumulating research indicates that dietary factors are possibly just as significant in cancer occurrence. The consensus among researchers is that as much as 25 to 35% of cancer mortality may be related to dietary factors. (9)

The largest number of studies have investigated the relationship between consumption of fruits and vegetables and the incidence of lung cancer. Of 32 studies conducted since 1980, a statistically significant positive association with fruits or vegetables was shown; in only two of the studies, no association was found. In a few cases a positive association has been seen only in certain gender or age groups, and it is unclear whether the assocation is stronger for fruits or for vegetables. Despite disparities in the investigations reviewed (methodologies, statistical analyses, etc.), the evidence is strong and consistent for a protective role of fruits and/or vegetables on the development of lung cancer. (10-13)

In the majority of studies conducted, a statistically significant inverse association existed between fruit and/or vegetable consumption and the following cancers: oral (10-13), pharyngeal (10-13), laryngeal (10-13), esophageal (10-13), gastric (10-12;14), bladder (10;11;13;14), rectal (10-12;14), pancreatic (10;11), and liver (13) . Controversial effects have been found for cancers of the ovary (10;11), cervix (10-12;14), breast (10;11;13;14), colon (10-12), and prostate (10;11;14). Thus, there seems to be a strong inverse relationship for fruit and vegetable consumption and cancers of the upper digestive and respiratory tracts and less protection for sites located lower in the body (13). In addition, cancers without hormone-related etiologies were more affected by fruit and vegetable consumption than the hormone-dependent cancers; i.e., ovarian, cervical, breast, and prostate cancer (11).

When differentiating between the effect of fruits versus vegetables and specific fruits and vegetables, a number of interesting associations emerge. Fruit consumption was strongly associated with a decreased incidence of oral, pharyngeal, laryngeal, and esophageal cancers. Fruit in general, lettuce, onions, tomatoes, celery, and squash seemed to protect against gastric cancer. Consumption of green leafy vegetables and carrots, which are rich in beta carotene, appeared to be associated with a lower risk of lung cancer. For pancreatic cancer, almost every study found consumption of one or more fruits or vegetables to be protective. Fruit and vegetable consumption in general, and of carrots specifically, seemed protective against bladder cancer (11).

Free Radicals

Free radicals are compounds that contain one or more unpaired electrons. They are formed daily through normal bodily processes such as the formation of prostaglandins and intracellular oxygen metabolism. In addition, environmental pollutants such as radiation, cigarette smoke, and herbicides can react to form free radicals. Although free radicals are a natural result of body chemistry, they can be detrimental. In order to stabilize itself, a free radical will bind with an electron from a stable compound, rendering the compound unstable and thus, dysfunctional. (26)

Oxygen free radicals or oxidants are normal byproducts of aerobic metabolism. Oxidants include the hydroxyl radical, hydrogen peroxide, the superoxide anion radical, and singlet molecular oxygen. (27) When uncontrolled, oxidants are capable of damaging compounds of all biochemical classes, including proteins and free amino acids, nucleic acids, carbohydrates, lipids and lipoproteins, and connective tissue macromolecules. Thus, oxidants can ultimately affect such cellular activities as metabolism, membrane function, and gene expression. (28;29)

Prime targets for oxidative reactions are the unsaturated bonds found in cellular membranes. Consequent peroxidation results in a loss of membrane fluidity and potential cellular lysis. Oxidation of sulfur-containing enzymes and other proteins culminates in cross-linking, denaturation, and inactivation. Oxidative damage to carbohydrates can alter cellular receptor functions, and damage to DNA can cause mutations which may be carcinogenic. (30)

As a result of the potential detrimental effects of oxidants, aerobic organisms have developed an elaborate antioxidant defense system that protects cells and tissues from oxidative damage. The major classes of biological antioxidants known at present are enzymes, nonenzymatic scavengers, and vitamins. Antioxidant enzymes include superoxide dismutase, catalase, and glutathione peroxidase. Nonenzymatic scavengers include uric acid, glutathione, and protein thiols. Antioxidant vitamins include vitamins C and E and beta carotene. The extent of tissue damage is dependent upon the critical balance between free radical generation and antioxidant defenses. (28;30)

Functions of the Antioxidant Vitamins

Vitamins Cand E and beta carotene are nutrients that can directly scavenge free radicals. Located inside the cells as well as in the blood, they can protect the internal structures of the cells as well as neutralize any circulating free radicals. The antioxidant vitamins often work synergistically and may help protect each other from destruction. Dependent upon their chemical structures, vitamin C, vitamin E, and beta carotene share similar as well as different antioxidant functions. (28;30)

Vitamin C (ascorbate) is water soluble and thus, interacts with free radicals in the fluid compartments of cells and in extracellular fluids. Ascorbate is considered the most important antioxidant in extracellular fluids and carries out many cellular activities of antioxidant nature as well. It can directly quench superoxide, hydroxyl radicals, hypochlorite, hydrogen peroxide, peroxyl radicals, hypochlorite, and singlet oxygen. In addition, vitamin C can also chemically regenerate vitamin E after it has been used in free radical termination reactions. (27;28;30-32)

Vitamin E, which encompasses a group of related tocopherols, is the principle lipid-soluble antioxidant in the body. It is present in all cellular membranes and is responsible for protecting the polyunsaturated fatty acids of membranes from lipid peroxidation. As with vitamin C, vitamin E can directly quench peroxyl radicals, hydrogen peroxide, superoxide, and singlet oxygen. Vitamin E may also protect the chemical bonds of beta carotene against oxidation. (27;30-32)

Beta carotene is one of a number of carotenoid pigments found in plants. In addition to its antioxidant role, beta carotene serves as a precursor of vitamin A. It is found in cellular membranes and in the serum. A high concentration of beta carotene is found in the adrenal and pituitary glands, white blood cells, the brain, platelets, and the lens of the eye. Considered the most efficient quencher of singlet oxygen in nature, beta carotene is also capable of inhibiting the oxidation of compounds by peroxyl radicals and thus, protects membranes from lipid peroxidation. Beta carotene functions efficiently at lower oxygen partial pressures; vitamin C and E are more effective at higher oxygen partial pressures. (28;30;31;33)

Evidence of Antioxidant Protection in Cancer

At present, evidence of a protective role of antioxidant nutrients is strongest in the areas of cancer, cataracts, and coronary heart disease. Increasing evidence has also shown a relationship between these nutrients and the enhancement of the immune system. In addition, a number of investigators have shown a protective effect of vitamin E in individuals with Parkinson's disease and other neurological conditions. Vitamins C and E have been shown to be capable of neutralizing toxic compounds such as nitrosamines and heavy metals which are known to be carcinogenic. (28)

Strong epidemiologic evidence exists showing a protective effect of vitamin C for nonhormone-dependent cancers. Of 46 studies in which a dietary vitamin C index was determined, 33 found statistically significant protection; high vitamin C intake conferred a twofold protective effect compared with low vitamin C intake. Of 29 investigations that assessed fruit consumption, significant protection was found in 21. For cancers of the larynx, esophagus, oral cavity, and pancreas, evidence for a protective effect of vitamin C or another component in fruit is strong and consistent. Several researchers investigating lung cancer have found significant protective effects of vitamin C or of foods containing more vitamin C than beta carotene. It is probable that vitamin C, beta carotene, and other factors in fruits and vegetables act jointly. (28;34-37)

There are several mechanisms by which vitamin C provides protection against cancer. It can function directly as an antioxidant by quenching free radicals. Vitamin C also inhibits nitrosamine formation in the gastrointestinal tract, therefore preventing the development of gastrointestinal cancers. By aiding in detoxification reactions, vitamin C can reduce the carcinogenic potential of heavy metals, pesticides, and industrial-use hydrocarbons. Lastly, vitamin C is believed to enhance the immune system by propagating its ability to remove potentially carcinogenic cells from the body. (26;28;38)

Few researchers have investigated the association of vitamin E with cancer risk. Results of these studies have been mixed. Six epidemiological studies have revealed a protective effect of vitamin E on breast, lung, and any type of cancer (39-42). An equal number have shown no association between vitamin E status and risk of lung, colon, stomach, ovarian, breast, and rectal cancers (39-42). In several of these studies, however, although the differences were not statistically significant, serum vitamin E levels were consistently lower in subjects who developed cancer than in those who did not (34-36;43;44).

Vitamin E is the body's primary means of preventing lipid peroxidation in most cells and tissues. Not only does it protect cellular membranes from peroxidation, vitamin E also aids in the repair of damaged membranes. As with vitamin C, vitamin E inhibits the formation of nitrosamines, therefore reducing the risk for cancer. Vitamin E has also been shown to enhance immune function and consequently, increase expected lifespan. (28;44)

During the last decade, over 50 epidemiological studies have consistently correlated a high intake of foods rich in beta carotene with reduced risk of lung, esophageal, gastric, colon, rectal, breast, and cervical cancer. The most consistent and strongest associations have been seen with lung cancer. Beta carotene has also been shown to reverse precancerous lesions, most notably oral lesions. (28;34;45;46)

Although epidemiologic studies do not determine cause and effect, they do show patterns which gain in significance with each recurrence. In many of the clinical trials investigating beta carotene, the correlations reported were with certain foods rather than with beta carotene itself. However, a specific correlation between beta carotene and reduced cancer risk was also observed in studies where serum levels of beta carotene were measured. In studies in which the effects of beta carotene-rich foods were differentiated from those of foods rich in other carotenoids, a stronger protective effect was shown with beta carotene-rich foods. Therefore, although it is possible that the protective factors observed in these studies could include other food components, there is strong scientific evidence that beta carotene plays a significant role. (28;34;45)

Because vitamin A has not been consistently associated with reduced cancer risk, it is postulated that the protective antioxidant function is performed by its precursor compound beta carotene. The most important antioxidant role of beta carotene is its ability to neutralize the chemically reactive singlet oxygen molecule. Singlet oxygen can impair or destroy cellular components and can lead to the formation of free radicals, also capable of causing damage. The beta carotene molecule is not destroyed by this energy transfer reaction; one molecule of beta carotene can quench up to 1000 molecules of singlet oxygen. Beta carotene is also capable of protecting lipid membranes from free radical damage and stimulating the immune system. (28;47)

Food Sources and Recommended Consumption Levels of Vitamins C and E and Beta Carotene

The highest levels of vitamin C are contained in fruits such as strawberries, melons, grapefruits, oranges, and tangerines, and vegetables such as asparagus, broccoli, green peppers, Brussels sprouts, cauliflower, snow peas, sweet potatoes, tomatoes, raw cabbage, and leafy greens such as turnip, spinach, collard, and mustard greens and kale.

