DIETARY FIBER CONSUMPTION PATTERNS OF COLLEGE STUDENTS

By

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CHAPTER I

THE RESEARCH PROBLEM

Introduction

The theory that inadequate fiber intake is related to heart disease, diabetes, obesity, colon cancer, and many other degenerative disorders has been widely discussed in the scientific literature (Burkitt, 1969; Bingham et al., 1979: Mbofung et al., 1984; Lanza et al., 1987). This theory is based on epidemiological observations of disease patterns in various parts of the world when dietary fiber intakes are compared (Bingham et al., 1979). One such observation is the low incidence of bowel disorders, such as diverticular disease and colon cancer in rural Africa, when compared to the incidence in developed countries such as the United States, the United Kingdom, and France (Burkitt, 1969; Painter and Burkitt, 1971). Dietary fiber intakes are from one to four times higher in Africa than in these developed countries (Mbofung et al., 1984).

Different types of dietary fiber have different physiological effects. For example, pectin, a soluble fiber, is effective in lowering serum cholesterol and increasing fecal output of bile acids, while wheat bran, which contains mostly insoluble fiber, stimulates colonic

function and speeds passage time (Van Staveren et al., 1982). Pectin and gums increase intestinal transit time and delay the absorption of glucose and other nutrients (Eastwood and Passmore, 1983).

The insufficiency of specific data on dietary fiber intake of various countries intereferes with the interpretation of epidemiologic studies in this field. This is partly due to the difficulties involved with the analysis of dietary fiber, although numerous methods have been attempted. Also, values on dietary fiber content of foods are not usually provided in national food composition tables (Lanza and Butrum, 1986).

Only recently has adequate measurement of fiber been possible for various human foods. Many foods still have not been analyzed for total fiber content. The level and types of dietary fiber are essential in determining physiological effects (Bingham et al., 1979).

Purpose and Objectives

The purpose of this study was to assess the dietary fiber and macronutrients intake patterns of college students.

The objectives of this study were:

1. To determine the level of dietary fiber intake of college students and to compare the dietary fiber intake with current dietary recommendations.

2. To determine the food group sources of dietary fiber in college student diets, and to compare these intakes

with the Basic Four Food Group recommendations.

3. To determine the macronutrient intake of college students and to compare this with the U.S. Dietary Goals recommendations.

Null Hypotheses

This research project is a descriptive study of students dietary habits using already existing records. Although specific research hypotheses cannot be tested because this is not an analytical research project, null hypotheses were developed to help evaluate and describe the results.

The null hypotheses of this study were:

Hypothesis 1: There will be no difference between the fiber consumption of college students and the U.S. currently recommended dietary fiber intake.

Hypothesis 2: There will be no difference between the quantity of dietary fiber provided by fruits, vegetables, and grains.

Hypothesis 3: There will be no difference between the number of basic four food group servings of grains, fruits, and vegetables consumed by college students and the recommended numbers of servings.

Hypothesis 4: There will be no difference between the proportions of macronutrients--carbohydrate, fat, and protein--consumed by college students and the recommended proportions.

Assumptions

The assumptions of this study were:

1. Students were accurate and complete in recording their dietary intakes.

2. The fiber and macronutrient intakes of subjects was accurately estimated by the values used in the "Food Processor II" computer program (ESHA Corporation, P.O. Box 13028, Salem, Oregon 97309).

3. Fatty acid analysis in the data base is incomplete.

Limitations

The limitations of this study were:

1. The sample size was limited to the students in one class: FNIA 1113, Basic Human Nutrition, rather than a random sample of all students from Oklahoma State University.

2. Accurate fiber data for all foods is not available.

Definitions

The following definitions were used in this study:

Alimentary: "Digestive tract from the mouth and esophagus to the rectum, and including accessory glands" (Graves and Taber, 1938).

Colorimetric Analysis: "Determination of the amount of a particular chemical which is present in a sample, using a chemically developed color as a measure of a concentration (Thomas and Chamberlin, 1980).

Dietary History: "Food records by recall to discover usual food pattern over relatively long period of time" (Bureau of Human Nutrition and Home Economics, 1948).

Diverticular Disease: The abnormal condition of having a pouchlike bulging through the muscular wall. This may occur in the stomach, in the small intestine, or, most commonly, in the colon (Glanze et al., 1985).

