THE RELATIONSHIP OF DIETARY FIBER AND VITAMIN AND MINERAL INTAKE

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CHAPTER I

THE RESEARCH PROBLEM

Introduction

"Eating habits can have a significant impact on the incidence and severity of many health disorders" (U.S. Preventive Services Task Force, 1989). In the United States, diseases associated with dietary excess and imbalance rank among the leading causes of illness and death. Diet has been found to play a leading role in coronary artery disease and in cancer of the colon, breast and prostate (Greenwald, Lanza, & Eddy, 1987; Hargreaves, Baquet, & Gamshadzahi, 1989; Hocman, 1989). Obesity can occur when caloric intake consistently exceeds energy expenditure and is a risk factor for disorders such as hypertension and diabetes (Council on Scientific Affairs, 1989; Anderson, 1985).

Many components of food have been linked to disorders of deficiency or toxicity. Osteoporosis has been linked to inadequate dietary intake of calcium. Diverticular disease is more prevalent in cultures consuming low fiber diets. The prevalence of dental caries, however, is more prevalent when diets contain excessive intakes of refined carbohydrates. The public and even some health care professionals zealously hail a nutrient when it is identified as the "cure" for a certain ill, and consume or encourage consumption of large doses in the form of purified supplements (Greger, 1987). This can lead to toxicity, such as with vitamin B_6 which causes sensory nerve dysfunction at megadose levels (Greger, 1987). Recently, consumption of oat bran, a semi-purified food component, has increased dramatically because of health claims (Kirby, Anderson, Sieling, Rees, Chen, Miller & Kay, 1981). Although researchers found oat bran consumption to decrease blood lipids, the relationship was not due only to the presence of fiber, but also, to the fact that dietary fat and cholesterol intake were displaced by fiber. Human diets are complex and there are difficulties in studying dietary components as separate entities. For example, non-heme iron absorption is increased in the presence of ascorbic acid (Hallberg, 1984). Food components also can act as antagonists, such as phytates which bind zinc and prevent its absorption (Sandstead & Evans, 1984). Identifying the functions of individual constituents of the diet in health and disease is important, but consumers and researchers must not become so concerned with one problem that the ultimate goal of overall health is forgotten.

It is important to understand the relationships of various food components within diets and possible interrelated effects on health. Various types of dietary fiber have been linked to the prevention of heart disease, colon and other cancers, diverticulosis, and the successful treatment of obesity and diabetes (Council on Scientific Affairs, 1989). But, fiber is not the sole component of food responsible for lowering health risks. Vitamin A and its precursors have been linked to the prevention of several types of cancer, as has vitamin C (Hocman, 1989). Also, low fat intakes, common in high fiber diets, have been linked to prevention of certain cancers, cardiovascular disease and obesity (Council on Scientific Affairs, 1989).

With better insight into the confounding variables inherent in the diet, a pattern may emerge which will provide a better understanding of the impact of eating habits on health. This study will assess the adequacy of vitamin and mineral intake of college students in relationship to fiber intake.

Objectives

The objectives of this study are:

1. To investigate the relationship of vitamin and mineral intake to the levels of dietary fiber intake.

2. To assess the adequacy of vitamin and mineral intake by college students as compared to the Recommended Dietary Allowances (RDAs), Estimated Safe and Adequate Daily Dietary Intakes (ESADDIs), and Estimated Minimum Requirements. These guidelines are listed in Tables I through III.

TABLE I

RECOMMENDED DIETARY ALLOWANCES (1989) USED TO CALCULATE ADEQUACY

Nutrient	Unit	Male[a]	Female[a]
Vitamin A	RE	1000	800
Thiamin	mg	1.5	1.1
Riboflavin	mg	1.7	1.3
Niacin	mg	19	15
Vitamin B6	mg	2.0	1.6
Vitamin B12	µg	2.0	2.0
Folacin	µg	200	180
Vitamin C	mg	60	60
Vitamin E	mg	10	8
Calcium	mg	1200	1200
Iron	mg	10	15
Magnesium	mg	350	280
Phosphorus	mg	1200	1200
Selenium	µg	70	55
Zinc	mg	15	12

Note. From Food and Nutrition Board: Recommended Dietary Allowances. 10th rev. ed., 1989. Washington, D.C.: National Academy of Sciences.
[a]Age group: 19-24 years.

TABLE II

ESTIMATED SAFE AND ADEQUATE DAILY DIETARY INTAKES FOR ADULTS

Nutrient	Unit	Range	Mid-point
Pantothenic acid	mg	4 - 7	5.5
Copper	mg	1.5 - 3.0	2.25

Note. From Food and Nutrition Board: Recommended Dietary Allowances. 10th rev. ed., 1989. Washington, D.C.: National Academy of Sciences.

TABLE III

ESTIMATED MINIMUM REQUIREMENTS
OF HEALTHY PERSONS
>18 YEARS OF AGE

Nutrient	Unit	Level
Potassium	mg	2000
Sodium	mg	500

Note. From Food and Nutrition Board: Recommended Dietary Allowances. 10th rev. ed., 1989. Washington, D.C.: National Academy of Sciences.

Hypotheses

H_o1. There will be no difference in fiber intake between days within subjects.

H_o2. There will be no relationship between the intake of dietary fiber and intake of vitamins and minerals.

H_o3. Students consuming >18 gm fiber/day will not have significantly higher vitamin or mineral intake than students who consume <18 gm fiber/day.

H_o4. Students consuming >1 gm fiber/100 kcal will not have significantly higher vitamin or mineral intake than students who consume <1 gm fiber/100 kcal.

H_o5. The subjects' average vitamin and mineral intakes will not meet 2/3 of current RDAs, ESADDIs, and Estimated Minimum Requirements for this population.

Assumptions

For this study it is assumed that the students were accurate and complete in recording their dietary intakes. This was the first assignment of the semester, the students did not yet know the elements of a "good" diet as defined in the class. They were encouraged to identify what they actually ate and were told that they would not be graded on what they ate, but only on how accurately they completed the record. In addition, the students were not aware that they would be given the opportunity to turn this assignment in for its use in research.

It also is assumed that the fiber, vitamin, and mineral values used in the "Food Processor II" computer program are accurate.

Limitations

The sample population may limit the ability to generalize the results of this analysis. A random or stratified sample of all Oklahoma State University students would have been a better sample. Self-reporting, although widely used by researchers, is also a limitation due to its questionable accuracy in thoroughness of reporting and determination of serving sizes. Finally, since the composition of foods from restaurants may differ from homemade foods, the analysis is limited because the source of food eaten was not noted in all cases in this study.

Definitions

Dietary Fiber - "the portion of plant cells that cannot be digested by human alimentary enzymes and, therefore cannot be absorbed from human small intestine" (Slavin, 1987, p. 1165).

Dietary Record - A tool used to gather information about groups or individuals to determine usual patterns of eating and/or assess dietary intakes to establish the degree of adequacy as compared to accepted standards (Mahalko, Johnson, Gallagher, & Milne, 1985).

ESADDIs - Estimated Safe and Adequate Daily Dietary Intakes - a range of intake for nutrients considered by the Food and Nutrition Board to be essential, but lacking clear research to establish specific intake requirements for age and gender based on nutrient needs (Food and Nutrition Board, 1989).

RDAs - Recommended Dietary Allowances - "are the levels of intake of essential nutrients that, on the basis of scientific knowledge, are judged by the Food and Nutrition Board to be adequate to meet the known nutrient needs of practically all healthy persons" (Food and Nutrition Board, 1989, p. 10).

Data Collection

The data were collected from Oklahoma State University students enrolled in FNIA 1113, Basic Human Nutrition, during the Spring and Fall semesters of 1986 and 1987. As their first assignment in the class, students were to record all food and beverage consumption for four days. At the end of each semester all students were given the opportunity to return the assignment to the instructor for use in research and to receive extra credit points in exchange.

Format of Thesis

The described research was organized as a manuscript and will be submitted to the Journal of the American Dietetic Association. Chapter IV was written in accordance with the Guidelines for Authors from that journal. The remaining text follows formats specified in the Graduate College Style Manual from Oklahoma State University and the Publication Manual of the American Psychological Association.

CHAPTER II

REVIEW OF LITERATURE

Dietary Patterns and Intakes of College Students

Food Behaviors and Dietary Patterns

Most dietary research with college students has focused on eating patterns and food behaviors, not diet composition. In the literature, researchers indicate that college students are too busy to eat adequately and in general have poor eating habits (Jakobovits, Halstead, Kelley, Roe, & Young, 1977; Khan & Lipke, 1982; Driskell, Keith, & Tangney, 1979) There is also a concern that students, because they are busy, eat mostly fast-food (Roberts, 1989). However, very little literature examines where students eat. Jakobovits, et al. (1977) found that of the women studied 96% regularly used their lodging for meals and snacks. These women also stated that other eating facilities were seldom used. Driskell, et al. (1979) found that almost half of their subjects ate at dormitory hall cafeterias. Hertzler and Frary (1989), using a correlational method, found that "men were more likely to eat breakfast at a fast-food service than were women (r = -.33)" (p. 351).

Meal-skipping by college students has been scrutinized. A study in New Mexico found a significant relationship between the time at which students awoke and whether they enjoyed eating breakfast (Stasch, Johnson, & Spangler, 1970). In addition, this study found that those who liked breakfast also ate lunch regularly and were raised by mothers who prepared breakfast. Jakobovits, et al. (1977) attributed skipping lunch to the lack of a defined lunch period and little time to eat between classes. Lack of time is a frequent cause of meal skipping in other cultures. A study of students in Nigeria found the most frequent causes of skipping meals to be lack of time (45.5%) and lack of appetite/fatigue from studies (33%) (Nnanyelugo & Okeke, 1987).