The richest source of vitamin E is vegetable oils. Other good sources include seeds, nuts, whole grains, and wheat germ. In general, animal foods contain a small amount of vitamin E. Good sources of beta carotene include leafy greens, yellow-orange vegetables such as pumpkins, carrots, sweet potatoes, and winter squash, and yellow-orange fruits such as cantaloupes, papayas, apricots, mangoes, and peaches. (25;48;49) Table 2 shows the top fifteen food sources of vitamin C, vitamin E, and carotenes consumed by Americans (50).

Table 2. Top Fifteen Sources of Vitamin C, Vitamin E, and Carotenes in the American Diet (50)

	Vitamin C	**Vitamin E**	**Carotenes**
1	Orange Juice	Mayonnaise	Carrots
2	Grapefruit (and juice)	Potato chips	Tomatoes
3	Tomatoes (and juice)	Apples	Sweet potatoes
4	Fortified fruit drinks	Nuts	Yellow squash
5	Oranges	Peanut butter	Spinach (cooked)
6	Potatoes (not fried)	Oil and vinegar	Cantaloupe
7	Potatoes (fried)	Tomatoes	Mixed vegetables
8	Green salad	Margarine	Romaine lettuce
9	Other fruit juices	Sweet roll	Broccoli (raw)
10	Broccoli (raw)	Tomato sauce	Spinach (raw)
11	Coleslaw, cabbage	Sweet potatoes	Tomato sauce
12	Spaghetti and sauce	Eggs	Margarine
13	Orange juice substitute	Cold cereal	Orange juice
14	Cold cereal	Shrimp	Iceberg lettuce
15	Hot dogs, lunch meat	Cake	Pizza

Little evidence exists regarding the specific consumption levels of antioxidants necessary to reduce the risk of developing cancer. In fact, at present, only one group of investigators has suggested such intake levels. These figures are based on the consumption levels necessary to obtain antioxidant plasma levels associated with a reduced risk of cancer. The RDA for vitamin C for males and females aged 15 years and older is 60 mg per day (51); this level has also been suggested for reducing the risk of developing intestinal cancer (52). The RDA for vitamin E for males aged 15 years and older is set at 10 mg and for females of the same age group 8 mg per day (51); according to Gey et al. (52), 30-50 mg of vitamin E is the daily intake suggested for reducing the risk of developing intestinal cancer. Because beta carotene is not an essential nutrient, an RDA has not been established for this provitamin. However, a daily intake of 15 mg of beta carotene has been suggested to reduce the risk of developing lung and gastric cancer (52).

The Use of Food Records in Research

The use of food records for obtaining nutrient intakes of the free-living population has increased. There has been much debate concerning the number of days to be used in the recording process. Stuff et al. (53) recommended the use of seven day food records as opposed to the standard three day food records. However, Gersovitz et al. (54) found that record accuracy declines after the fourth day and thus, recommended the utilization of food records of no more than four days' duration. The U.S. Public Health Service obtains dietary information via one-day dietary records; they believe that a large number of accurately recorded one-day records are as reliable as a small number of seven-day records (55). When characterizing the dietary intake of a group, Chalmers et al. (55) found that the dietary record need consist of only one day.

Debate also exists concerning *which* days to use for diet records if more than one day is examined. Records containing the dietary intake of consecutive days have been found to be more reliable than those containing the intake of random days. St. Jeor et al. (56) proposed the inclusion of Saturday and/or Sunday in dietary recording in order to control for food intake variability typically found with weekends. Variability in weekend intake has been found to be particularly true among college students (55). Therefore, consecutive-day records should be used in the acquisition of dietary intake information, with at least one weekend day represented when studying college students.

Although the majority of information on food intake is based on self-report, there are limitations to the utilization of food records. Inaccuracy of recording all food items and their amounts is a primary limitation; this can be improved through training. Because attention on food intake increases when one is required to maintain a food record, normal daily food choices and consumption may be altered. (53) Finally, because food composition tables are used for the analysis of food records, only approximations of the nutrient content of the foods consumed can be derived (56).

The purpose of this thesis was to analyze food behavior patterns of a college student population in order to assess their compliance with the Five A Day recommendation relative to the intake of antioxidants vitamins C and E and beta carotene.

Objective 1. Determine the daily consumption of antioxidants.

Objective 2. Determine the daily consumption of antioxidants obtained from fruits.

Objective 3. Determine the daily consumption of antioxidants obtained from vegetables.

Objective 4. Estimate the number of servings of fruits and vegetables consumed daily.

Objective 5. Compare the levels of antioxidants obtained from the consumption of various numbers of servings of fruits and vegetables with Five A Day compliance.

CHAPTER III

METHODOLOGY

Subject Selection The subject population included male and female Virginia Tech students enrolled in the Fall 1992 introductory nutrition course (HNF 1004). Three-day dietary records, required as part of the course, were alphabetized by the subject's gender and every second record was chosen. A research protocol and consent form was approved by the Human Subject Review Board (Appendix A).

Diet Records

Graduate teaching assistants (GTAs) explained the directions for completion of three-day dietary records (3DRs) during the second week of classes (Appendix B). A sample record sheet is shown in Appendix C. Students recorded all foods and beverages (except water) consumed during the three days designated, describing the item (brand, variety, preparation method, etc.) and the amount or portion size eaten. To estimate portion sizes, students were provided with two-dimensional drawings of portion sizes of common food and beverage items (Appendix D). In addition, a 15 minute demonstration was given during class time to illustrate portion sizes utilizing food models and measuring utensils common to university dining halls and local food services. Students were advised to obtain help, if necessary, from the GTAs relative to the 3DR.

As 3DRs were coded, inadequate records were excluded and were replaced with another randomly selected diet record in order to obtain at least 200 records. Records considered to be inadequate included those containing:

1. two or more unknown food/beverage items (e.g. conscons, mystic drink),
2. two or more foods with unspecified portion sizes,
3. a three day average caloric intake of less than 800 or greater than 5000,

and

4. illegible writing.

Reliability

Using the Nutritionist IV software package code listings (57), all foods and beverages were coded by two graduate students. To ensure consistency in coding, all coding decisions made by the two coders (the investigator and colleague) regarding any unclear item were recorded. In addition, the following information was recorded:

♦ code numbers of foods/beverages with different varieties, processing methods, or preparation methods (e.g., fruits and vegetables, canned vs. fresh vegetables, fried vs. baked chicken)

♦ code numbers for all food/beverage items designated as a "fruit" or "vegetable"

♦ the break down of combination foods to constituent components and proportions according to the Joy of Cooking Cook Book (58) (e.g., pizza, apple pie, and beef stew)

♦ any vaguely described food or beverage (e.g., Appendix E)

♦ any additional discrepancies.

To ensure that data were entered into the computer accurately, the investigator and colleague compared each 3DR completed by the student against the data entered for that 3DR. Two reliability tests were then administered. One tested for the consistency between the two coders in coding food and beverage items and the other tested for consistency in defining portion sizes. After coding five 3DRs separately, the investigator and colleague compared foods and beverages and corresponding portion sizes. The number of consistently coded versus the number inconsistently coded were used to determine the percent reliability of the data for both the food items and the portion sizes. The following equations were used:

$$\frac{\text{number of foods and beverages coded correctly}}{\text{total number of foods and beverages coded}} \times 100 = \text{Percent Reliability of Food Items Coded}$$

$$\frac{\text{number of portion sizes coded correctly}}{\text{total number of portion sizes coded}} \times 100 = \text{Percent Reliability of Portion Sizes Coded}$$

If a reliability score of 90% or higher was not obtained, the investigator and colleague coded ten 3DRs together until this score was achieved. This protocol was followed prior to entering data into the computer and was repeated with each subsequent 25 3DRs to ensure consistency in coding decisions.

Dietary Analysis

Analysis of the 3DRs was carried out using the Nutritionist IV nutrient analysis software package (57). The following variables were measured or described:

1. Consumption Levels of Antioxidants and Antioxidant Activity

The three day averages of antioxidants (espressed in mg) and antioxidant activities (expressed in mmol) were determined from the total diet, from fruits specifically and vegetables specifically, and from fruits and vegetables combined. Antioxidant consumption was derived from foods and beverages only; vitamin and mineral supplements and foods fortified with more than 100% of the RDA for vitamins or minerals (e.g., Total cereal, Rapid Weight Gain Beverage, Exceed Carbo-Fluid, etc.) were excluded from the analysis.

Consumption levels of vitamins C and E and beta carotene were expressed in mg. Nutritionist IV analysis expressed vitamins C and E in mg and beta carotene in retinol equivalents (RE). Therefore, mathematical conversion was necessary only for beta carotene. To convert retinol equivalents of beta carotene to micrograms, beta carotene values in RE units were multipled by a factor of six. Values were then divided by 1000 to convert micrograms to milligrams.

The antioxidant activity of vitamins C and E and beta carotene were also determined by converting antioxidant consumption levels to molar units. Based on the molecular weights of the antioxidants (vitamin C = 176; vitamin E = 431; beta carotene = 537), the following formula was used for conversion:

$$\text{micromoles} = \frac{\text{micrograms of antioxidant}}{\text{molecular weight of antioxidant}}$$

2. Number of Servings of Fruits and Vegetables Consumed

The three day averages of the number of servings of fruits, vegetables, and fruits and vegetables consumed were determined. Researchers determined which food and beverage items were regarded as a "fruit" or "vegetable" and recorded the corresponding code numbers in the code book to validate future coding. According to the Five A Day program (4) and the researcher's interpretation, the following items were designated as a "fruit" or "vegetable" (14):

1. All fruits and vegetables except avocados, coconut, olives, or nuts.
2. All fruits and vegetables processed by freezing, drying, or canning.
3. All juice products containing at least 10% fruit juice (lemonade not made from concentrate and any type of fruit punches, aides, drinks, and sodas were excluded; cocktails made with real fruit juice were included).

Items not considered a fruit or vegetable in this investigation were fruits contained in bagels, breads, cookies, cereals, or yogurt, condiments (e.g., barbecue sauce, catsup, relish, jelly, jams), and vegetables deep fried in fat (e.g., french fries, hash browns, and onion rings). Exclusion of these items was based on the assumption that their antioxidant content was insignificant due to either the presence of a negligible amount of fruit or vegetable or destruction of antioxidants by frying. These foods were included in the analysis of the total nutrient intake of the diet, but were disregarded in the fruit and vegetable analyses.

Based on the Five A Day program definitions (4), serving sizes of fruits and vegetables, as specified in Table 3, were then determined. Based on USDA recommendations (59), combination foods were broken down to their constituent components and portions of these components according to a comprehensive cook book typifying most regional recipes (58); thus, serving sizes were determined from these recipes. Based on the methodology of Johnson et al.(60), portions less than 1/4 of a serving were not included in the determination of the total number of servings of fruits and vegetables consumed. The average number of servings consumed was expressed to the nearest half serving.