Gravimetric: "A weighed amount of the qualitively known sample is treated so that the component to be determined, or some suitable derivative of it, transferred to a separate phase; it must then be separated by an appropriate method from the other components and finally the component or its known derivative must be weighed. From the data obtained, the percentage of the component in the sample can be calculated by the laws of stoichiometry" (Erdey, 1963).

Legume: "Any of a large family of herbs, shrubs, and trees, including the peas, beans, vetches, clover, etc., with usually compound leaves, flowers having a single carpel, and fruit that is a dry pod splitting along two sutures" (Webster's New World Dictionary, 1984).

Pulse: "The edible seeds of peas, beans, lentiles, and similar plants having pods" (Webster's New World Dictionary, 1984).

Format of Thesis

This thesis contains six chapters, consisting of Introduction, Literature Review, Materials and Methods, Results, Journal Article, and Conclusions. Chapter V was

written in accordance with the Guidelines for Authors from the Journal of American Dietetic Association and will be submitted to that journal.

CHAPTER II

REVIEW OF LITERATURE

Definition of and types of dietary fiber and analysis methods will be reviewed. Dietary fiber content of food (grains, fruits, and vegetables), worldwide dietary fiber consumption patterns, and health implications of dietary fiber will be discussed.

Definition of Dietary Fiber

Trowell (1972) defined dietary fiber as "plant cellular material resistant to digestion by the alimentary enzymes of human beings." In 1975, gastroenterologists pointed out that "the dietary fiber consisted of not only insoluble indigestible structural cell wall polysaccharides (cellulose and hemicellulose) and lignin, but also the water-soluble indigestible storage plant polysaccharides: gums, mucilages, and particularly pectin (Trowell, 1976)." In 1987, Bingham proposed a definition "unavailable carbohydrate, indigestible residue, and plant polysaccharıdes and lignın which are resitant to hydrolysis by digestive enzymes of man". The most popular current definition of dietary fiber is "the portion of plant cells that cannot be digested by human alimentary enzymes and, therefore, cannot be absorbed from human small intestine" (Slavin, 1987).

Types of Dietary Fiber

Eastwood and Passmore (1983) reported that "the main components of plant cell wall are fibrous polysaccharides (mainly cellulose), matrix polysaccharides (pectin substances, hemicellulose, and glycoproteins), and incrusting substances, mainly lignin." All these components, except lignin, are polysaccharides (Schneeman, 1986; Slavin, 1987). Fibrous or viscous polysaccharides, indigestible in the mammalian small intestine, are structural components of plant cell walls and make up dietary fiber (Trowell et al., 1976).

The chemical composition of cell-wall materials differs in different plant types. Therefore, the chemistry of dietary fiber differs from plant to plant and is affected by the growing conditions and age of the plant (Eastwood and Passmore, 1983; Schneeman, 1986). For example, the amount of cellulose and lignin increases as the plant grows (Schneeman, 1986).

Cellulose

Cellulose is a polymer of glucose linked by beta 1-4 bonds. It is relatively insoluble in alkali (Southgate, 1986; Schneeman, 1986) and is the major structural polysaccharide in plant cell walls (Schneeman, 1986; Slavin, 1987).

Hemicellulose

Hemicellulose is a branched polymer of pentose and hexose sugars, xylose, mannose, glucose, arabinose, and galactose (Eastwood and Passmore, 1983) and is a structural polysaccharide associated with the cell wall (Schneeman, 1986; Slavin, 1987). It is insoluble in water but soluble in dilute alkali (Southgate, 1986). Hemicellulose with a higher degree of branching has a higher solubility than hemicellulose with a lower degree of branching.

Lignin

Lignin is a three dimentional structural nonpolysaccharide (Schneeman, 1986; Slavin, 1987) and is a polymer of a aromatic alcohols (Eastwood and Passmore, 1983). Lignin is insoluble in 12 molar sulfuric acid (Southgate, 1986).

Pectin

Pectin is primarily composed of D-galacturonic acid, is highly soluble in water (Southgate, 1986) and is a non-structural polysaccharide secreted by the cells upon injury. It is found in cell walls and intercellular cement (Schneeman, 1986; Slavin, 1987).