Breakfast is usually the most skipped meal by college students and dinner the least. Hertzler and Frary (1989) found that 43% of the students studied skipped breakfast more than half the time; this result was consistent in both sexes. Dunn-Sluyter (1984) found that breakfast was more likely to be skipped than other meals and that on-campus students were more likely to skip it than off-campus students. Khan and Lipke (1982) found that 23.6% of the students skipped breakfast, while only 4% skipped dinner and 12.4% skipped lunch. They also found no significant differences between the sexes in skipping lunch or dinner. Jakobovits, et al. (1977) found lunch to be skipped most frequently with only 24% of the women eating it everyday.

Dinner was skipped least: 70% of the women reported never missing dinner. Breakfast was never missed by 47% of the women and another 34% only missed it once or twice per week. In a study by Hernon, Skinner, Andrews, and Penfield (1986) 58% of males, 49% of females consuming >1,200 kcals per day, and 25% of females consuming <1,200 kcals per day reported that they usually ate three or more meals per day. In Virginia, 73% of the students reported eating one meal per day and the remainder consumed two meals (Driskell, et al., 1979).

Jakobovits, et al. (1977) defined "Frequency of food intake" to include meals and snacks. They found the average frequency of intake to be 5.31 (S.D. 1.28) in women. Khan and Lipke (1982) found nutrition majors to eat significantly fewer times per day (4.34) than non-majors (4.96) ($p < .05$). In addition, female nutrition majors were found to eat 4.44 times per day and female non-majors were found to eat significantly more times (5.54) ($p < .01$). This study found that males ate significantly less often (4.10 times) than women (4.92 times) ($p < .05$).

Snacking is described in the literature as a poor eating habit (Jakobovits, et al., 1977; Khan & Lipke, 1982), yet it is a very popular practice and is found to have a significant positive impact on dietary adequacy in college students (Khan & Lipke, 1982). Only two women in the study by Jakobovits, et al. (1977) reported no snacks over a seven-day period. Forty-seven percent of the women in this study snacked primarily in the evening. Per-subject, per-day there were 0.45 morning, 0.84 afternoon, and 1.54 evening snacks. Hertzler and Frary (1989) found that 81% of their sample snacked one to three times per day, while 4% snacked four or more times, and 14% stated that they hardly ever snacked. In a study by Khan and Lipke (1982), men consumed 1.10 snacks per day and women 1.92 snacks. The highest consumption of snacks in their study was 2.5 snacks per day by women who were non-nutrition majors. Hernon, et al. (1986) found that 41% of the women consuming <1,200 kcal, 59% of the women consuming >1,200 kcal, and 64% of the men usually ate two or more snacks daily. Slightly more than two-thirds of the students reported snacking once or twice per day in the study by Driskell, et al. (1979).

Carbonated beverages were reported as one of the most common snack foods (Driskell, et al., 1979; Khan & Lipke, 1982; Nnanyelugo & Okeke, 1987; Stasch, et al., 1970). Other snack foods included coffee, tea, bread products, fruit, candy, cookies, milk, alcoholic beverages, fruit juice, sandwiches, salted snack items, and desserts (Driskell, et al., 1979; Jakobovits, et al., 1977; Khan & Lipke, 1982; Nnanyelugo & Okeke, 1987; and Stasch, et al. 1970). Snacks differ by culture and region. Fruits comprised snacks consumed by 83% of Nigerian students (Nnanyelugo & Okeke, 1987); whereas, only 7% of college students surveyed in New Mexico chose fruit (Stasch, et al., 1970). Nelson and King (1982) attributed the low consumption of fruit snacks in Louisiana to the lack of availability in college campus vending machines. Their survey indicated that fresh fruit was the first snack preference of the majority of the students polled and fruit drinks the most popular beverage. Stasch, et al. (1970) also attributed changes in snack foods consumed at college versus those consumed at home to availability.

When asked to list foods eaten regularly to improve health, students listed high protein foods (42%), fruits (25%), vegetables (21%), and milk (19%), while salads, apples, and oranges were listed by 10% of the students (Stasch, et al., 1970). However, this study also found that vegetables were under-represented when students listed preferred foods. When intake was compared to the USDA Food Basic Four Groups, Hernon, et al. (1986) found that males and females (consuming >1,200 kcals) met recommendations for all food groups except breads and cereals and females consuming <1,200 kcals were below the recommendations in all food groups. Dunn-Sluyter (1984) found that consumption from the meat and dairy groups tended to be above the USDA recommendations and consumption from the fruit/vegetable and bread/cereal groups were below the recommendations.

Nutrient Intakes

Research assessing the adequacy of several nutrients in the diets of college students is summarized in Table IV.

Studies found most intakes to be adequate. The nutrient of most concern was iron, especially in women.

The RDA for iron was lowered for adult women by the 1989 RDAs. The 18mg/day RDA for iron was set more realistically at 15 mg/day. In addition, the RDA for calcium was increased for young adults in 1989 from 800 to 1,200 mg/day (Food and Nutrition Board, 1989).

TABLE IV

NUTRIENT ADEQUACY OF STUDENT DIETS:
A SUMMARY OF RESEARCH

					Vitamins				
Author	n	Group	Ca	Fe	A	C	B-1	B-2	B-3
Driskell et al.	50	male	o	+	o	+	+	+	+
1979	100	female	o	-	o	+	+	+	+
Hernon et al.	58	male	+	+	+	+	+	+	+
1986	192	f>1200kcal	+	-	+	+	+	+	+
	53	f<1200kcal	-	-	+	+	-	-	-
Hoffman 1989	70	male	+	+	o	o	o	o	o
	134	female	-	-	o	o	o	o	o
Jakobovits et al. 1977[a]	195	female	+	-	+	+	-	+	+
Khan and Lipke	71	male	+	+	+	+	+	+	+
1982	179	female	+	-	+	+	+	+	+
Nnanyelugo and Okeke 1987[b]	120	mixed[c]	-	+	+	+	+	-	-

Note. Symbols: o = nutrient not studied; + = nutrient intake means met or exceeded standards used; - = nutrient intake means did not meet standards used. Researchers used 1980 RDAs as the standard except as in [a] and [b].

[a]1974 RDAs used as standard.

[b]WHO/FAO guidelines used as standard.

[c] n=90 male, 30 female.

Diet and Health

"Diseases associated with dietary excess and imbalance rank among the leading causes of illness and death in the United States." (U.S. Preventive Services Task Force, 1989). Diet is known to play a role in coronary artery disease, stroke, obesity, some types of cancer, diabetes, hypertension, constipation, diverticular disease and other gastrointestinal disorders (Council on Scientific Affairs, 1989; Eastwood & Passmore, 1983; U.S. Preventive Services Task Force, 1989). This review will provide a short explanation of fiber, vitamin, and mineral intake patterns in relation to the risk of developing some of these diseases. In addition, it will examine the complexity of food and intake patterns.

Fiber, Vitamins, and Minerals in Disease Prevention

Cardiovascular Disease. An inverse relationship has been found between coronary heart disease (CHD) and the intake of dietary fiber (Anderson, 1985). Part of this relationship is due to the lowering effect of dietary fiber on hypercholesterolemia, hyperlipidemia, and hypertension (Council on Scientific Affairs, 1989; Kirby, et al., 1981). The latest enthusiasm for oat bran brought the benefits of fiber in the prevention of CHD into the popular press. The type of dietary fiber impacts its effects on blood lipids. The soluble fiber components, which have the greatest effect on blood lipids, include gums, mucilages, and pectic substances (Jenkins, Wolever, Taylor, Reynolds, Nineham, & Hockaday, 1980; Moag-Stahlberg, 1990). Psyllium, rice bran, oats and barley are food sources of these fibers (Kirby, et al., 1981; Moag-Stahlberg, 1990). Insoluble fibers, such as those found in wheat, have little or no effect on blood lipids, but still appear be a factor in lowering the incidence of CHD (Anderson, 1985).

Other dietary factors also impact the risk of cardiovascular diseases. The most important are the amount and fatty acid composition of dietary fat (Anderson, 1985; Moag-Stahlberg, 1990). Sodium, chloride, potassium, and calcium also may affect blood pressure (Anderson, 1985). Additionally, the hypothesis that selenium deficiency is an important causative agent in CHD is both supported (Oster, Dahm, Oelert, & Prellwitz, 1989) and refuted (Ikram, Crozier, Webster, & Low, 1989).

Cancer. Estimates are that 35% (10 - 70%) of all cancer deaths may be attributed to diet (Doll & Peto, 1981). The dietary factors most related to cancer causation include fat, alcohol, and nitrates; the ones most related with cancer prevention include fiber, vitamins A, C, and E, selenium, and zinc (Hargreaves, Baquet, & Gamshadzahi, 1989). A lower incidence of cancer has been related to a higher intake of fruits and vegetables. This effect is ascribed in part to fiber, vitamin A, beta-carotene, vitamin C, and vitamin E contained in fruits and green and yellow vegetables (Heilbrun, Nomura, Hankin, & Stemmermann, 1989; Hocman, 1989).

Fiber is best known for its apparent preventative impact on cancer. Greenwald, Lanza, and Eddy (1987) reviewed 40 epidemiological studies from North America, Europe, India, Japan, Australia, Israel, South Africa, and Puerto Rico. An inverse relationship between colon cancer and fiber from cereals, fruits, and vegetables was found in all of these studies. Because diets are so complex, researchers have found multiple effects in degenerative disease. In a case-control study of American-Japanese men, the greatest impact of dietary fiber on lowering the risk of developing colon cancer was in those men who consumed less than 61 grams of fat per day (Heilbrun, et al., 1989). The researchers also observed a negative association of vitamin C intake with colon cancer risk.

The incidence of other cancers also has been related to the intake of fruits and vegetables. Le Marchand, Yoshizawa, Kolonel, Hankin, and Goodman's (1989) research in Hawaii "demonstrated a clear dose-dependent negative association between beta-carotene and lung cancer risk in both sexes" (p. 1158). The results of this case-control study found no clear relationship between lung cancer risk and intake of retinol, vitamin C, folic acid, iron, dietary fiber, or fruits. The results did show that all vegetables, dark green vegetables, cruciferous vegetables, and tomatoes had stronger inverse associations with risk than beta-carotene alone. The authors suggest that other constituents of vegetables, such as lutein, lycopene, or indoles also may be protective against lung cancer. Hocman's review (1989) also indicates that other constituents of plant foods may have anticarcinogenic properties.