Table 3. One Serving of Fruits and Vegetables According to the "Five A Day Program" (1) and the "Food Guide Pyramid" (21)

Five A Day Program	Food Guide Pyramid
1 medium piece of fruit	1 medium apple, orange, banana
1/2 cup raw fruit	1/2 cup chopped, cooked, or canned fruit
3/4 cup fruit or vegetable juice	3/4 cup fruit or vegetable juice
1 cup raw, leafy vegetable	1 cup raw, leafy vegetable
1/2 cup cooked or canned* vegetable	1/2 cup other vegetable, cooked, canned*, or chopped raw
1/4 cup dried fruit	1/4 cup dried fruit*

* included based on standards of previous food guides

3. Comparison of the Levels of Antioxidants and Number of Servings of Fruits and Vegetables Consumed

The relationship between the level of antioxidants obtained from the number of servings of fruits and vegetables, alone and combined was described. Six serving ranges were used in this comparison: 0.1 to 1.9, 1.0 to 1.9, 2.0 to 2.9, 3.0 to 3.9, 4.0 to 4.9, and ≥ 5.0 servings.

Descriptive Statistics

Consumption levels of antioxidants and the number of servings of fruits and vegetables consumed were assessed. Mean values of each were determined for male and female subjects. Because antioxidant consumption levels varied from zero to very high levels, both means and medians were determined. For the same reason, ranges were determined rather than standard deviations. Inferential statistics were not carried out because attainment of the research objectives did not require them.

CHAPTER IV

RESULTS

Sample Population

Subjects included 95 male and 122 female Virginia Tech students enrolled in the HNF 1004 introductory nutrition course. The sample size represented approximately 60% of the total number of undergraduate students enrolled in the HNF 1004 course. Approximately half of the subjects were freshmen or sophomores and the other half were juniors or seniors.

Diet Records

A total of 217 diet records were analyzed. Ten of the originally selected 3DRs were considered inadequate and were replaced; two 3DRs contained two or more food items that were not included in the data base, one was illegible, and seven had an average daily caloric intake of less than 800 or greater than 5000.

Reliability

Table 4 shows the scores of the two reliability tests conducted four times throughout the investigation. Reliability test scores indicated consistency between investigators in coding.

Table 4. Scores of Reliability Tests Obtained on Four Occasions

Date	Reliability of Food Items Coded (%)	Reliability of Portion Sizes Coded (%)
11/05/92	98	100
11/12/92	100	100
11/19/92	100	100
11/26/92	100	100

Consumption Levels of Antioxidants and Antioxidant Activity

Consumption Levels of Antioxidants

For all antioxidant consumption levels and antioxidant activities assessed, median values were lower than average values. Therefore, average values were positively skewed by individuals with excessively high antioxidant intakes. Median values indicate that the majority of subjects consumed lower levels of antioxidants than revealed through average values. However, for the purpose of this study, average values will be discussed.

The average daily amounts of antioxidants obtained from the consumption of fruits are shown in Table 5. College students obtained an average of 61 mg of vitamin C (RDA=60 mg) (51), 0.6 mg of vitamin E (RDA=8 and 10 mg) (51), and 0.7 mg of beta carotene (RDA does not exist) from fruits. Males obtained a slightly higher level of vitamin C than females (65 vs. 59 mg, respectively), whereas females obtained a slightly higher level of

Table 5. Average Three-Day Consumption of Antioxidants Obtained from Fruits by College Students

Antioxidants	**Gender**		
	Male (95)	**Female (122)**	**Both (217)**
Vitamin C (mg)			
Mean	65	59	61
Median	36	38	38
Range	0-301	0-521	0-521
Vitamin E (mg)			
Mean	0.6	0.6	0.6
Median	0.4	0.4	0.4
Range	0.0-2.5	0.0-2.9	0.0-2.9
Beta Carotene (mg)			
Mean	0.7	0.8	0.7
Median	0.5	0.5	0.5
Range	0.0-3.6	0.0-4.4	0.0-4.4

beta carotene than males (0.8 vs. 0.7 mg, respectively). Both genders obtained 0.6 mg of vitamin E from fruits.

Table 6 shows the average daily consumption of antioxidants obtained from vegetables by college students. College students obtained an average of 38 mg of vitamin C, 1.5 mg of vitamin E, and 8.7 mg of beta carotene from vegetables. Levels of vitamin C otained from vegetables were higher for male subjects than for female subjects (42 vs. 35 mg, respectively). Males also obtained more vitamin E than females (1.7 vs. 1.3 mg, respectively). Comparing beta carotene levels, however, females obtained a higher level than males (9.7 vs. 7.6 mg, respectively).

Table 6. Average Three-Day Consumption of Antioxidants Obtained from Vegetables by College Students

Antioxidants	**Gender**		
	Male (95)	**Female (122)**	**Both (217)**
Vitamin C (mg)			
Mean	42	35	38
Median	28	25	26
Range	1-238	1-141	1-238
Vitamin E (mg)			
Mean	1.7	1.3	1.5
Median	1.6	1.0	1.1
Range	0.2-8.5	0.0-6.1	0.0-8.5
Beta Carotene (mg)			
Mean	7.6	9.7	8.7
Median	2.1	2.4	2.3
Range	0.0-62.2	0.0-74.4	0.0-74.4

The average daily amounts of antioxidants obtained from the consumption of fruits and vegetables are shown in Table 7. College students obtained an average of 99 mg of vitamin C, 2.1 mg of vitamin E, and 9.4 mg of beta carotene from fruits and vegetables. Compared to female subjects, male subjects obtained higher levels of vitamin C (107 vs.

Table 7. Average Three-Day Consumption of Antioxidants Obtained from Fruits and Vegetables by College Students

Antioxidants	Gender		
	Male (95)	Female (122)	Both (217)
Vitamin C (mg)			
Mean	107	94	99
Median	88	78	81
Range	1-495	4-552	1-552
Vitamin E (mg)			
Mean	2.3	1.9	2.1
Median	2.0	1.6	1.7
Range	0.2-9.2	0.3-6.8	0.2-9.2
Beta Carotene (mg)			
Mean	8.2	10.4	9.4
Median	2.5	3.9	3.1
Range	0.1-64.3	0.1-75.1	0.1-75.1

94 mg, respectively) and vitamin E (2.3 vs. 1.9 mg, respectively) from fruits and vegetables. However, females obtained a higher level of beta carotene from fruits and vegetables than males (10.4 vs. 8.2 mg, respectively).

Table 8 shows the average daily consumption of antioxidants obtained from the total diets (all foods). College students obtained an average of 122 mg of vitamin C, 12.4 mg of vitamin E, and 9.7 mg of beta carotene from total diets. Male subjects obtained 133 mg of vitamin C from all foods while female subjects obtained 114 mg. Vitamin E consumption levels were also higher for males than for females (14.0 vs. 11.3 mg, respectively). Females, however, obtained a higher level of beta carotene than males (10.6 vs. 8.5 mg, respectively).

Table 8. Average Three-Day Consumption of Antioxidants Obtained from the Total Diets of College Students

Antioxidants	Gender		
	Male (95)	Female (122)	Both (217)
Vitamin C (mg)			
Mean	133	114	122
Median	118	91	102
Range	13-501	9-625	9-625
Vitamin E (mg)			
Mean	14.0	11.3	12.4
Median	12.4	8.7	10.0
Range	2.4-59.5	2.7-50.1	2.4-59.5
Beta Carotene (mg)			
Mean	8.5	10.6	9.7
Median	2.8	4.1	3.3
Range	0.1-64.3	0.1-75.1	0.1-75.1

Antioxidant Activity

Tables 9 through 12 show the average daily antioxidant activity obtained from the consumption of fruits, vegetables, fruits and vegetables, and the total diets of college students. For all food categories, vitamin C contributed the majority of total antioxidant activity. For fruit intake of college students, vitamin E contributed approximately the same level of antioxidant activity as beta carotene (1.4 vs. 1.3 μmol, respectively). For vegetable as well as fruit and vegetable consumption, beta carotene contributed more antioxidant activity than vitamin E (16.2 vs. 3.5 μmol and 17.5 vs. 4.9 μmol, respectively). Vitamin E contributed more antioxidant activity to the total diets of college students than beta carotene (28.8 vs. 18.0 μmol, respectively).

Table 9. Average Daily Antioxidant Activity Obtained from the Consumption of Fruits by College Students

Antioxidant Activity	**Gender**		
	Male (95)	**Female (122)**	**Both (217)**
Vitamin C (mmol)			
Mean	369	335	347
Median	205	216	216
Range	0-1710	0-2960	0-2960
Vitamin E (mmol)			
Mean	1.4	1.4	1.4
Median	0.9	0.9	0.9
Range	0.0-5.8	0.0-6.7	0.0-6.7
Beta Carotene (mmol)			
Mean	1.2	1.4	1.3
Median	0.9	0.9	0.9
Range	0.0-5.6	0.0-8.2	0.0-8.2
Total (mmol)			
Mean	372	338	350
Median	207	218	218
Range	0-1721	0-2975	0-2975

Table 10. Average Daily Antioxidant Activity Obtained from the Consumption of Vegetables by College Students

Antioxidant Activity	Gender		
	Male (95)	Female (122)	Both (217)
Vitamin C (mmol)			
Mean	239	199	216
Median	159	142	148
Range	6-1352	6-801	6-1352
Vitamin E (mmol)			
Mean	3.9	3.0	3.5
Median	3.7	2.3	2.6
Range	0.5-19.7	0.0-14.2	0.0-19.7
Beta Carotene (mmol)			
Mean	14.1	18.0	16.2
Median	3.9	4.5	4.3
Range	0.0-115.9	0.0-138.5	0.0-138.5
Total (mmol)			
Mean	257	220	236
Median	167	149	155
Range	7-1488	6-954	6-1510

Table 11. Average Daily Antioxidant Activity Obtained from the Consumption of Fruits and Vegetables by College Students

Antioxidant Activity	**Gender**		
	Male (95)	**Female (122)**	**Both (217)**
Vitamin C (mmol)			
Mean	608	534	563
Median	500	443	460
Range	6-2813	23-3136	6-3136
Vitamin E (mmol)			
Mean	5.3	4.4	4.9
Median	4.6	3.7	3.9
Range	0.5-21.3	0.7-15.8	0.5-21.3
Beta Carotene (mmol)			
Mean	15.3	19.3	17.5
Median	4.7	7.3	5.8
Range	0.1-119.6	0.1-139.8	0.1-139.8
Total (mmol)			
Mean	629	558	585
Median	509	443	460
Range	7-2954	24-3292	7-3297

Table 12. Average Daily Antioxidant Activity Obtained from the Consumption of the Total Diets of College Students

Antioxidant Activity	Gender		
	Male (95)	Female (122)	Both (217)
Vitamin C (mmol)			
Mean	756	648	693
Median	670	517	580
Range	74-2847	51-3551	51-3551
Vitamin E (mmol)			
Mean	32.5	26.2	28.8
Median	28.8	20.2	23.2
Range	5.6-138.1	6.3-116.2	5.6-138.1
Beta Carotene (mmol)			
Mean	15.8	19.7	18.0
Median	5.2	7.6	6.1
Range	0.1-119.6	0.1-139.8	0.1-139.8
Total (mmol)			
Mean	804	694	740
Median	704	545	609
Range	80-3105	57-3807	57-3829

Number of Servings of Fruits and Vegetables Consumed

The average daily number of servings of fruits consumed by college students is shown in Table 13. Thirty-two percent of male college students and 34% of female college students consumed the recommended two or more servings of fruits daily. Therefore, 34% of male and female college students consumed at least two servings of fruits daily. The largest percentage of males (34%) and females (36%) consumed 1.0 to 1.9 servings of fruits. Male subjects consumed an average of 1.8 servings of fruits daily compared to an average of 1.7 servings consumed by female subjects.