Gums

Gums are water-soluble viscous, non-structural polysaccharides, which are polymers of glucose, galactose,

mannose, arabinose, rhamnose, and their uronic acids (Eastwood and Passmore, 1983; Schneeman, 1986; Slavin, 1987).

Mucilages

Mucilages are non-structural polysaccharides (Schneeman, 1986; Slavin, 1987) composed of galactose-mannose, glucose-mannose, arabinose-xylose, and galacturonic acid-rhamnose. They are from seeds and seaweed, can hold considerable water, and are viscous (Eastwood and Passmore, 1983).

Analysis of Dietary Fiber

Correct measurements of dietary fiber are important for accurate prediction and interpretation of its therapeutic effects (Anderson and Bridges, 1988). It is difficult to find methods to estimate dietary fiber because the most widely accepted definition for dietary fiber is physiological (Slavin, 1987), meaning that the definition is based on the digestive ability of the small intestine.

Crude Fiber Analysis

Crude fiber analysis is known as the Weende method and is the oldest method of fiber analysis (Lanza and Butrum, 1986). The method was developed in the first part of the 19th century (Van Soest, 1977), and was originally designed to measure fiber in animal feeds (Slavin, 1987).

This method measures the indigestible components

remaining after boiling fat free food with sulfuric acid and then with sodium hydroxide solutions (Furda, 1986). This process breaks down all soluble fiber and variable amounts of insoluble fiber. Crude fiber analysis does not give constant values for various fiber components and greatly underestimates fiber components. Only 20% of the hemicellulose, 10 to 40% of the lignin, and 50 to 90% of the cellulose remain after crude fiber analysis (Lanza and Butrum, 1986).

Neutral Detergent Fiber Analysis

Van Soest, working at the USDA station at Beltsville, Maryland in 1963, developed the neutral detergent and acid detergent methods of fiber analysis (Horvath and Robertson, 1986).

The neutral detergent fiber method is the most convenient analysis of water-insoluble dietary fiber (Lanza and Butrum, 1986). This method removes cell contents and water-soluble plant cell wall components of foods by boiling with sodium lauryl sulphate at a neutral pH (Goering and Van Soest, 1970; Lanza and Butrum, 1986). The fiber measured by this method are cellulose, insoluble hemicellulose, and lignin (Lanza and Butrum, 1986; Schneeman, 1986; Slavin, 1987). However, nearly all the water-soluble fibers (pectins, gums, mucilages, and some hemicelluloses) are lost in the procedure (Lanza and Butrum, 1986; Slavin, 1987).

The acid detergent fiber method measures the cellulose and lignin remaining after extraction of food with the

boiling acid detergent solution (Goering and Van Soest, 1970). However, the acid detergent fiber contains some pectins and as much as 10% of residual hemicelluloses (Lanza and Butrum, 1986). These two methods underestimates the total fiber content of foods because the soluble fibers are lost during the procedure (Schneeman, 1986).

Total Fiber Methods of Dietary Fiber Analysis

The Southgate procedure removes individual nonfibrous fractions through a serious of chemical and enzymatic extraction steps and leaves total dietary fiber (Slavin, 1987). It uses colorimetric techniques for sugar analysis and may not completely remove starch from some foods (Anderson and Bridges, 1988). The Southgate method gives higher dietary fiber values than other dietary fiber methods (Slavin, 1987).

Hellendoorn et al., (1975) developed the enzymatic gravimetric method to measure carbohydrates indigestible in the human intestinal tract. The procedures uses physiological enzymes (pepsin and pancreatin) to remove protein and starch in foods. This procedure only measures insoluble dietary fiber, however, it does not remove all pectin and starch completely (Lanza and Butrum, 1986; Slavin, 1987).

Enzymatic methods of Asp et al., are a development of the method of Hellendoorn et al., and uses physiological enzymes, pepsin and pancreatin, to remove starch and protein. The procedure measures soluble and insoluble

fiber. Soluble fiber is precipitated with ethanol. This method uses incubation (19 to 38 hours) and repeated centrifugation to regain the dietary fiber fraction. In a modified method, separation of both insoluble and precipitated soluble fiber is done by filtration (Asp, 1986). This procedure can overestimate fiber if starch hydrolysis and protein removal are not complete (Schneeman, 1986; Slavin, 1987).