Cancer risk in females has been associated with fiber intake. Two studies, one in Canada (Brisson, Verreault, Morrison, Tennina, & Meyer, 1989) and the other in Sweden (Holm, Callmer, Hjalmar, Lidbrink, Nilsson, & Skoog, 1989), found that low fiber intake may be one of the factors related to an increase in breast cancer risk. Brisson and co-workers (1989) found that lower intake of beta-carotene and elevated intake of saturated fat also were factors in increased risk of breast cancer in women. The researchers based their assessment on differences in breast tissue morphology (Brisson, et al., 1989), tumor size, and estrogen receptor content of the tumor (Holm, et al., 1989). In a study of ovarian cancer risk, protection by high beta-carotene intake ranked as the most important nutritional factor and came after age, body mass index, and parity (Slattery, Schuman, West, French, & Robison, 1989). Intake of calories, fat, protein, fiber, and vitamins A and C did not significantly alter the risk of developing ovarian cancer in this study.

Gastrointestinal Disorders. While other health benefits may exist, fiber's bowel regulating effect does prevent constipation and its complications. In the U.S. the annual sales of over-the-counter laxatives and stool softeners exceeds $400,000,000 (Anderson, 1985). The same results can be achieved by simply consuming more fiber through food (Anderson & Whichelow, 1985; Council on Scientific Affairs, 1989; Gear, Brodribb, Ware, & Mann, 1981; Harvey, Pomare, & Heaton, 1973). Insoluble fibers such as those in wheat create a bulking effect that soluble fibers do not (Anderson, 1985; Eastwood & Passmore, 1983; Moag-Stahlberg, 1990).

The regulating effect of fiber on transit times through the gastrointestinal tract prevents hyperactivity or hypoactivity both of which may lead to the development of diverticular disease (Eastwood & Passmore, 1983; Gear, et al., 1981). Higher cereal fiber consumption was found to lower the incidence of asymptomatic diverticular disease by Gear, Ware, Fursdon, Mann, Nolan, Brodribb, and Vessey (1979). Fiber also alleviated the symptoms of diverticular disease (Painter & Burkett, 1971).

Obesity. Obesity is itself a risk factor for many diseases such as CHD, hypertension, cancer, and diabetes (U.S. Preventive Services Task Force, 1989). The American Medical Association's Council on Scientific Affairs (1989) observed that some scientists believe excessive energy intake is inevitable with low fiber diets. Presumably, by increasing complex carbohydrates and limiting refined carbohydrates in the diet, energy intake will decrease significantly yet appetites will be satisfied. Studies of the use of fiber in the treatment of obesity have had conflicting results (Eastwood & Passmore, 1983), however, Ryttig, Tellnes, Haegh, Boe, and Fagerthun (1989) found weight loss and weight maintenance to be significantly greater in mildly obese women who consumed a dietary fiber supplement in a long-term trial.

Diabetes. While weight reduction is important in the control of adult onset diabetes, soluble fiber, and to a lesser extent insoluble fiber also improves control of blood glucose (Anderson, 1985; Council on Scientific Affairs, 1989). O'Dea and colleagues found that glucose tolerance in diabetic males improved most on a diet low in fat and high in carbohydrate and dietary fiber (O'Dea, Traianedes, Ireland, Niall, Sadler, Hopper, & De Luise, 1989). In addition, fasting glucose concentrations fell significantly with the low fat, high carbohydrate plus dietary fiber diet.

Nutrient Complexity of Food

The complexities of food and diet challenge the researcher when attempting to study the relationships between diet and chronic diseases. The first level of complexity is the variety of compounds found in an individual food and the deviation in concentration of such compounds. The second level of complexity is the interaction of the compounds with each other and with preparation methods. This interaction can improve or hinder nutrient utilization by the human body. And finally, the third level of complexity is the variety of foods consumed or diet diversity.

Even before researchers were able to identify the differences in nutrients supplied by various foods, food groups were devised to encourage consumption of a varied diet. Foods were categorized according to similar attributes like protein or vitamin and mineral content (Popkin, B. M., Haines, P. S., & Reidy, K. C., 1989). To illustrate the first and third levels of complexity, Table V (see p. 22) shows some nutrients provided by the Basic Four Food Groups and the diet diversity which is encouraged by this tool.

The increased interest in the role of diet in health has encouraged research about dietary diversity. Randall and co-workers found in two separate studies that diversity scores (variety) of intake in fruits and vegetables had high positive correlations with intakes of fiber, vitamin A, and vitamin C (Randall, Marshall, Graham, & Brasure, 1989; Randall, Nichaman, & Contant, 1985).

Also within the first level of complexity is the influence of environmental conditions on the nutrient content of foods. The content of some minerals in foods is influenced by soil content of the minerals (Ferrando, 1987). Other environmental factors influencing the nutrient content of food include harvesting, packing, and storage techniques.

The second level of complexity of the diet has been termed bioavailability. Greger (1987) advocated that

TABLE V

MAJOR NUTRIENTS OF THE BASIC FOUR FOOD GROUPS

Group/Adult Servings	Major Nutrients Supplied in Significant Amts: By All in Group	Major Nutrients Supplied in Significant Amts: By Only Some Foods
Fruits and vegetables 4 servings/day to include one source of vitamin A and one source of vitamin C	Carbohydrate Water	Vitamins: A C folacin Minerals: iron calcium Fiber
Grain products 4 servings/day to include 2 servings of whole grain	Carbohydrate Protein Vitamins: thiamin niacin Minerals: iron	Water Fiber
Milk/milk products 2 servings/day	Protein Fat Vitamins: A riboflavin B_{12} Minerals: calcium phosphorus Water	Carbohydrate Vitamin D
Meats/meat alternates 2 servings/day to include plant sources several times/week	Protein Vitamins: niacin B_6 Minerals: iron zinc	Carbohydrate Fat Vitamin B_{12} Water Fiber

Note. From Christian, J. L. and Greger, J. L. (1988) Nutrition for Living (2nd ed.). Menlo Park, CA: Benjamin/Cummings nutrition educators encourage consumers to consider bioavailability when selecting foods, supplements, and fortified foods. The bioavailability of nutrients is influenced through enzymatic inhibition, antagonistic relationships between nutrients, solubility of element species, and other factors of diet such as fiber and chelators.

A prominent example of enzymatic inhibition is action of trypsin inhibitors which prevent utilization of proteins (Ferrando, 1987). Antagonistic relationships between minerals include: Mo-Cu, Na-K, Cu-Zn, Cd-Zn, Fe-Zn, Mn-Fe. In addition, the solubility of the element species will affect its bioavailability (Ferrando, 1987). Nutrients have synergistic relationships as well, as illustrated by the increased absorption of iron in the presence of ascorbic acid (Hallberg, 1984).

Fiber adversely affects absorption of some vitamins and minerals as will as producing temporary side effects of gas, intestinal distension, and diarrhea with rapid increases in the diet, (Council on Scientific Affairs, 1989; Eastwood & Passmore, 1983). Shultz and Leklem (1987) measured the intake of vitamin B_6 and the biochemical status of vegetarian (high fiber intake) and non-vegetarian women. They found no adverse effect of fiber on the bioavailability of vitamin B_6. Laitinen, Rasanen, and Vuori (1988) did not find a relationship between fiber and serum zinc levels of 3- to 18-year old girls and boys but did find an inverse relationship between fiber intake and serum copper. Jenkins, et al. (1980) found no evidence of trace mineral deficiency after long-term use of guar supplements which provided 14-26 grams of fiber per day.

Walker's (1987) review of research assessing fiber intake and nutritional adequacy of diets concluded that diets high in fiber characteristically do not have significant ill effects. Walker also suggested that the beneficial effects of reduced risk for various degenerative diseases far outweigh the possible adverse effects of reduced bioavailability of minerals. The Council on Scientific Affairs (1989) has recommended consumption of fiber from a wide variety of foods to decrease the possible adverse effects from overconsumption of any one type of fiber.

Fiber/Vitamin/Mineral Intake Patterns

One concern in today's food supply is the increased consumption of fast-foods. Roberts (1989) found that fast-food is high in fat, protein, and sodium and low in fiber and calcium. Witschi, Capper, Hosmer, and Ellison reported most sodium in foods eaten by adolescents was added during food manufacture or preparation.

Dietary fiber is found only in plant products with legumes, fruits, vegetables, nuts, and whole grains providing a wide variety of fibers (Slavin, 1987). In studies of college populations, intake of fruits, vegetables, and whole grains tended to be low (Dunn-Sluyter, 1984; Hernon, et al., 1986, Yang, 1990). Hanson, Nazarieh, Arquitt, and Winterfeldt (1986) found that only 23% of students consumed an adequate fiber intake of more than 20g/day. Yang (1990) found a mean fiber intake of 13g/day in college students with grains providing most of the fiber.

Vitamin B_6 also is an important contribution of fruits and vegetables. Manore, Vaughan, and Lehman (1990) found that fruits and vegetables contributed 43% of total B_6 intake in the diets of elderly persons. Analysis of the 1977-1978 USDA Nationwide Food Consumption Survey revealed that breads and cereals also are important sources of vitamin B_6 in the American diet (Pao & Mickle, 1981).

The major source of sodium in the diets of adolescents was found to be the bread/cereal food group, contributing 30% of average sodium intake (Witschi, et al., 1987). The other food groups contributed as follows: miscellaneous (24%), meat/eggs (21%), dairy (16%) and fruit/vegetable (9%). In those "who added salt at the table, the addition represented only 1.3% of their sodium intake" (p. 1652). Potassium sources differed markedly from those which provided sodium. Fruits/vegetables contributed the most (39%) to total potassium intake, dairy (24%), meat/eggs (16%), bread/cereal (11%), and miscellaneous (10%).