Table 13. Average Number of Servings of Fruits Consumed Daily by College Students

Number of Servings	Males (95)		Females (122)		Both (217)	
	N	%	N	%	N	%
0.0	22	23	15	12	37	17
0.1-0.9	10	11	29	24	39	18
1.0-1.9	32	34	36	30	68	31
2.0-2.9	11	12	22	18	33	15
3.0-3.9	8	8	15	12	23	11
4.0-4.9	5	5	2	2	7	3
≥ 5.0	7	7	3	2	10	5

As seen in Table 14, 31% of male college students and 23% of female college students consumed the recommended three or more servings of vegetables daily. Overall, 26% of male and female college students consumed at least three servings of vegetables daily. Almost one third of males and females consumed 1.0 to 1.9 servings of vegetables, the serving range consumed by the largest proportion of subjects. Male subjects consumed an average of 2.6 servings of vegetables daily compared to an average of 2.1 servings consumed by female subjects.

Table 14. Average Number of Servings of Vegetables Consumed Daily by College Students

Number of Servings	Males (95)		Females (122)		Both (217)	
	N	%	N	%	N	%
0.0	0	0	0	0	0	0
0.1-0.9	14	15	25	20	39	18
1.0-1.9	27	28	39	32	66	31
2.0-2.9	25	26	30	25	55	25
3.0-3.9	11	12	18	15	29	13
4.0-4.9	7	7	8	6	15	7
≥ 5.0	11	12	2	2	13	6

Table 15 shows the average number of servings of fruits and vegetables consumed daily by college students. Twenty-eight percent of males and 25% of females consumed five or more servings of fruits and vegetables, the level recommended by the Five A Day program. Of the total population, 26% of male and female college students obtained five or more servings of fruits and vegetables. Compared to all other serving ranges, the largest proportion of subjects consumed five or more servings. The average number of servings of fruits and vegetables consumed was 4.4 for males and 3.8 for females.

Table 15. Average Number of Servings of Fruits and Vegetables Consumed Daily by College Students

Number of Servings	Males (95)		Females (122)		Both (217)	
	N	%	N	%	N	%
0.0	0	0	0	0	0	0
0.1-0.9	4	4	7	6	11	5
1.0-1.9	14	15	16	13	30	14
2.0-2.9	19	20	26	21	45	21
3.0-3.9	18	19	27	22	45	21
4.0-4.9	13	14	16	13	29	13
≥ 5.0	27	28	30	25	57	26

Comparison of the Levels of Antioxidants and Number of Servings of Fruits and Vegetables Consumed

The consumption levels of antioxidants obtained from different numbers of servings of fruits, vegetables, and fruits and vegetables are depicted in Figures 2, 3, and 4. In general, antioxidant levels increased with increasing number of servings of fruits, vegetables, and fruits and vegetables consumed. There were four exceptions to this observation. The level of vitamin E obtained from the consumption of 4.0 to 4.9 servings of fruits, vegetables, as well as fruits and vegetables was lower than that obtained from the consumption of 3.0 to 3.9 servings. In addition, vitamin C obtained from the consumption of 4.0 to 4.9 servings of vegetables was also lower than that obtained from the consumption of 3.0 to 3.9 servings.

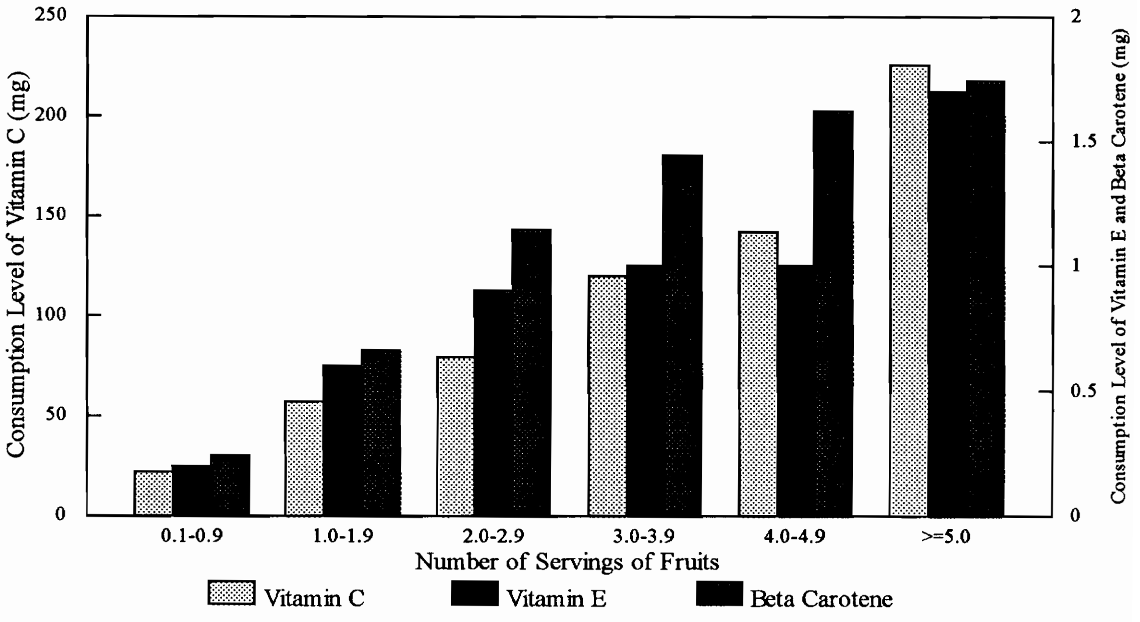


Figure 2. Antioxidant levels obtained from the three-day average consumption of varying numbers of servings of fruits by college students (N=217).

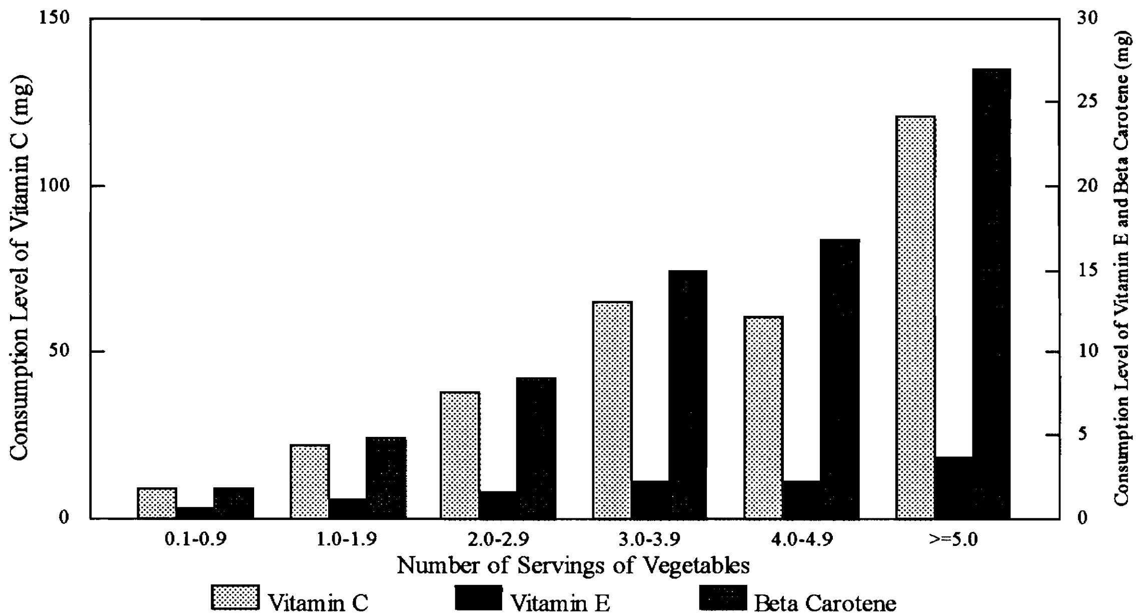


Figure 3. Antioxidant levels obtained from the three-day average consumption of varying numbers of servings of vegetables by college students (N=217).

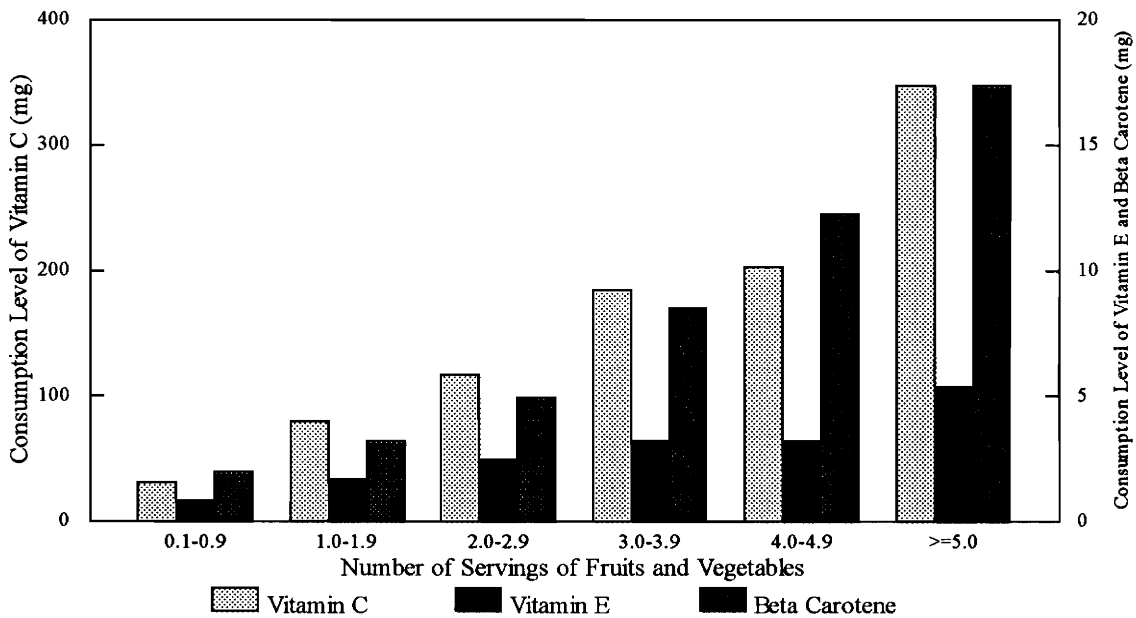


Figure 4. Antioxidant levels obtained from the three-day average consumption of varying numbers of servings of fruits and vegetables by college students (N=217).