Prosky developed the enzymatic gravimetric method (Asp, 1986), which was designed to measure total soluble and insoluble fiber. The procedure enzymatically removes protein and starch from fat free foods. The residue is corrected for ash and protein content, and the fiber is estimated gravimetrically. This procedure does not determine each fiber component (Schneeman, 1986).

The Food and Drug Administration carried out a large collaborative study to estimate total dietary fiber in foods using an enzymatic gravimetric procedure based on the methods of Asp, Englyst, Furda, Schweitzer, Southgate, Theander, and Van Soest. The results showed large interlaboratory variations due to incomplete hydrolysis of starch and incomplete removal of protein. The method was modified and a second collaborative study was undertaken. The modified method is now an accepted method by the Association ofOfficial Analytical Chemists (Lanza and Butrum, 1986; Slavin, 1987).

Health Implications of Dietary Fiber

The effect of dietary fiber intake on diabetes, coronary heart disease, colon cancer, colonic diverticular disease, and constipation will be reviewed.

Diabetes

Diabetes is not common in rural areas where dietary fiber intake is high but is common in urban areas where dietary fiber intake is low. Water-soluble fibers, such as guar gum, pectin and fiber from legumes, play as important role in modifying glucose metabolism (Anderson, 1985). Glucose absorption is delayed when high-fiber foods are given apparently due to delayed gastric emptying, incomplete carbohydrate absorption from high-fiber foods, and delayed glucose absorption ın small intestine (Harold et al., 1985).

Harold et al., (1985) studied the effect of dietary fiber in insulin-dependent diabetics. The subjects consumed a series of three diets: control (normal daily intake), wheat bran (normal daily intake plus 78 g wheat bran per day), and cellulose (normal daily intake plus 30 g cellulose per day). The wheat bran and cellulose diets included 60 g of dietary fiber, with 50% of the daily dietary fiber intake from wheat bran or cellulose. The mean daily insulin dose decreased by 8% for wheat bran and 10% for cellulose. Although, high levels of cellulose and wheat bran consumption were beneficial to insulin-dependent diabetics, individual tolerance of these high levels of wheat bran or

cellulose limited the level of fiber in the diet.

Parsons (1984) investigated the effect of 3 g bran (control), 17 g Kellog's All bran, or 18 g Kellog's All bran plus whole apple in noninsulin-dependent diabetics. After consumption of the bran diet, the mean plasma glucose concentration was reduced over the 180 minutes test period. After consumption of the bran plus whole apple diet, the mean plasma glucose levels were lower than after the refined diet at 10 and 30 minutes. Peak plasma glucose levels of the bran and bran plus whole apple diet were lower than the control diet (25.2 % and 46.2 % rise from base-line, respectively). This study suggests that bran and bran and whole apple diet reduced the rise in plasma glucose that occur following meals.

Jenkins et al., (1980) studied the effect of long term guar consumption on diabetic glucose control. Eleven diabetics participated in this study and were given 14 to 26 g guar per day in crispbread form for six months. Eight were followed up into their second year. At six months, the fasting blood glucose level of the diabetics had increased by 11 mg/dl but this increase was not significant and their body weight decreased by 2.2 kg. Fasting blood glucose level of eight of the diabetics in the follow up was 238 mg/dl before guar and remained the same after guar while their body weight fell by 1.9 kg below pre-guar value. Two diabetics at 6 and 12 months on guar showed a reduction of fasting blood glucose level by 72 mg/dl and 36 mg/dl and body weight by 2.7 kg and 2.3 kg, respectively. This study

shows that long term guar treatment may reduce fasting blood glucose levels in some diabetics.

The effect of moderate amount (7 g) of apple pectin in decreasing insulin delivery by an artificial pancreas was studied. The results showed that mean insulin delivery after pectin treatment was 4.34 units less than before pectin and blood glucose level decreased by 13 mg/dl. Thus, pectin could be effective in lowering insulin requirement and blood glucose level of insulin dependent diabetics (Poynard et al., 1980).

Colon Cancer

Various theories described how dietary fiber may reduce the risk of colon cancer. Greenwald et al., (1987) reported that "it may 1) reduce the concentration of potential carcinogenic substances in the bowels by increasing the amount of feces passed, 2) reduce contact between fecal carcinogens and the colonic mucosa by reducing transit time through the colon, or 3) decrease carcinogen production by altering bacterial mechanisms." These researchers evaluated 40 epidemiological studies done in North America, Europe, India, Japan, Australia, Israel, South Africa, and Puerto Rico, and found an overall negative relationship between colon cancer and fiber from cereals, fruits, and vegetables.