The relationship of dietary fiber intake to intake of minerals and fat was explored by Hanson, et al. (1986). The researchers found a positive relationship between higher fiber intakes (>1g/100kcal; >20g/day) and intake of potassium, magnesium, iron, copper, and selenium. A negative relationship existed between higher fiber intakes and fat intake and no relationship existed with calcium intake. These results were attributed to the composition of the fiber containing foods. Yang (1990) found that while whole wheat flour consumption was positively correlated with fiber intake, refined flour intake was positively correlated with fat intake of college students. In addition, higher fiber diets contained a lower percentage of calories from fat and less cholesterol. A study of food consumption trends of U.S. women found that diet diversity and the number of lower-fat foods consumed have increased (Popkin, et al., 1989). However, the percentage of women consuming higher-fat foods also has increased.

In reviewing the literature, Randall, et al. (1985) found little empirical investigation of the relationship between diet diversity and nutrient intake or nutritional status. Greenwald, et al. (1987) encouraged the analysis of the impact of total diet and dietary interactions in studies of colon cancer risk, because dietary fiber may interact with or be linked to other dietary factors. The complexity of diet and the relationship of fiber to nutrients are areas of needed research to better understand the role of diet in health.

CHAPTER III

METHODS AND PROCEDURES

Introduction

Chapter III will present the methods and procedures of the study. For the purpose of presentation the chapter has been divided into five sections, as follows; null-hypotheses, subjects, research instrumentation, procedures, and treatment of the data. This study follows guidelines of the Oklahoma State University Institutional Review Board and was approved by this group.

Statement of the Null-Hypotheses

The null-hypotheses which were proposed for testing in the study are restated as follows:

H_o1. There will be no difference in fiber intake between days within subjects.

H_o2. There will be no relationship between the intake of dietary fiber and intake of vitamins and minerals.

H_o3. Students consuming >18g fiber/day will not have significantly higher vitamin or mineral intake than students who consume <18g fiber/day.

H_O4. Students consuming >1g fiber/100 kcal will not have significantly higher vitamin or mineral intake than students who consume <1g fiber/100 kcal.

H_O5. The subjects' average vitamin and mineral intakes will not meet 2/3 of current RDAs and ESADDIs for this population.

Subjects

The subjects in the study were students enrolled in FNIA 1113 at Oklahoma State University during the Spring and Fall semesters of 1986 and 1987. FNIA 1113, Basic Human Nutrition, is an introductory level course and students did not have any other college level nutrition training before this class. Twenty-six men and 104 women participated in the study. Subject participation was on a voluntary basis and they received course credit for their participation.

Instrumentation

The research instrument consisted of the first class assignment which required completion of a four-day dietary record. The students received written instructions and explanation of household measures, see Appendix A, which also were read aloud and discussed in class. A display of food models illustrating various serving sizes was provided to students to help them make accurate estimations of food intake. The students received verbal instructions to record four consecutive week days and to carry the food records with them in order to report exact descriptions as the food was consumed. Accuracy and truthfulness were encouraged because the assignment was based on the completeness and accuracy of the descriptions of the food consumed, not on adequacy of the diet. At the end of the semester all students were given the opportunity to return the first assignment to the instructor for use in research and to receive in exchange extra credit points in the class.

Procedures

Forms for recording dietary intakes were distributed to all students for the first class assignment of the semester (Appendix A). Students were instructed to record the amount, in household measures, and precise description of all food and beverage items consumed, including sauces and condiments, over four consecutive days. At the end of the semester, students who wished to volunteer for this study returned their food intake records to the instructor of the class.

Four day food records with obvious errors or inconsistencies were not used. Only two of the days were used from 113 four day records (23 men and 90 women). The days were randomly assigned from every combination of days one through four. Seventeen records (3 men and 14 women) included all four days. The data were coded and entered by laboratory technicians using the Food Processor II computer program (ESHA Research, 1988). The amount of nutrients in each food consumed and the total nutrient intake of each subject for each day was analyzed.

Fiber intake was split into four groups based on level of intake for the analysis of variance (ANOVA). All inferential statistics used percentage of the 1989 Recommended Dietary Allowance or Estimated Safe and Adequate Daily Intake or Estimated Minimum Requirements for Health Persons (Food and Nutrition Board, 1989) as the unit of measurement for intake of vitamins and minerals. Alpha level was set at 0.05 for all statistical analyses.

Data Analysis

The dietary factors evaluated in this study were fiber; the vitamins A, E, C, B_6, B_{12}, thiamin, riboflavin, niacin, folacin, and pantothenic acid; and the minerals calcium, copper, iron, magnesium, phosphorus, potassium, selenium, sodium, and zinc. Descriptive statistics typically used for survey data (means, medians, ranges, and standard deviations) (Monsen & Cheney, 1988) were calculated.

Kolmogorov-Smirnov goodness of fit test determined normality of the data distribution. Nutrient intake data with non-normal distributions were transformed logarithmically and retested for normality before being used in statistical anaylses. A one-way ANOVA by day was conducted to determine if fiber intake varied by day. The relationship between fiber intake and the intake of various vitamins and minerals was determined using a series of Pearson correlation coefficients.

ANOVAs and multiple regressions were used to determine if increased fiber intake was related to vitamin and mineral intake. A Tukey's Highly Significant Difference (HSD) post hoc test was completed on all significant ANOVAs. Because kilocalorie intake influences vitamin and mineral intake each ANOVA was performed twice. In one set of ANOVAs, fiber intake was grouped as grams/day which allowed kilocalorie intake to influence the results. The other set of ANOVAs were run using fiber intake calculated as grams/100 kcal thereby preventing the influence of kilocalories on the results.

Fiber intake groups were determined using even increments of fiber intake where groups one through four contained the most equal number of subjects possible. Therefore, the fiber intake groups are based on the level of intake by this sample. The fiber intake groups used to allow the influence of kilocalories consisted of 1) <6 g/day (n=15), 2) 6 to <12 g/day (n=59), 3) 12 to <18 g/day (n=33), 4) 18 or more g/day (n=23). The fiber intake groups for the second set of ANOVAs were as follows: 1) <.5 g/100 kcal (n=28), 2) .5 to <.75 g/100 kcal (n=49), 3) .75 to <1 g/100 kcal (n=28), 4) 1 or more g/100 kcal (n=25).

In order to account for the variance in nutrient intake due to kilocalorie intake, the multiple regression was done stepwise. Kilocalorie intakes were forced in first which showed the shared and unique variance accounted for by this variable in regard to intake of each nutrient. Fiber intake was forced in second. From the results, the unique variance in nutrient intakes accounted for by fiber intake could be calculated.

Vitamin and mineral intake levels were based on percent of the RDAs, ESADDIs, and Estimated Minimum Intakes for these analyses (see Tables I-III, pp. 4-5). Statistical analyses were performed using the SPSS-X Data Analysis System (SPSS Inc., 1988).

CHAPTER IV

THE RELATIONSHIP OF DIETARY FIBER AND VITAMIN AND MINERAL INTAKE

Laura M. Campbell and Christa F. Hanson

Abstract

This study assessed the adequacy of vitamin and mineral intake of college students and examined relationships between fiber intake and intake of various nutrients. The nutrient intake patterns of 130 college students, 26 men and 104 women, were assessed. Nutrients measured included fiber; vitamins A, C, E, B_6, B_{12}, thiamin, riboflavin, niacin, pantothenic acid; and minerals, calcium, copper, iron, magnesium, phosphorus, potassium, selenium, sodium, and zinc. Analyses indicated that nutrient intake of this sample was marginal for fiber in all groups, marginal for copper and calcium in female subjects, and marginal for copper in the group overall. Significant relationships were established between fiber intake and the intake of vitamin A, thiamin, riboflavin, niacin, vitamin B_6, folacin, pantothenic acid, vitamin C, vitamin E, copper, iron, magnesium, phosphorus, potassium, selenium, and zinc.

Further research is needed using groups with higher fiber intake from foods to determine more about these relationships.

Introduction

Eating habits have a significant impact on the incidence and severity of many degenerative health disorders, such as cardiovascular disease, obesity, diabetes, and cancer. Fiber, in particular, has been implicated as a preventive factor in most of these diseases (1-3). Dietary choices, however, are complex in terms of nutrients and other components (4). Researchers are beginning to explore the multi-dimensionality of food and diversity of diet in epidemiological studies rather than focusing on single nutrient components (5,6).

One purpose of this study was to assess relationships of fiber intake to vitamin and mineral intakes. In addition, the nutritional adequacy of vitamin and mineral intake was assessed for this college student sample in order to determine nutritional needs.

Methods

This study used two and four day self-reported dietary records voluntarily provided by students (26 men and 104 women) enrolled in a freshman level nutrition class at Oklahoma State University. The students received written and oral instruction on recording intake and the estimation of serving sizes in household measures.

The updated Food Processor II computer program (ESHA Research, Salem, Oregon, 1988) was used for nutritional analysis of the food records. Nutrient intake adequacy was established as mean intake of at least two-thirds of the 1989 RDAs for ages 19-24. For those nutrients without established RDAs, two-thirds of the mid-points of ESADDIs and Estimated Minimum Requirements for adults were used as guidelines for adequacy (7). Adequacy of fiber intake was compared to 25 gm per day which is based on the recommendation from the National Cancer Institute of 20-30 gm per day (8).

Descriptive statistics including means and standard deviations were obtained. Normal distribution of the data was tested using the Kolomogorov-Smirnov goodness of fit analysis. Logarithmic transformations were made to nutrient intake data with non-normal distributions and retested for normality before further analysis. A one-way ANOVA by day was conducted to determine if fiber intake varied by day. ANOVAs and multiple regressions were used to determine if increased fiber intake was related to vitamin and mineral intake.