An interesting trend can be seen in all of these figures. As expected, the levels of antioxidants obtained from 1.0 to 1.9 servings of fruits, vegetables, or fruits and vegetables consumed is approximately double those obtained from the consumption of 0.1 to 0.9 serving. However, this proportional increase does not occur for the remainder of the serving ranges; antioxidant levels obtained per serving seem to decrease as the number of servings increases. This trend did not hold true for the ≥ 5.0 serving range because the number of servings consumed may have been much greater than five and thus, consumption levels of antioxidants would have been greatly increased.

CHAPTER V

DISCUSSION

Consumption Levels of Antioxidants and Antioxidant Activity

Consumption Levels of Antioxidants

The average amount of vitamin C obtained by college students in this study (122 mg) was twice that of the 1989 RDA (51) and the level recommended to reduce the risk of developing intestinal cancer (51), both of which are 60 mg. Approximately half of the total amount of vitamin C was obtained from fruits. Compared to the RDA, college students also obtained a more than adequate amount of vitamin E (12.4 mg). Conversely, they obtained less than half the amount recommended to reduce the risk of developing intestinal cancer; i.e., 30-50 mg (52). The majority of vitamin E was obtained from foods other than fruits and vegetables. College students obtained more than half the daily intake of beta carotene suggested to reduce the risk of developing lung and gastric cancer (9.7 vs. 15 mg) (52); an RDA has not yet been established for beta carotene. Vegetable consumption provided nearly all of the beta carotene obtained.

Table 16 shows the percent of students in this study meeting 70% and 100% of the RDA for vitamin C and E (51) and 70% and 100% of the level of beta carotene recommended to reduce the risk of developing cancer (52). Seventy percent of the students obtained 100% of the RDA for vitamin C while 82% obtained 70% of the RDA. The majority of vitamin C was obtained from fruit and vegetable consumption, with a small percentage coming from foods other than fruits and vegetables (i.e., whole grains). This value for vitamin C differs greatly from that reported by Hertzler and Frary (61) where 18% of the college students studied consumed <70% of the RDA for vitamin C. For vitamin E, 61% met 100% of the RDA and 85% met 70% of the RDA. Virtually all of the vitamin E consumed was obtained from foods other than fruits and vegetables (i.e., vegetable oil, whole grains, and nuts). Twenty-one percent and 29% of the students met 100% and 70% of the level of beta carotene recommended to reduce the risk of developing cancer, respectively. The majority of beta carotene consumed was obtained from vegetable consumption, with a small percentage coming from foods other than fruits and vegetables (whole grains).

Table 16. Percent of Students Meeting 70% and 100% of the RDA for Vitamins C and E (51) and 70% and 100% of the Level of Beta Carotene Recommended to Reduce the Risk of Developing Cancer (52)

Antioxidant Obtained from Food Category	**Percent Students Meeting Recommendation**	
	70% Level	**100% Level**
Vitamin C		
Fruits	47	41
Vegetables	30	18
Total Diet	82	70
Vitamin E		
Fruits	0	0
Vegetables	1	0
Total Diet	85	61
Beta Carotene		
Fruits	0	0
Vegetables	25	18
Total Diet	29	21

Figures 5 through 7 show the percent of antioxidant levels recommended to reduce the risk of developing cancer (52) obtained from the consumption of various numbers of servings of fruits, vegetables, and fruits and vegetables combined. Consumption of the Five A Day recommended two or more servings of fruits provided at least 132% of vitamin C, 3% of vitamin E, and 8% of beta carotene recommended to reduce cancer risk. Consumption of the recommended three or more servings of vegetables provided at least

108% of vitamin C, 7% of vitamin E, and 100% of beta carotene recommended. Consumption of the recommended five or more servings of fruits and vegetables provided at least 290% of vitamin C, 11% of vitamin E, and 116% of beta carotene recommended. It should be noted that exact combinations of the number of servings of fruits and vegetables consumed was unknown; i.e., five servings of fruits and vegetables may represent any combination of fruits and vegetables. Thus, the daily consumption of five fruits and vegetables provided college students with levels of vitamin C and beta carotene recommended to reduce cancer risk but a marginal level of vitamin E, which is contained primarily in foods other than fruits and vegetables.

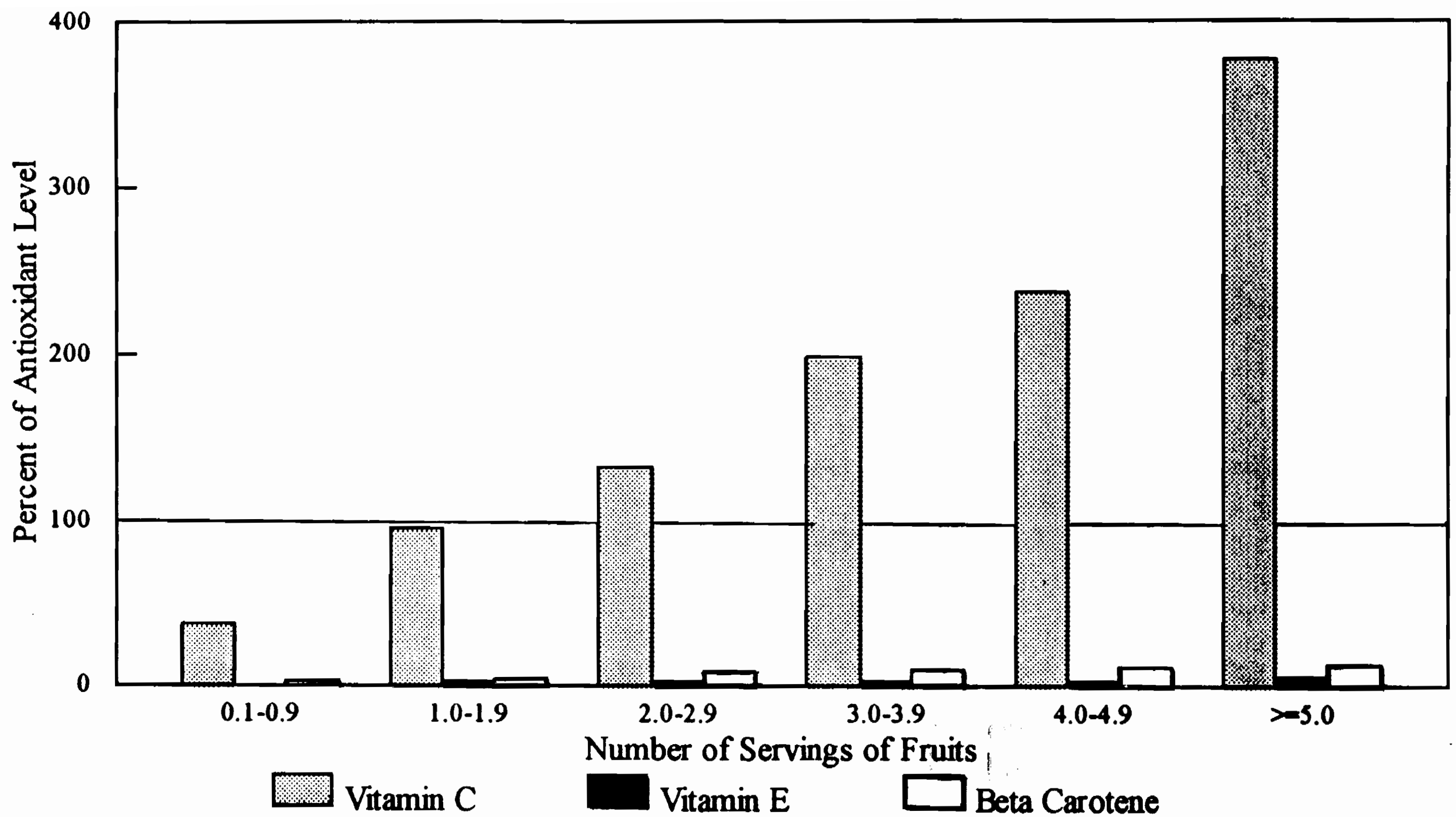


Figure 5. Percent of antioxidant levels recommended to reduce the risk of developing cancer (52) obtained from the consumption of various numbers of servings of fruits by college students (N=217).