Fiber intake groups were established to control for kilocalories as follows: 1) <.5 gm/100 kcal, 2) 0.5 to <.75 gm/100 kcal, 3) 0.75 to <1 gm/100 kcal, 4) 1 or more gm/100 kcal. Tukey's Highly Significant Difference (HSD) post hoc tests determined significance of changes in adequacy between fiber intake groups at the $p<.05$ level. Hierarchical multiple regressions used each vitamin and mineral as the dependent variable. Kilocalorie intake was the first independent variable and fiber intake was the second independent variable. Vitamin and mineral intake levels were based on percent of the RDAs, ESADDIs, and Estimated Minimum Requirements for these analyses. Statistical analyses were performed on SPSS-X (SPSS-X Inc., 1988).

Results

Adequacy of Intake

Table VI (see p. 44) summarizes the means and standard deviations of nutrient intakes and percentage of the RDA, ESADDI, or Estimated Minumum Requirements met by the sample means. Male subjects had adequate intake of all nutrients studied except fiber, for which they met only 62% of that recommendation ($\bar{X}$=15.5 gm, sd=7.6). Average fiber intake was low ($\bar{X}$=13.0 gm, sd=8.2) meeting only 52% of the 25 gm/day recommendation. Female subjects had a mean fiber intake of 12.4 gm/day (sd=8.2), 50% of the recommendation.

Female subjects also had low intakes of calcium ($\bar{X}$=738 mg, sd=354) and copper ($\bar{X}$=1.12 mg, sd=0.46) meeting 62% and 50% of the RDAs respectively. For the entire sample, copper intake ($\bar{X}$=1.22 mg, sd=0.51 mg) was below two-thirds of the RDA.

Mean intake of all subjects for vitamin B_{12} was more than twice (228%) the RDA ($\bar{X}$=4.56 µg, sd=3.96) and intake by male subjects was four times (409%) the RDA ($\bar{X}$=8.18 µg, sd=6.39). Male subjects had a mean consumption of vitamin C more than twice (269%) the RDA ($\bar{X}$=161.5 mg, sd=128.6). Mean sodium intake was high in all groups meeting 562% of the Estimated Minimum Requirement (7) of 500 mg for all subjects ($\bar{X}$=2809 mg, sd=1055), 526% for female subjects ($\bar{X}$=2630 mg, sd=992), and 705% for male subjects ($\bar{X}$=3527 mg, sd=1007).

Nutrient Intake Patterns

The ANOVA comparing average daily fiber intake for each subject showed no significant difference in fiber intake between days (F=0.5522; p=0.6470). ANOVAs comparing nutrient intake between the four fiber intake groups are summarized in Table VII (p. 45). Analyses showed significant differences in vitamin B_6 (F=2.678; df=3,126; p=0.050), copper (F=2.933; df=3,126; p=0.036), magnesium (F=4.407; df=3,126; p=0.006), and selenium (F=3.877; df=3,126; p=0.011) intakes between fiber intake groups. The Tukey's HSD post hoc tests, also summarized in Table VII (p. 45), revealed differences in vitamin B_6, magnesium and selenium intakes between fiber groups 1 (<.5gm/100 kcal) and 4 (at least 1 gm/100 kcal). Mean copper, magnesium, and selenium intakes were different between fiber groups 2 (0.5 to <.75 gm/100 kcal) and 4 (at least 1 gm/100 kcal). In addition, selenium intake was different between fiber groups 3 (0.75 to <1 gm/100 kcal) and 4 (at least 1 gm/100 kcal).

Using multiple regressions (see Table VIII, p. 46) the amount of variance in nutrient intake attributed to kilocalories was significant for all nutrients ($p<.001$). The unique variances (sr^2) of all nutrient intakes except vitamin B_{12}, calcium, and sodium were attributed to fiber intake ($p<.01$) and indicated a positive relationship.

Discussion

Nutrient Intake

Dietary adequacy of these subjects was similar to previously reported studies concerning the nutrient intake of college students (8-13). Intake studies in college students have most often reflected low iron intake, especially in women (8-12). The present study, based on the 1989 RDA, found that mean intakes of iron met at least two-thirds of the recommended levels for all groups. The mean iron intake of the female subjects met 82% of the 1989 RDA of 15 mg and would have met 68% of the 1980 RDA of 18 mg. Thus, it would appear that this sample of women consumed foods higher in iron and, therefore, had higher intakes of iron than those of previous studies.

There have been conflicting results regarding the adequacy of calcium intakes by women. Some researchers have found low calcium intakes (9-10, 13) and others found adequate calcium intakes (9, 11-12) in college women based on previous RDA or FAO/WHO guidelines. Hernon, et al (9), reported mean calcium intake of 793 mg (sd=38) for women consuming >1200 kcal per day and 468 mg (sd=65) for women consuming <1200 kcal per day. Hoffman (10) and Jakobovits (11) reported mean calcium intakes from food of 785 mg (sd=435) and 862 mg (sd=343), respectively. Calcium intake by female subjects in this study was similar to previous studies with a mean of 738 mg (sd=354) and met 62% of the 1989 RDA for calcium (1200 mg).

Hanson, et al., (14) found a low mean dietary fiber intake of 15.6 gm per day in college students (no.=61). The current study also found fiber intake to be low among all groups. Overall mean intake was 13.0 gm per day (sd=8.2). Intake by female subjects averaged 12.4 gm per day (sd=8.2) and male subjects averaged 15.5 gm per day (sd=7.6).

This study found two nutrients to be consumed in quantities greater than twice the recommended levels. Vitamin B_{12} intake was found to be high in the sample as a whole and in male subjects. Male subjects also consumed high amounts of vitamin C. These findings may be the result of higher kilocalorie intake in general by the male subjects or higher intake of foods containing vitamin B_{12}, for example meat, and foods containing vitamin C, for example, fruits and vegetables.

Sodium intake is of interest as a risk factor for hypertension. Witschi, et al. (15), found sodium intake in male and female adolescents (no.=200) to be 3,271 mg. In this study consumption averaged 2809 mg, with females consuming 2629 mg, and males 3598 mg. When compared to the NRC recommendation not to exceed 2400 mg per day (16) rather than the estimated minimum requirement of 500 mg, intakes met 117%, 109%, and 150%, respectively. This level of intake is probably indicative of the amount of processed foods consumed by this population.

Nutrient Relationships to Fiber

The main purpose of this study was to assess relationships of fiber intake to vitamin and mineral intakes. The first step was to establish the stability of fiber intake over the recorded days. No significant differences were found in dietary fiber intake over the recording period, thus it can be assumed that dietary fiber intake was stable over time.

The second step was to determine trends by grouping fiber intake levels (gm/100 kcal) and measuring differences in adequacy of vitamin and mineral intakes. The results from the ANOVAs revealed a significant difference in vitamin B_6 intake between fiber intake levels. Thus, except for vitamin B_6, no relationships between fiber intake and the intake of vitamins were found. Copper, magnesium, and selenium intakes were different between one or more of the fiber intake levels, indicating that diets with fiber intake greater than or equal to 1 gm/100 kcal had higher copper, magnesium, and selenium intakes. These results agree with a previous study (14) which found higher copper, magnesium, iron, selenium, and potassium in diets containing >1 gm fiber/100 kcal.

Multiple regression analyses revealed further significant relationships between intake of certain vitamins and minerals and intake of fiber. The amounts of unique variance in vitamin and mineral intakes accounted for by fiber intake are summarized in Table VIII (see p. 46). Significant relationships were indicated between the fiber intake and vitamin A, thiamin, riboflavin, niacin, vitamin B_6, folacin, pantothenic acid, vitamin C, and vitamin E intake. Thus, in addition to any change accounted for by kilocalories, as fiber intake increased the intake of each these nutrients increased. Significant relationships also were indicated between fiber intake and copper, iron, magnesium, phosphorus, potassium, selenium, and zinc intakes. So that as fiber intake increased the intake of each of these minerals increased (in addition to any change accounted for by kilocalories).

Implications

Analysis of the relationships between fiber, vitamin, and mineral intakes showed that fiber intake did account for significant amounts of unique variance in the intake of some vitamins and minerals. Relationships between fiber and vitamin intakes were positive as were the relationships between fiber and mineral intakes. Thus the fiber containing foods consumed by this sample were good sources of these vitamins and minerals.

The ANOVAs and post hoc tests showed no significant differences in nutrient intake levels between the fiber groups with intakes below 1 gm/100 kcal. Therefore, further study is needed to investigate interrelationships of nutrients with fiber utilizing groups of individuals with levels of dietary fiber intake at or above recommended levels from foods.

This study found that the average college student who participated needs to increase intake of fiber and copper containing foods. In addition, the average female participant needs to improve intake of dietary calcium. These results indicate that the impact of nutrition on health is still an important area for education and intervention by dietitians.

TABLES

Table VI. Energy and selected nutrient intakes of subjects

nutrient	unit	all (no.=130) mean	sd	%[a]	female (no.=104) mean	sd	%[b]	male (no.=26) mean	sd	%[c]
energy	kcal	1778	676	n/a[d]	1619	605	n/a	2411	577	n/a
dietary fiber	gm	13.0	8.2	52[e]	12.4	8.2	50[e]	15.5	7.6	62[e]
beta-carotene	RE	402	551	n/a	423	591	n/a	316	343	n/a
preformed vit A	RE	499	533	n/a	421	402	n/a	807	823	n/a
total vitamin A	RE	901	829	90	846	813	106	1123	867	112
thiamin	mg	1.42	0.67	95	1.29	0.61	117	1.97	0.60	131
riboflavin	mg	1.77	0.93	104	1.57	0.77	120	2.58	1.08	152
niacin	mg	19.3	9.7	102	17.2	8.9	115	27.8	8.4	146
vitamin B6	mg	1.61	0.94	81	1.45	0.91	91	2.25	0.78	113
vitamin B12	µg	4.56	3.96	228	3.66	2.37	183	8.18	6.39	409
folacin	µg	251	180	125	225	172	125	356	179	178
pantothenic acid	mg	4.23	2.95	77[f]	3.73	2.85	68[f]	6.22	2.52	113[f]
vitamin C	mg	96.6	83.8	161	80.3	58.8	134	161.5	128.6	269
vitamin E	mg	10.1	10.3	101	10.0	11.2	124	10.8	5.0	108
calcium	mg	843	464	70	738	354	62	1263	605	105[f]
copper	mg	1.22	0.51	54[f]	1.12	0.46	50[f]	1.64	0.54	73
iron	mg	12.3	6.5	82	11.5	6.6	77	15.5	4.8	155
magnesium	mg	254	121	73[f]	229	107	82[f]	355	122	101[f]
phosphorus	mg	1244	520	104	1119	424	93	1743	576	145
potassium	mg	2391	1031	120	2089	737	104	3598	1163	180
selenium	µg	88.0	40.7	126	78.9	35.2	144	124.2	41.7	177
sodium	mg	2809	1055	562[f]	2630	992	526[f]	3527	1007	705[f]
zinc	mg	10.3	4.8	68	9.2	4.2	77	14.3	5.1	95

[a]Calculated percentage of RDA (higher of male or female, 19-24 year olds) for those nutrients with established RDAs using the group mean intake, others as in [e] and [f].

[b]Calculated percentage of RDA (female, 19-24 year olds) for those nutrients with established RDAs using the group mean intake, others as in [e] and [f].

[c]Calculated percentage of RDA (male, 19-24 year olds) for those nutrients with established RDAs using the group mean intake, others as in [e] and [f].

[d]No established intake levels for groups.

[e]Calculated percentage of the mid-point (25 g/day) of National Cancer Institute's daily recommended intake of fiber (20-30 g/day) using the group mean intake.

[f]Calculated percentage of mid-point of those nutrients with established Estimated Safe and Adequate Daily Dietary Intakes for adults and percentage of Estimated Daily Minimum of sodium (500mg) and potassium (2000mg) intake using the group mean intake.

Table VII. Relationships between dietary fiber intake (gm/100 kcal) and nutrient intake adequacy[a]

nutrient	analysis of variance (df=3,126) F	p	mean adequacy of intake by fiber group[b] group 1 (no.=28)	group 2 (no.=49)	group 3 (no.=28)	group 4 (no.=25)
			%			
total vitamin A	0.195	0.900	68[X*]	74[X]	81[X]	75[X]
thiamin	0.521	0.669	103[X]	10[X]	108[X]	119[X]
riboflavin	0.108	0.956	131[X]	127[X]	121[X]	128[X]
niacin	1.871	0.138	107[X]	123[X]	113[X]	141[X]
vitamin B_6	2.678	0.050	71[X]	83[X,Y]	85[X,Y]	103[Y]
vitamin B_{12}	1.735	0.163	208[X]	188[X]	137[X]	178[X]
folacin	2.219	0.089	92[X]	107[X]	120[X]	139[X]
pantothenic acid	1.202	0.312	66[X]	66[X]	60[X]	78[X]
vitamin C	0.557	0.645	99[X]	111[X]	129[X]	127[X]
vitamin E	0.960	0.414	77[X]	101[X]	97[X]	94[X]
calcium	2.437	0.068	86[X]	71[X]	62[X]	61[X]
copper	2.933	0.036	51[X,Y]	51[X]	53[X,Y]	66[Y]
iron	1.436	0.235	79[X]	82[X]	68[X]	92[X]
magnesium	4.407	0.006	69[X]	73[X]	82[X,Y]	99[Y]
phosphorus	1.958	0.124	115[X]	100[X]	90[X]	113[X]
potassium	0.801	0.496	123[X]	115[X]	113[X]	132[X]
selenium	3.877	0.011	140[X]	146[X]	135[X]	188[Y]
sodium	0.866	0.461	561[X]	596[X]	519[X]	545[X]
zinc	1.152	0.331	72[X]	74[X]	68[X]	84[X]

[a]Percentages of 1989 RDAs or ESADDI and Estimated Minimum Requirement mid-points calculated for each individual by appropriate age and gender category.

[b]Groups had dietary fiber intake as follows: (1) <.5 gm/100 kcal, mean=0.38; (2) 0.5<.75 gm/100 kcal, mean=0.60; (3) 0.75<1 gm/100 kcal, mean=0.86; (4) ≥1 gm/100 kcal, mean=1.39.

[*]Means in the same row followed by like superscripts do not differ ($p<.05$). Differences were tested using Tukey's HSD post hoc.

Table VIII. Variance in nutrient intakes accounted for by energy and dietary fiber (no.=130)[a]

nutrient	kcal	fiber	
	R^2[b]	sr^2[c]	ß[d]
total vitamin A (RE)	0.165***	0.067**	0.300
thiamin (mg)	0.295***	0.110***	0.385
riboflavin (mg)	0.389***	0.041**	0.236
niacin (mg)	0.217***	0.108***	0.381
vitamin B_6 (mg)	0.347***	0.187***	0.501
vitamin B_{12} (µg)	0.225***	0.007	0.099
folacin (µg)	0.348***	0.087***	0.501
pantothenic acid (mg)	0.381***	0.083***	0.335
vitamin C (mg)	0.225***	0.057**	0.278
vitamin E (mg)	0.117***	0.056**	0.273
calcium (mg)	0.411***	0.000	0.011
copper (mg)	0.464***	0.183***	0.496
iron (mg)	0.445***	0.069***	0.305
magnesium (mg)	0.420***	0.324***	0.660
phosphorus (mg)	0.485***	0.050***	0.258
potassium (mg)	0.556***	0.073***	0.313
selenium (µg)	0.172***	0.154***	0.455
sodium (mg)	0.259***	0.015	0.041
zinc (mg)	0.298***	0.097***	0.361

[a]Nutrient intakes expressed as percent of RDA, ESADDI or Estimated Minimum Requirements, energy as kcal per day, and dietary fiber as grams per day.
[b]Total variance in nutrient intake accounted for by kilocalorie intake.
[c]Unique variance in nutrient intake accounted for by dietary fiber intake.
[d]For each standard deviation change of nutrient intake, intake of fiber will change by the amount of ß in standard deviations. Comparison of this column shows relative importance of intake relationships.
**$p<.01$, ***$p<.001$.

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CHAPTER V

RESULTS AND DISCUSSION

Introduction

Chapter V will present the results of statistical analyses not addressed in Chapter IV. The second section of Chapter V will consist of a discussion of the results and presentation of implications for further research.

Results

Table IX summarizes the medians and ranges of intakes by all subjects and classified by gender. Means and standard deviations were previously reported in Chapter IV and summarized in Table VI. Adequacy of intake was assessed by comparing means to RDAs or the mid-points of ESADDI and Estimated Minimum Requirements. These intakes as a percent of the guidelines are tabulated in Table X on page 52.

While mean iron intake overall met 82% of the RDA and intake by women met 77%, over one-half (55%) of the women had inadequate intakes (<67% RDA). Mean iron consumption by males met 155% of the RDA, all men had adequate intakes, and 88% of them consumed >100% of the RDA. At least one-half the women also consumed inadequate amounts of vitamin A (50%) and pantothenic acid (62%), yet, women, as a group,

TABLE IX

MEDIANS AND RANGES OF NUTRIENT INTAKES

Nutrient	Unit	All (no.=130) Median	Range	Female (no.=104) Median	Range	Male (no.=26) Median	Range
Energy	kcal	1669	428 - 3969	1569	429 - 3969	2344	1586 - 3508
Dietary fiber	gm	11.4	1.7 - 71.3	10.8	1.7 - 71.3	14.5	5.1 - 36.1
Beta-carotene	RE	176	21 - 3249	174	21 - 3249	176	53 - 1289
Preformed vit A	RE	338	9 - 3479	306	9 - 2347	487	144 - 3479
Total vitamin A	RE	577	36 - 4221	541	36 - 4221	763	208 - 3590
Thiamin	mg	1.28	0.44 - 3.93	1.19	0.44 - 3.93	1.87	0.57 - 3.21
Riboflavin	mg	1.55	0.44 - 5.35	1.39	0.44 - 5.35	2.32	1.00 - 5.26
Niacin	mg	16.4	2.0 - 65.4	15.1	2.0 - 65.4	27.9	10.7 - 40.9
Vitamin B_6	mg	1.35	0.43 - 7.32	1.20	0.43 - 7.32	2.15	0.79 - 4.11
Vitamin B_{12}	µg	3.62	0.30 - 34.49	3.16	0.30 - 16.95	6.58	2.69 - 34.49
Folacin	µg	201	44 - 1290	171	44 - 1290	327	76 - 739
Pantothenic acid	mg	3.65	0.99 - 27.85	3.26	0.99 - 27.85	5.94	2.32 - 13.25
Vitamin C	mg	73.1	4.4 - 514.5	67.3	4.4 - 321.0	136.6	23.5 - 514.5
Vitamin E	mg	7.88	0.83 - 78.17	7.56	0.83 - 78.17	11.1	1.9 - 19.9
Calcium	mg	750	105 - 2636	706	105 - 1890	1105	328 - 2636
Copper	mg	1.12	0.39 - 3.47	1.04	0.39 - 3.47	1.58	0.52 - 2.72
Iron	mg	10.5	2.0 - 53.3	9.7	2.0 - 53.3	14.6	9.0 - 24.4
Magnesium	mg	217	78 - 879	203	78 - 879	340	171 - 621
Phosphorus	mg	1185	323 - 3278	1075	323 - 2586	1643	657 - 3278
Potassium	mg	2226	653 - 6302	1971	653 - 5310	3414	2129 - 6302
Selenium	µg	79.3	11.6 - 230.0	73.9	11.6 - 230.0	125.3	27.3 - 215.0
Sodium	mg	2806	289 - 6209	2592	289 - 5448	3517	1286 - 6209
Zinc	mg	9.13	1.90 - 33.00	8.56	1.90 - 31.10	13.9	5.3 - 33.0

were considered to have intakes which were adequate. Mean intakes of calcium (738 mg) and copper (1.12 mg) by women were low. Calcium intake was inadequate in 63% and copper intake was inadequate in 84% of the women who participated.