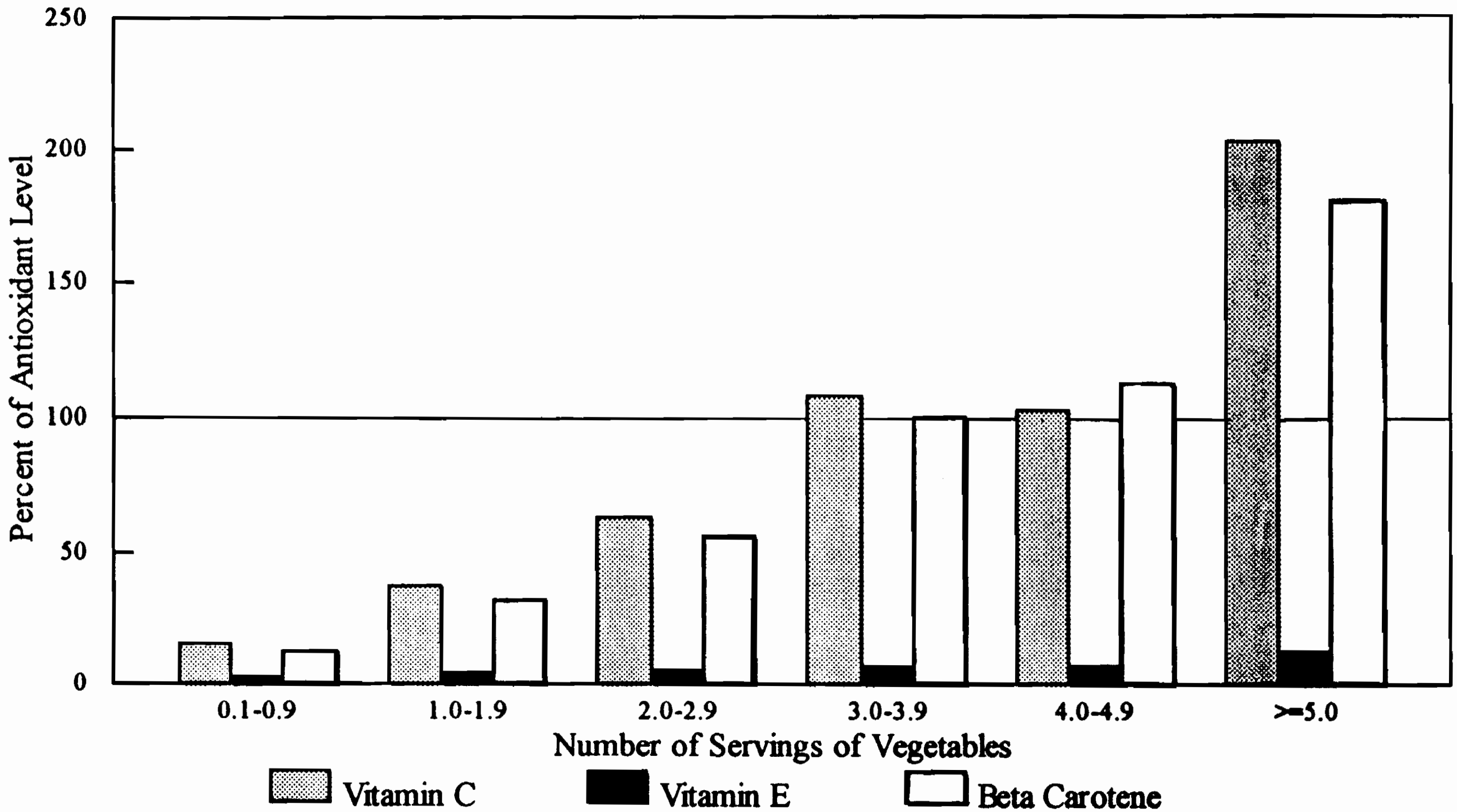


Figure 6. Percent of antioxidant levels recommended to reduce the risk of developing cancer (52) obtained from the consumption of various numbers of servings of vegetables by college students (N=217).

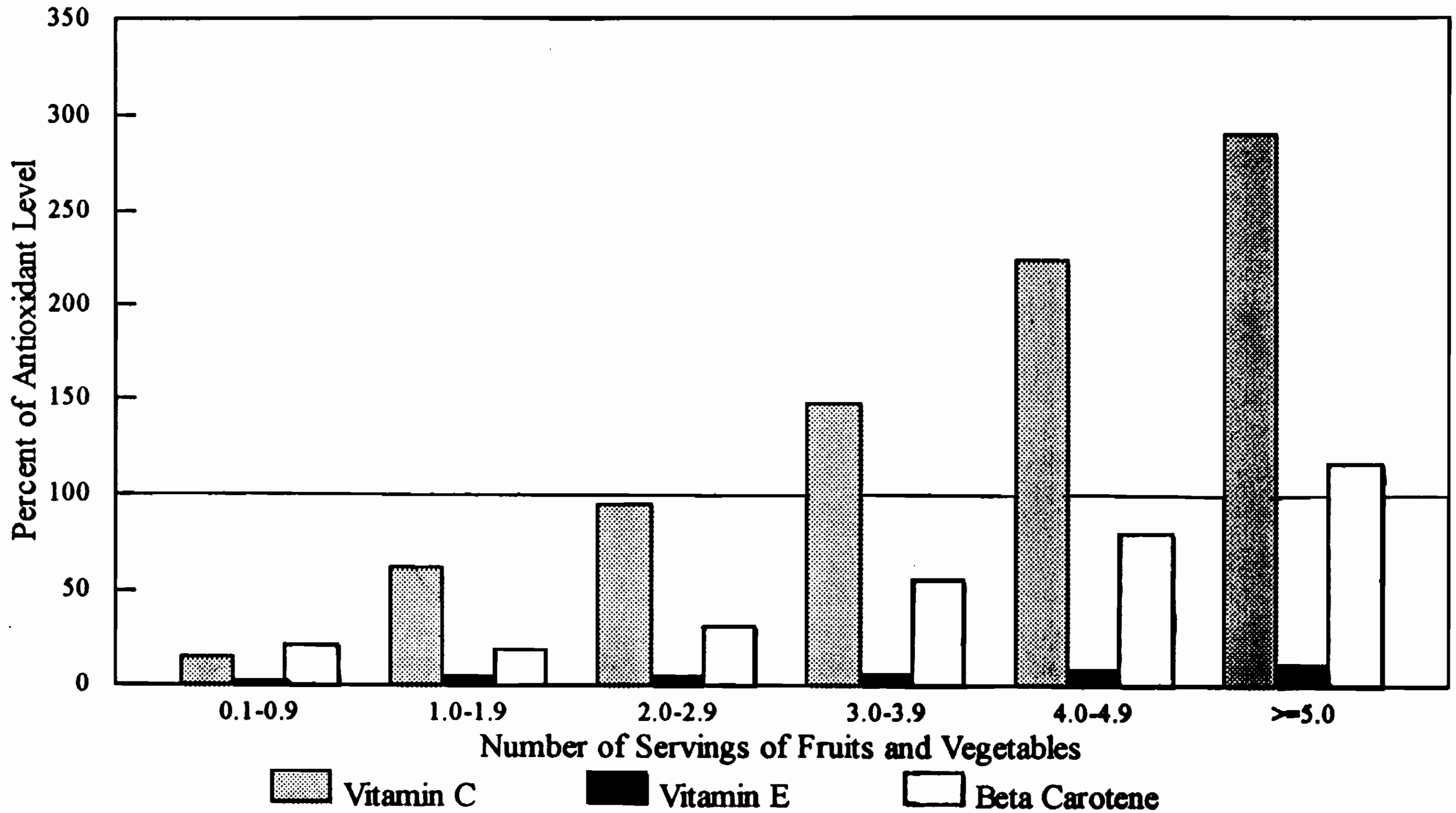


Figure 7. Percent of antioxidant levels recommended to reduce the risk of developing cancer (52) obtained from the consumption of various numbers of servings of fruits and vegetables by college students (N=217).

When comparing the level of antioxidant consumption by gender, male college students obtained more vitamin C from fruits, vegetables, fruits and vegetables, and the total diet than female college students. With the exception of fruits, males also obtained more vitamin E from all food categories than females; both genders consumed the same amount of vitamin E from fruits. Female subjects obtained more beta carotene from all food categories than male subjects. Because total caloric intake is generally higher for males than females, higher intakes of antioxidants for males were expected. Very little vitamin E is found in fruits; therefore, an equivalent amount obtained by males and females is not surprising. However, it is surprising that females obtained more beta carotene than males even though vegetable intake, the major source of beta carotene, was found to be higher for males than for females. Thus, it can be postulated that female subjects chose vegetables with higher beta carotene contents than those chosen by male subjects.

Antioxidant Activity

It should be noted that antioxidant functions may be specific to the antioxidant as well as interrelated (28;30). Because vitamin C is the major antioxidant contained in fruits and vegetables, vitamin C was found to contribute the majority of antioxidant activity from fruits, vegetables, fruits and vegetables, and the total diets of college students. The antioxidant activity of beta carotene was more significant for vegetables than for fruits. This was expected since vegetables, in general, contain a greater amount of beta carotene per serving than fruits and since a greater number of servings of vegetables than fruits were consumed. Because fruits and vegetables contain only trace amounts of vitamin E, the majority of the antioxidant activity of vitamin E was obtained from the consumption of foods other than fruits and vegetables.

Number of Servings of Fruits and Vegetables Consumed

Although the dietary patterns of college students specifically have not been the focus of many studies, several assessments have been conducted on the general American population. According to the NHANES II, 29% of Americans consumed the two or more servings of fruits and 27% consumed the three or more servings of vegetables recommended by the USDA; only nine percent obtained five or more servings of fruits and vegetables (3). In contrast to the present investigation, 34% of college students consumed at least two servings of fruits daily, 26% consumed at least three servings of vegetables daily, and 26% consumed five or more servings of fruits and vegetables daily. Whereas the present study revealed that males consumed a greater average number of servings of both fruits and vegetables than females, the NHANES II reported that fruit intake was higher among females than males and vegetable intake was higher among males than females.

In the "Five A Day Baseline Study of Americans' Fruit and Vegetable Consumption" the typical American was found to eat 3.5 servings of fruits and vegetables a day (7). This value was slightly lower than the 4.1 servings found to be consumed by college students in the present study. Both studies showed that approximately one quarter of the population assessed consumed the recommended five servings or more of fruits and vegetables. Comparing the number of servings of fruits and vegetables consumed daily by males versus females, the Five A Day Baseline Study revealed that males obtained approximately three servings and females obtained almost four servings. Conversely, the present investigation revealed that college males consumed 4.4 servings of fruits and vegetables while college females consumed 3.8 servings.

Comparison of the Levels of Antioxidants and Number of Servings of Fruits and Vegetables Consumed

As expected, antioxidant levels increased with increasing numbers of servings of fruits, vegetables, and fruits and vegetables consumed. Exceptions were seen for levels of vitamin E obtained from the three food categories ("fruits," "vegetables," and fruits and vegetables") and vitamin C obtained from vegetables; antioxidant levels were lower with the consumption of 4.0 to 4.9 servings than with the consumption of 3.0 to 3.9 servings. These inconsistencies may have occurred due to differences in specific fruit and vegetable choices; foods selected at the 3.0 to 3.9 serving range were probably better sources of vitamin E and C than those selected at the 4.0 to 4.9 serving range.

Another trend seen was that the level of antioxidants obtained per serving of fruits and/or vegetables consumed decreased as the number of servings increased. This phenomenon was also probably due to differences in specific fruit and vegetable choices. College students who consumed only one or two servings of fruits and/or vegetables seemed to choose those which are good sources of antioxidants. As fruit and/or vegetable intake increased above two servings, however, choices seemed to be fruits and/or vegetables containing lower concentrations of antioxidants.

This theory is supported by observations of Byers and Perry (50). According to these investigators, tomato sauce is one of the top fifteen sources of vitamin E and C and orange juice is the top source of vitamin C consumed by Americans. In the present study, the most commonly consumed vegetable was found to be tomato sauce (found in pizza and spaghetti) and one of the most commonly consumed fruits was orange juice. Therefore, because these foods are the major sources of vitamins E and C in the diets of college students, the highest level of antioxidants per serving would be found for the first one and two servings of fruits and/or vegetables consumed.