TABLE X

DISTRIBUTION OF NUTRIENT INTAKE ADEQUACY

Nutrient	Intake as % of Guidelines[a]					
	<67%	67-100%	>100%	<67%	67-100%	>100%
	% women[b]			% men[c]		
Vitamin A, RE	50	17	33	42	16	42
Thiamin, mg	15	27	58	4	19	77
Riboflavin, mg	16	31	53	8	8	84
Niacin, mg	14	36	50	4	19	77
Vitamin B_6, mg	38	39	25	11	31	58
Vitamin B_{12}, µg	9	10	81	0	0	100
Folacin, µg	23	32	45	8	8	84
Pantothenic acid,mg	62	28	10	23	23	54
Vitamin C, mg	31	12	57	8	19	73
Vitamin E, mg	29	28	43	23	19	58
Calcium, mg	63	24	13	23	38	39
Copper, mg	84	14	2	42	46	12
Iron, mg	55	29	16	0	12	88
Magnesium, mg	44	36	20	19	42	39
Phosphorus, mg	24	38	38	4	8	88
Potassium, mg	12	46	48	0	0	100
Selenium, µg	6	17	77	4	8	88
Sodium, mg	1	2	97	0	0	100
Zinc, mg	44	41	15	11	58	31

[a]Expressed as percentages of 1989 RDAs or ESADDI and Estimated Minimum Requirement mid-points.
[b]no.=104
[c]no.=26

Men who participated were found to have adequate intake for all vitamins and minerals using the group average. In addition, over one-half of the men who participated had intakes which were more than adequate for thiamin (77%), riboflavin (84%), niacin (77%), vitamin B_6 (58%), vitamin B_{12} (100%), folacin (84%), pantothenic acid (58%), vitamin C (73%), vitamin E (58%), iron (88%), phosphorus (88%), potassium (100%), selenium (88%), and sodium (100%).

Meal and snack consumption patterns, summarized in Tables XI and XII, showed that 38% of the males skipped breakfast and 31% of the females skipped the meal. Overall, more subjects skipped breakfast (32%) than lunch (5%) or dinner (8%). Subjects consumed and average of 1.25 snacks per day and ate 3.98 times. Only 13% of the subjects reported no food consumption between meals.

TABLE XI

FREQUENCY OF MEALS AND SNACKS BY MALE, FEMALE, AND ALL SUBJECTS

Subjects	Snacks Eaten per Day		Meals and Snacks per Day	
	Average Number	Range	Average Number	Range
All (no.=130)	1.25	0 - 4	3.98	2 - 7
Female (no.=104)	1.20	0 - 4	3.94	2 - 7
Male (no.=26)	1.40	0 - 3.5	4.13	3 - 6

TABLE XII

MEAL AND SNACK CONSUMPTION PATTERNS

Meal/snack	All Subjects (no.=130)		Female (no.=104)		Male (no.=26)	
	number of subjects	per-cent	number of subjects	per-cent	number of subjects	per-cent
Breakfast						
Always skipped	13	10	9	9	4	15
Skipped at least once[a]	29	22	23	22	6	23
Lunch						
Always skipped	1	<1	1	1	0	0
Skipped at least once[a]	5	4	5	5	0	0
Dinner						
Always skipped	1	<1	1	1	0	0
Skipped at least once[a]	7	5	5	5	2	8
Snacks						
Never consumed	17	13	15	14	2	8

[a]Two- and four-day food records were used. A meal could be skipped up to three times on the four-day records yet remain in this category. This category does not include subjects who always skipped the meal.

Wide ranges and large standard deviations also indicated the disparity of the data. Visual comparison of means and medians indicated that data for most of the nutrients were negatively skewed. Kolmogorov-Smirnov tests were used to evaluate the normality of the data distributions further.

Four day and two day intake averages for those vitamins and minerals with established guidelines were expressed as percentages of RDAs for the appropriate gender and age group, or mid-points of ESADDIs or Estimated Minimum Requirements. Kolmogorov-Smirnov goodness of fit tests, summarized in Table XIII, found the data to have non-normal distributions ($p<.05$) for vitamin A, thiamin, vitamin B_6, vitamin B_{12}, folacin, pantothenic acid, vitamin C, vitamin E, iron, magnesium, and zinc. Data for riboflavin, niacin, calcium, copper, phosphorus, potassium, selenium, and sodium had normal distributions. In addition, examination of the data distributions for fiber (gm) and energy (kcal) determined a non-normal distribution of fiber intake data and normal distribution for energy. After transformation of data with non-normal distributions to logarithms the data were found to be normally distributed (p=0.173 to 0.924).

TABLE XIII

KOLMOGOROV-SMIRNOV p-VALUES FOR TESTING THE HYPOTHESIS THAT THE DATA[a] COME FROM A NORMAL DISTRIBUTION

Energy and Nutrients	p-values[b]	Nutrients	p-values[b]
Energy, kcal	0.264[c]	Vitamin C, mg	0.009
Dietary fiber, gm	0.006[c]	Vitamin E, mg	0.001
Total vitamin A, RE	0.001	Calcium, mg	0.154
Thiamin, mg	0.004	Copper, mg	0.090
Riboflavin, mg	0.172	Iron, mg	0.002
Niacin, mg	0.079	Magnesium, mg	0.052
Vitamin B_6, mg	0.005	Phosphorus, mg	0.249
Vitamin B_{12}, µg	0.001	Potassium, mg	0.119
Folacin, µg	0.004	Selenium, µg	0.133
Pantothenic acid, mg	0.001	Sodium, mg	0.572
		Zinc, mg	0.029

[a] Mean of two- or four-day intakes for each subject, no.=130.
[b] Significance indicates non-normal distribution.
[c] Means expressed as units listed; all other means expressed as percent of RDA or ESADDI or Estimated Minimum Requirements.

Those analyses which adjusted for the influence of kilocalories were reported in Chapter IV. This included ANOVAs using fiber intake groups of gm fiber/100 kcal and multiple regressions. Pearson correlation coefficients (Table XIV) did not adjust for the influence of kilocalories and showed significant relationships between fiber intake and all vitamin and minerals at the <.001 significance level. The correlations were positive and ranged from 0.3133 to 0.8187.

TABLE XIV

CORRELATION OF DIETARY FIBER[a] INTAKE TO INTAKE OF ENERGY, VITAMINS, AND MINERALS (no.=130)

	r		r
Energy, kcal	0.5053***	Vitamin C, mg	0.4465***
Beta-carotene, RE	0.3416***	Vitamin E, mg	0.3757***
Preformed vit A, RE	0.3776***	Calcium, mg	0.3316***
Total vitamin A, RE	0.4288***	Copper, mg	0.7134***
Thiamin, mg	0.5607***	Iron, mg	0.5640***
Riboflavin, mg	0.4904***	Magnesium, mg	0.8187***
Niacin, mg	0.5190***	Phosphorus, mg	0.5444***
Vitamin B_6, mg	0.6705***	Potassium, mg	0.6097***
Vitamin B_{12}, µg	0.3133***	Selenium, µg	0.5486***
Folacin, µg	0.6710***	Sodium, mg	0.3622***
Pantothenic acid, mg	0.5610***	Zinc, mg	0.5449***

[a] Pearson correlation coefficients using dietary fiber intake (gm/day) and each listed variable.

***p<.001.

Analysis of variance between fiber intake groups expressed as grams per day and the Tukey's HSD post hoc tests are summarized in Table XV. There were significant differences in adequacy of intake for all vitamins and minerals except calcium. The Tukey's HSD post hoc tests on these ANOVAs showed all nutrient intakes by fiber group 4 (>18 gm/day) to be different ($p<.05$) from at least two of the groups with lower fiber intake.

Discussion

Review of the Purpose and Objectives

The purpose of the study was to assess the adequacy of vitamin and mineral intake of college students in relationship to fiber intake. The specific objectives of the study were as follows:

1. To investigate the relationship of vitamin and mineral intake to the levels of dietary fiber intake.

2. To assess the adequacy of vitamin and mineral intake by college students as compared to the Recommended Dietary Allowances (RDAs), Estimated Safe and Adequate Daily Dietary Intakes (ESADDIs), and Estimated Minimum Requirements.

Summary of the Hypotheses

The first hypotheses stated that there would be no difference in fiber intake between days within subjects. No

TABLE XV

RELATIONSHIPS BETWEEN DIETARY FIBER INTAKE (GM/DAY) AND NUTRIENT INTAKE ADEQUACY[a]

Nutrient	Analysis of Variance (df=3,126)		Mean Adequacy of Intake by Fiber Group[b]			
	F	p	Group 1 (no.=15)	Group 2 (no.=59)	Group 3 (no.=33)	Group 4 (no.=23)
			%			
Total vitamin A	3.525	0.017	47^{x*}	$66^{x,y}$	$87^{x,y}$	108^{y}
Thiamin	12.589	0.001	78^{x}	98^{x}	125^{y}	151^{y}
Riboflavin	8.092	0.001	89^{x}	$112^{x,y}$	$142^{y,z}$	167^{z}
Niacin	14.494	0.001	88^{x}	101^{x}	135	174
Vitamin B_6	25.110	0.001	57^{x}	70^{x}	99	140
Vitamin B_{12}	3.136	0.028	135^{x}	156^{x}	224^{x}	214^{x}
Folacin	23.696	0.001	55	95	144^{x}	187^{x}
Pantothenic acid	11.822	0.001	44^{x}	59^{x}	79^{y}	94^{y}
Vitamin C	8.144	0.001	58^{x}	$98^{x,y}$	168^{z}	$158^{y,z}$
Vitamin E	5.933	0.008	53^{x}	$86^{x,y}$	117^{y}	115^{y}
Calcium	2.563	0.058	49^{x}	68^{x}	78^{x}	80^{x}
Copper	28.185	0.001	33^{x}	46^{x}	61	79
Iron	13.621	0.001	53^{x}	68^{x}	95^{y}	122^{y}
Magnesium	41.224	0.001	48	68	92	126
Phosphorus	9.785	0.001	74^{x}	$93^{x,y}$	$114^{y,z}$	135^{z}
Potassium	13.995	0.001	80^{x}	105^{x}	135^{y}	162^{y}
Selenium	11.479	0.001	105^{x}	$135^{x,y}$	162^{y}	203
Sodium	4.980	0.003	451^{x}	522^{x}	$611^{x,y}$	667^{y}
Zinc	11.281	0.001	52^{x}	$68^{x,y}$	$82^{y,z}$	100^{z}

[a]Percentages of 1989 RDAs or ESADDI mid-points or Estimated Minimum Requirement mid-points calculated for each individual by appropriate age and gender category.