CHAPTER V

IMPLICATIONS

How does one educate the lay public on the issue of antioxidants? Much debate exists whether antioxidants themselves or whether other constituents contained in fruits and vegetables, such as fiber, sulforaphane, or the absence of fat, are responsible for a reduction in the risk of cancer development. Therefore, the consumption of food sources rich in antioxidants should be advocated rather than specific antioxidants (61;62). Table 17 shows the portion sizes of different fruits and vegetables needed in order to obtain the recommended level of vitamin C and beta carotene to reduce the risk of developing cancer (63). Vitamin E is found predominately in foods other than fruits and vegetables.

Table 17. Portion Sizes of Various Fruits and Vegetables Meeting the Recommended Levels of Vitamin C and Beta Carotene to Reduce the Risk of Developing Cancer (64)

Vitamin C (Approximately 60 mg)	**Beta Carotene (Approximately 15 mg)**
1 cup cauliflower	1/2 cup cooked sweet potatoes
2 cups tomato sauce	1 1/2 medium carrots
1 grapefruit	1 1/2 cantaloupes
1/2 cup orange juice	7 cups cooked collard greens
12 cups raisins	12 cups cooked broccoli

On January 6, 1993, the Food and Drug Administration (FDA) released labeling regulations that require scientific justification for health claims manufacturers make for food and dietary supplements. Six of the seven specific health claims are related to fruits and vegetables (65):

- excess dietary fat increases cancer risk
- excess dietary saturated fat and cholesterol increase heart disease risk

- excess sodium increases hypertension risk
- fruits, vegetables, and grains that contain soluble fiber decrease heart disease risk
- fiber-containing grain products, fruits, and vegetables decrease cancer risk
- fruits and vegetables decrease cancer risk

As with any nutrient, in order to obtain the recommended level, the consumption of food and beverage sources should be emphasized whereas the consumption of supplements should be discouraged.

Because beta carotene and other carotenoids are fairly new compounds under investigation, few resources regarding their content in foods and beverages are available. A new database was developed by the Agricultural Research Service (ARS) and the National Cancer Institute to aid in the assessment of beta carotene and other carotenoids. The database provides levels of the five most common carotenoids in 150 fruits and vegetables and over 2,000 mixed foods containing fruits and vegetables (66).

CHAPTER VI

CONCLUSIONS

College students consumed an average of 122 mg of vitamin C, 12.4 mg of vitamin E, and 9.7 mg of beta carotene daily. Therefore, according to Gey et al. (52), an adequate amount of vitamin C was consumed and inadequate amounts of vitamin E and beta carotene were consumed in order to reduce the risk of developing certain cancers. Eighty-two percent of the subject population obtained at least 70% of the RDA for vitamin C (51), 85% obtained 70% of the RDA for vitamin E (51), and 29% obtained 70% of the level of beta carotene recommended to reduce the risk of developing cancer (52). Gender differences showed that males consumed more vitamin C and E, while females consumed more beta carotene.

Over half of vitamin C intake was obtained from fruits, the majority of vitamin E intake was from foods other than fruits and vegetables, and the majority of beta carotene intake was from vegetables. Of the total antioxidant activity, vitamin C obtained from all foods contributed the majority. Beta carotene obtained from fruits and vegetables contributed more activity than vitamin E, and vitamin E obtained from foods other than fruits and vegetables contributed more activity than beta carotene.

Thirty-four percent of the students consumed at least two servings of fruits daily and 26% consumed at least three servings of vegetables daily. A total of 26% of the students obtained the recommended five or more servings of fruits and vegetables daily. Males were found to consume an average of 1.8 servings of fruits and 2.6 servings of vegetables daily, while females consumed 1.7 servings of fruits and 2.1 servings of vegetables daily. The average number of servings of fruits and vegetables consumed daily was 4.4 for males and 3.8 for females. Consumption of five or more servings of fruits and vegetables, in any combination, provided levels of vitamin C and beta carotene recommended to reduce the risk of developing cancer (52) but a marginal level of vitamin E (contained primarily in foods other than fruits and vegetables).

In general, antioxidant levels increased with increasing number of servings of fruits and vegetables consumed. However, when compared on a per serving basis, levels did not increase proportionately. Therefore, it was postulated that the initial fruits and vegetables consumed were those with high antioxidant contents.

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Appendix A

CERTIFICATION OF EXEMPTION OF PROJECTS
INVOLVING HUMAN SUBJECTS

93-071

Principal Investigator(s): Dr. Ann Hertzler and Paige Mitchell

Department(s): Human Nutrition and Foods

Project Title: The Consumption Levels of Fruits and Vegetables and Antioxidants of College Students

Source of Support: Departmental Research X Sponsored Research ______ Proposal No.____________

1. The criteria for "exemption" from review by the IRB for a project involving the use of human subjects and with no risk to the subject is listed below. Please initial all applicable conditions and provide the substantiating statement of protocol.

[x] a. The research will be conducted in established or commonly established educational settings, involving normal education practices. For example:

1) Research on regular and special education instructional strategies;

2) Research on effectiveness of instructional techniques, curricula or classroom management techniques.

[ ] b. The research involves use of education tests (__ cognitive, __ diagnostic, __ aptitude, __ achievement), and the subject cannot be identified directly or through identifiers with the information.

[x] c. The research involves survey or interview procedures, in which:

[ ] 1) Subjects cannot be identified directly or through identifiers with the information;

[x] 2) Subject's responses, if known, will not place the subject at risk of criminal or civil liability or be damaging to the subject's financial standing or employability;

[ ] 3) The research does not deal with sensitive aspects of subject's own behavior (illegal conduct, drug use, sexual behavior or alcohol use);

[ ] 4) The research involves survey or interview procedures with elected or appointed public officials, or candidates for public office.

[ ] d. The research involves the observation of public behavior, in which:

[ ] 1) The subjects cannot be identified directly or through identifiers;

[ ] 2) The observations recorded about an individual could not put the subject at risk of criminal or civil liability or be damaging to the subject's financial standing or employability;

[ ] 3) The research does not deal with sensitive aspects of the subject's behavior (illegal conduct, drug use, sexual behavior or use of alcohol).

[ ] e. The research involves collection or study of existing data, documents, recording pathological specimens or diagnostic specimens, of which:

[ ] 1) The sources are publicly available; or

[ ] 2) The information is recorded such that the subject cannot be identified directly or indirectly through identifiers.

2. I further certify that the project will not be changed to increase the risk or exceed exempt condition(s) without filing an additional certification or application for use by the Human Subjects Review Board.

Note: If children are in any way at risk while this project is underway, the chairman of IRB should be notified immediately in order to take corrective action.

Principal Investigator(s) Date	Principal Investigator(s) Date
Departmental Reviewer Date 2/11/93	Chair, Institutional Review Board Date 2/11/93

Appendix B

DIRECTIONS FOR ACTIVITIES RECORD AND THREE DAY FOOD INTAKE RECORD

A. Activities Record (Note: Example on page 4)

1. Record all of your activities for one 24 hour week day beginning when you get up in the morning until the same time the next day. Do not record activities for a weekend day, i.e. Saturday or Sunday. Use the Activities Record sheet on page 5.

2. Select your activities from the list on page 6. Any activity not included on this list should be matched as close as you can to an activity that is on the list (in other words, an activity that you think most resembles your activity). For example, not many people go disco dancing anymore, but any activity resembling vigorous dancing could fall under this catagory.

3. Try to be as accurate as possible in recording your beginning and ending times. If an activity is repeated, you will not have to summarize before entering it on the computer (see page 13 for computer availability).

4. Your total minutes for the 24 hours should be 1440 minutes.

B. Three Day Food Intake Record (Note: Example on pages 7-8)

1. Using the Three Day Food Intake Record sheets on pages 9-10, record everything you eat or drink (except water) for 3 consecutive days including one weekend day (Saturday or Sunday). Include gum, candies, snacks, etc., from getting up to going to bed (6 a.m. to 6 a.m. the next day). If you consume processed foods (e.g. cake mix, canned beef stew, pop tarts), keep the package so you can use the label to assist in identifying the food item or a similar item on the computer software - see page 13 for computer availability.

2. In the amount columns, indicate the total quantity of each food eaten for each day. Estimate as accurately as possible in cups, teaspoons, tablespoons, grams, ounces, slices (bread), etc. for recording purposes. If the dish includes more than one ingredient, break it down. Examples: spaghetti sauce, noodles, meat, cheese. (Conversion tables for different volumes and other measurements are found on pages 11-12.) Calculate your three day total for each item and record in the appropriate column.

3. Record the number of servings for each food/drink you've listed under the appropriate column. If your food/drink doesn't fit under one of the five food groups, place a (X) under the Limited Extras column. To determine the appropriate food group and serving size see page 46 of your textbook and pages 12-13 of your HNF 1004 Supplement.

4. Try to eat what you would ordinarily eat. Knowing you have to record the food will undoubtedly make some difference in your choices. Try to keep this effect to a minimum. Remember, you will NEVER be graded on what or how much you eat.

5. It is easier to record the food you eat as you eat it or immediately after. This is so you don't forget the little things like margarine, salad dressing, sugar, beverages, etc.

6. This food intake record is to give you an idea of your usual daily intake. It will be the basis for your term project, which will be explained in class.

7. If you take any vitamin or mineral supplements, record the brand name and amount (e.g. dosage such as mg.) of each of the indicated vitamins/minerals and check (✓) the day you took the supplement.

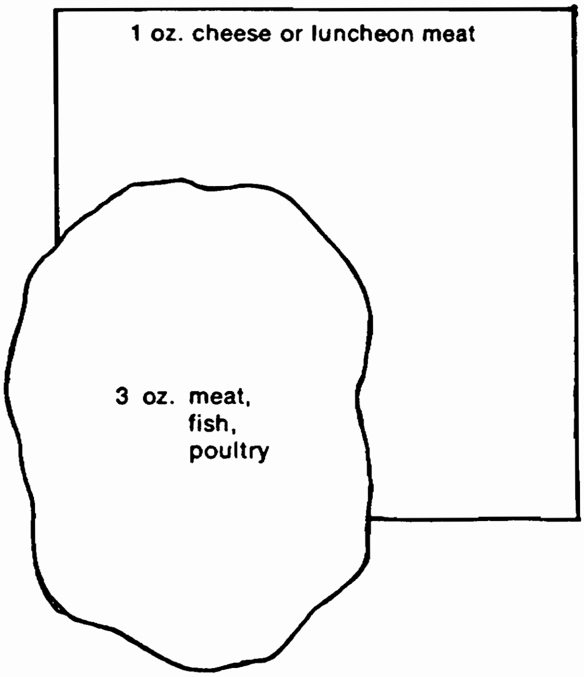
C. Your activities record and three day food intake record are due September 9, 1992. Make certain you have completed the information at the top of each page (name, class time, and date). Your records will be checked and returned to you at a later date for your use in the term project. Specifically you may pick up your "checked" Food Intake Record and Activities Record on September 28 from Room 339 Wallace. Remember, points will be taken off for each day it is late, excluding weekends.