[b]Groups had dietary fiber intake as follows: (1) <6 gm/day, mean=4.8; (2) 6<12 gm/day, mean=9.2; (3) 12<18 gm/day, mean=14.7; (4) ≥18 gm/day, mean=25.9.

*Means in the same row followed by like superscripts do not differ (p<.05). Differences were tested using Tukey's HSD post hoc.

significant difference in fiber intake between days was found, therefore, H_o1 was not rejected.

The second hypothesis stated that there would be no relationship between the intake of dietary fiber and intake of vitamins and minerals. Fiber intake was positively related to the intake of vitamin A, thiamin, riboflavin, niacin, vitamin B_6, folacin, pantothenic acid, vitamin C, vitamin E, copper, magnesium, phosphorus, potassium, selenium, and zinc intakes. Therefore, H_o2 was rejected for those vitamins and minerals.

The third hypothesis stated that students consuming >18 gm fiber per day will not have significantly higher vitamin or mineral intake than students who consume <18 gm fiber/day. Significant differences of vitamin and mineral intakes were found between students consuming >18 gm of fiber per day and those students consuming less dietary fiber. All tests were significant except for vitamin B_{12}, and calcium. Based on these results H_o3 was rejected for all vitamins and minerals except for vitamin B_{12} and calcium.

Hypothesis four stated that students consuming >1 gm fiber/100 kcal will not have significantly higher vitamin or mineral intake than students who consume <1 gm fiber/100 kcal. Significantly greater intakes of vitamin B_6, copper, magnesium, and selenium at the higher fiber intake level were found. Thus, H_o4 was rejected for these nutrients.

The final hypothesis stated that the subjects' average vitamin and mineral intakes will not meet 2/3 of the current RDAs, ESADDIs, and Estimated Minimum Requirements for this population. Mean intake levels were above the established guidelines for all nutrients except fiber and copper. In addition, calcium intake by female subjects fell below the guidelines. Therefore, H_o5 was rejected for all vitamins and all minerals, except copper for all subjects and calcium in women. Thus, mean dietary intakes of vitamins and minerals from the diets of these subjects were adequate with copper and calcium being the only exceptions.

Discussion and Implications

Relationships existed between the intake of dietary fiber and the intake of certain vitamins and minerals. Dietary fiber intake was found to be positively related to vitamin A, thiamin, riboflavin, niacin, vitamin B_6, folacin, pantothenic acid, vitamin C, vitamin E, copper, magnesium, phosphorus, potassium, selenium, and zinc beyond the effect of kilocalories. Diets containing adequate levels of dietary fiber also contain significantly more vitamin B_6, copper, magnesium and selenium. Even though the average dietary fiber intake was low in this sample, vitamin and mineral intakes were adequate when compared to established guidelines (two-thirds RDAs, ESADDIs, or Estimated Minimum Intakes) except for copper and calcium in women, and copper in the whole sample.

These data indicated that while most nutrient intakes were adequate based on typically used standards, even when dietary fiber intakes were below standards for health, the quality of many of the individual intakes could be improved by increasing the intake of higher fiber foods. Some nutrient intake patterns are influenced by fiber intake; therefore, foods and/or food combinations apparently are sources of both fiber and these nutrients.

There were some limitations in this research study, which should be considered when interpreting these data. The sample was not a random sample of college students. This may decrease the generalizability of these results to other college students or college age populations. Ideally, a random stratified sample of all students would be used. The current nutrient databases sometimes have missing or inaccurate values, especially for some trace minerals. This will lower accuracy of the analysis for those nutrients.

Findings derived from the study may have practical implications for other researchers or practitioner in this area. In general, promoting the increased intake of high fiber foods will improve the intake of important vitamins and minerals. One prime target for such nutrition education may be college women, since this study showed inadequate intake of copper and many fiber containing foods are good sources of copper

This sample had low average dietary fiber intake. An area of further research would be to determine the pattern of relationships between fiber intake and the intake of vitamins and minerals at greater fiber intakes, more similar to those seen in other countries and proposed for the prevention or treatment of disease.

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APPENDICES

APPENDIX A

FNIA 1113 ASSIGNMENT INSTRUCTIONS, DEMONSTRATION OF COMMON SERVING SIZES, AND FOOD RECORD FORM

INSTRUCTIONS FOR FOOD RECORD SHEETS

Date Due:___________________(to be filled in by student!)

1. Keep a record of all the foods and beverages you put into your mouth and swallow for four days. Keep food records on the following pages (D3-D6).

2. List the food as soon as it is eaten, perhaps at the table. DO NOT TRUST YOUR MEMORY!!!!

3. Describe each item as completely as possible. Examples:
   a) state "fried chicken" if it is fried not just "chicken"
   b) milk, whole; or milk, 2%; or milk, skim not just milk.
   c) bread, white soft; bread, firm, whole wheat; bread, enriched french.

4. Include all extras as butter and jelly for bread; butter or sauce on vegetables; dressing on salads and spreads on sandwiches. Remember, vegetables which you yourself have not prepared can be assumed to contain 1/2 tsp. butter or margarine per 1/2 cup serving.

5. Observe and estimate the size of the serving in common household measures (tablespoons, cups, slice, etc.). List the amount you actually ate in the column headed "amount." Review the display outside room HEW 401. Refer to page D-2 for standard portions commonly served in restaurants and residence halls.

   Indicate at the end of each day if you feel that this was a typical day for you, and IF NOT, WHY?

6. This dietary study is a semester long project. Work carefully, neatly, and promptly on all parts of it to maximize the learning you can gain from it. This careful work will also maximize the score you receive for it!!

7. **Complete all of the dietary assignments in pencil. Corrections are neater and easier to make when pencil is used.**

DEMONSTRATION OF COMMON SERVING SIZES

Observe the serving sizes of various foods in the display case outside HEW 401.

Dishes of various sizes:

1 c	measuring cup
1 c	cereal dish
1/2 c	sauce dish
1/2 c	juice glass
1 c	milk glass
1.5 c	iced tea glass

Equivalents by weight:

1 lb. = 16 oz. = 453.6 g
1 oz. = 28.35 g
3.5 oz. = 100 g

Equivalents by volume:

1 qt. = 4 c
1 c =1/2 pint = 16 Tbsp
1 Tbsp = 3 tsp

Food is commonly served in the following portion sizes:

MILK GROUP

Milk	1 cup glass
Cottage cheese	1/2 c
Ice cream	1/2 c
Yogurt	3/4 c (6 oz. carton) or 1 c (8 oz.)look at the package and check quantity

MEAT GROUP

meat, fish or poultry will vary but a 3 ounce portion is typical in a residence hall.

FRUIT

canned types	1/2 c
raw	1 piece (an apple, orange, or banana, etc.)
	1/2 grapefruit or 1/4 cantaloupe

VEGETABLES

1/2 cup when cooked
lettuce wedge - 1/8 large head or 1/4 small head
green salads 1 cup raw

GRAINS

1 slice bread or 1 roll
dry cereal (see Appendix A packet)
macaroni and cheese - 1 cup as a main dish or 1/2 c as a side dish

DESSERTS

cake - 2" x 2" square
pie - 1/7 of pie
gelatin 1/2 c

MISCELLANEOUS

jelly, cream - 1 Tbsp
butter, margarine = 1 pat = 1 tsp
sugar, 1 packet = 1 tsp

FOOD RECORD SHEET NAME______________

DAY________DATE__________ ROLL NO.___________

FOOD	AMOUNT	BASIC FOUR FOOD GROUP
BREAKFAST		
LUNCH		
DINNER		
SNACKS		

TYPICAL? EXPLAIN

APPENDIX B

CONSENT FORM

Oklahoma State University

Department of Food, Nutrition and Institution Administration

425 HOME ECONOMICS WEST
STILLWATER, OKLAHOMA 74078
(405) 624-5039

CONSENT TO PARTICIPATE

I have been told about the nutrition research study at Oklahoma State University to investigate the nutrient and dietary fiber intake of college students. I understand that I agree to:

1) Allow my dietary records written for my class assignment in FNIA 1113 to be copied and analyzed for fiber and other nutrient values.

2) Tell whether I live on campus and eat in the university on campus dining hall or live and eat off campus.

I understant that I can drop out of the study any time I want to. Any unusual findings from my diet will be reported to me and no information about me will be given to other people. I understand that all information about me will be strictly confidential.

I voluntarily agree to be in this study.

Signed: ______________________________

Student ID #: ______________________________

Date: ______________________________

VITA

Laura Marie Hutton Campbell

Candidate for the Degree

of Master of Science

Thesis: THE RELATIONSHIP OF DIETARY FIBER AND VITAMIN AND MINERAL INTAKE

Major Field: Food, Nutrition and Institution Administration

Biographical:

Personal Data: Born in Oklahoma City, Oklahoma, September 5, 1961, the daughter of E. Gene and Susie M. Hutton.

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Professional Experience: Research Assistant, Department of Food, Nutrition, and Institution Administration, January, 1988 to December, 1988 and May, 1990 to June, 1990; Teaching Assistant, College of Home Economics, January, 1989 to May, 1989; Applied Pre-Professional Practice Program, Oklahoma State University, August, 1989 to May, 1990.

Organizations: American Dietetic Association; Society for Nutrition Education; International Federation for Home Economics.