Appendix C: Sample of Three Day Food Intake Record

AMOUNT				ITEM NUMBER*	FOOD/DRINK	TOTAL NUMBER OF SERVINGS					
Day 1	Day 2	Day 3	3 Day Total			Fruits	Vegetables	Breads/ Cereals	Milk/ Milk Products	Meat/ Meat Alternates	Limited Extras
	1 1½"		1 1½"	1348	RICE KRISPY SQUARES			½			
	½		½	1096	CHEESE PIZZA DELUXE			1			
	3		3	645	POTATO SKINS		1				
	16 oz		16 oz	686	BEER - REG.						X
		2	2	436	KRISPY KREME DONUTS						X
		2	2	947	APPLE FRITTERS						X
		3 sl	3 sl	329	FRENCH BREAD			3			
		8	8	105	BUTTER PATS						X
		2	2	630	MUSHROOMS		½				
		½ c	½ c	507	BROCCOLI		1				
		½ c	½ c	124[illegible]	RICE CHEX			1			
		¼ c	¼ c	1613	TERIYAKI SAUCE						X
		10 oz	10 oz	690	WINE						X
		2	2	412	BROWNIES - LG.						X
		½ P	½ P	67	CHOCOLATE MOUSSE				½		
		3 oz	3 oz	1273	CHICKEN - WHITE					1	

Place a check under each day supplement is taken			VITAMIN/MINERAL SUPPLEMENT	CALCIUM (mg)	IRON (mg)	VITAMIN C (mg)
✔	✔	✔	ONE-A-DAY PLUS MINERALS	130	10	60

Appendix D: Portion Sizes of Foods and Beverages (Hertzler*)



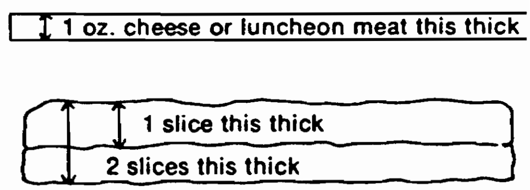
Meat and Meat Alternates

Protein Foods

2 servings

One serving =

2 to 3 ounces of lean cooked meat, poultry, or fish—all without bone; 2 eggs, 1 cup cooked dry beans, dry peas, or lentils; 4 tablespoons peanut butter; ¼ block tofu.



3 oz. meat, fish, poultry

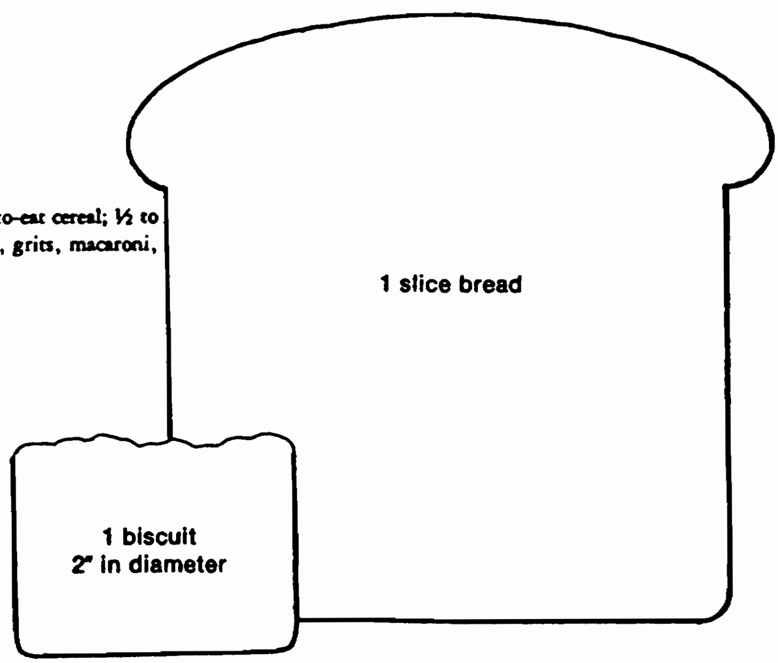
Breads and Cereals

B Vitamin Foods

4 servings
(enriched or whole grain)

One serving =

1 slice of bread; 1 ounce ready-to-eat cereal; ½ to ¾ cup cooked cereal, cornmeal, grits, macaroni, noodles, rice, or spaghetti.



* Hertzler AA. The four food groups-food for fitness. Virginia Cooperative Extension Service. Publication No. 348-906. 1988.

Fruits and Vegetables

Vitamin A & C Foods

4 servings

Include:

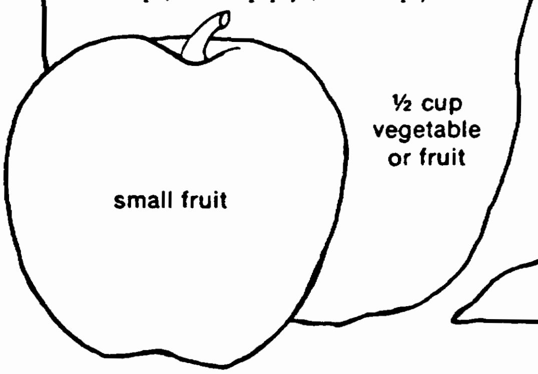
—a citrus fruit, papaya, or other vitamin C source daily.

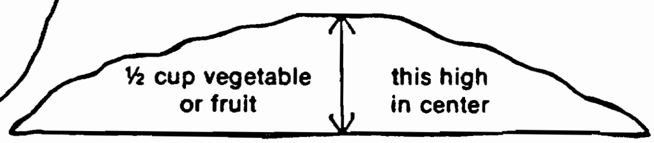
—a dark-green or deep-yellow vegetable for vitamin A at least every other day.

—other vegetables and fruits, including potatoes.

One serving =

½ cup of vegetable or fruit (fresh, frozen, or canned); a 2 to 3 inch apple, orange, or potato; a 6-inch banana; half a medium grapefruit or cantaloupe; ⅓ of a papaya; or ½ cup juice.





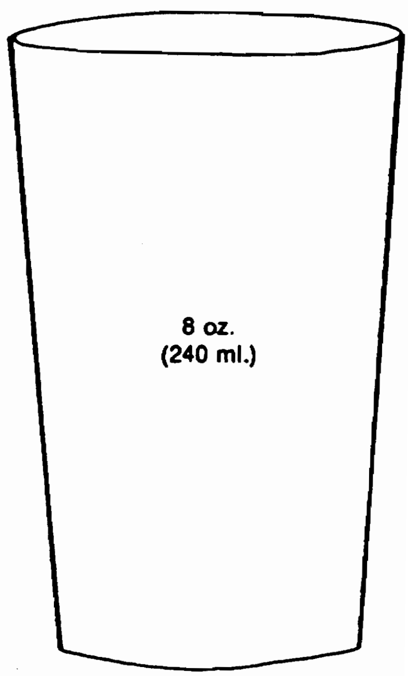
Milk Foods

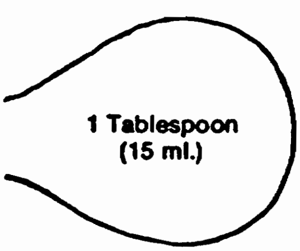
Calcium Foods

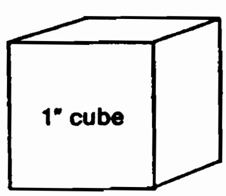
Children	2 to 3 servings
Adults	2 servings
Pregnancy	3 servings

One serving =

8 oz. milk (whole, 2%, buttermilk or skim), 4 oz. evaporated milk, 2 one-inch cubes or 2 oz. of cheese, 1½ cups cottage cheese, 1½ cups ice cream, ½ block tofu, 8 oz. yogurt.







Appendix E

Food and Beverage Items Recorded by Subject
and Investigator Interpretation

Recorded by the Student	Coded by the Investigator
beans	green beans
beer	regular beer
bread	enriched white bread
burrito	beef burrito
canned fruit	sweetened fruit or canned fruit in heavy
syrup	
carrots/broccoli/spinach/cabbage/	assumed cooked unless adjacent items
included	
peas/beans	salad dressing or vegetable dip
cereal	Kellogg's bran flakes cereal
cheese	American cheese
chicken	roasted, all parts
cookie	chocolate chip, baked from mix
crackers	Keebler club crackers
cream cheese (corresponding bagel)	1 tsp. regular cream cheese
dip/vegetable dip	French onion dip
dog	fast food hot dog with bun
dressing/salad dressing	French dressing
egg	50 gram boiled egg
french fries	McDonald's medium french fries
fried chicken	batter-dipped fried, all parts
fruit juices	reconstituted from frozen concentrate
hamburger/ground beef	fried ground beef, medium fat
ice cream	chocolate ice cream, 10% milk fat
juice	frozen reconstituted orange juice
Kool-aid/punch	reconstituted powdered fruit punch
lemonade	reconstituted powdered lemonade drink
lunch meat	boiled ham, high fat
meatballs	meat loaf (1 oz.=1 meatball)
milk	whole milk
noodles/pasta without spaghetti or tomato sauce listed adjacently	cooked enriched macaroni
peas	green peas, cooked from frozen
pie	apple pie, home recipe
pizza	cheese pizza

popcorn	Pop Secret, butter flavor
potato	medium baked potato
roast beef	bottom, lean and fat
salad	tossed green salad
soda	regular cola
spaghetti	cooked enriched spaghetti
spaghetti sauce	Prego, regular
steak	broiled sirloin steak, lean and fat
tuna fish	oil-packed tuna fish
turkey	turkey roll, light and dark
white rice/rice	white long-grain rice
yogurt	mixed fruit, custard style

VITA

Paige Mitchell was born in Lincoln, Nebraska on February 25, 1967. She graduated from Harrisonburg High School in June, 1985. That fall she attended Virginia Tech in the beautiful town of Blacksburg, Virginia. In May, 1990, she completed a dietetic internship and graduated Cum Laude with a bachelor's degree in dietetics. During the Fall of 1990, she began her master's degree work at Virginia Tech. She completed requirements for dietetic registration and received her Registered Dietitian (RD) status in September, 1992. Upon completion of her degree, she intends to pursue employment in the wellness/fitness or education field of dietetics.

Paige I. Mitchell

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