In evaluating different regions of Great Britain, death rates due to colon cancer were negatively correlated with intakes of the pentose from dietary fiber. Cereal fibers are about 60% pentose sugars and may have protective effects

against colon cancer (Anderson, 1985).

A random sample of males, aged 55 to 64 years in Copenhagen, Denmark was compared to subjects in rural Kuopio, Finland, who have a 4-fold difference in colon cancer. A four-day dietary history showed that the high incidence group (Copenhagen subjects) whose dietary fiber intake was 17.2 g ate more white breads and total meat and beer and less potatoes and milk than the low incidence group (Kuopio subjects). The low incidence Kuopio group, consuming 30.9 g of dietary fiber, ate more potatoes and milk and had higher stool weight. Use of laxatives, abdominal pain during defecation, and frequency of stool were similar in both groups (MacLennan, 1978).

Kromhout et al., (1982) investigated the relations between diet, other risk indicators, and chronic disease. The subjects were 871 middle-aged men in Zutphen, Netherlands. Food intake data provided information about food consumption pattern for 6 to 12 months before the interview. During the 10 years of follow-up, 27 men died from coronary heart disease (CHD), 44 from cancer, and 107 from all causes. CHD mortality of men in the lowest quintile of dietary fiber intake was four times higher than that of men in the highest quintile, however, this relationship disappeared after multivariate analysis. Cancer mortality of men in the lowest quintile of dietary fiber intake was three times higher than that of men in the highest quintile and this relationship persisted after multivariate analysis. Mortality from all causes in men in

lowest quintile was three times higher than in men in highest quintile of fiber intake. Average dietary fiber intake of subjects was 30 g per day. Mean dietary fiber intake of highest quintile was 37 g per day. According to the authors, a recommendation of 37 g dietary fiber intake per day may be beneficial in preventing the chronic disease in Western countries.

Coronary Heart Disease

Coronary heart disease (CHD) is less common among people with high dietary fiber intakes than among those with low dietary fiber intakes, with dietary fiber intake negatively correlated with coronary heart disease (Anderson, 1985).

Gummy fiber, such as is found in oat bran, appears to be protective against heart disease. Control and oat bran diets were fed in an alternating sequence to eight men with previously documented hypercholesterolemia. One hundred grams of oat bran was included in the test diet. Serum total cholesterol concentrations were constant on the control diets, while a progressive reduction (13%) was observed in seven men consuming the oat bran diets. With this diet, plasma low-density lipoprotein cholesterol concentrations were 14% lower, while high-density lipoprotein cholesterol concentrations were not changed. Fecal excretion of total bile acids was 54% higher by subjects on the oat bran diets than on the control diets (Kirby et al., 1981).

In another study (Jenkins et al., 1975), twelve healthy males were given 36 g of wheat fiber, pectin (obtained from apple) or guar gum (obtained from seeds of the cluster bean) for two weeks. Mean serum cholesterol level of subjects fell by 36.3 and 29.2 mg per dl when guar gum and pectin were given. When subjects ate wheat fiber, the mean serum cholesterol level rose by 6.7 mg per dl. This study emphasized that increased consumption of gel containing vegetable and fruit fiber may lower serum cholesterol levels.

Colonic Diverticular Disease

Increased pressure in a segment of colon apparently causes diverticular disease, and dietary fiber may protect against this ailment. Insoluble fiber, which increases fecal bulk and colonic water and softens the stool, reduces incidences and symptoms of diverticular disease (Klurfeld, 1987).

Gear et al., (1979) reported that vegetarians consuming 41.5 g of dietary fiber per day had significantly lower incidences of asymptomatic diverticular disease (12%) than nonvegetarians (33%) who consumed 21.4 g of dietary fiber per day. The major effect was due to higher levels of cereal fiber consumption.

Gear et al., (1981) also studied bowel transit time of vegetarians and non-vegetarians. Vegetarians had more rapid transit time than non-vegetarians, 40.6 hours vs 63.8 hours, respectively. Subjects with dietary fiber intake of more

than 30 g per day had transit time of less than 75 hours while 38% of those eating less fiber had transit times exceeding 75 hours and varying up to 124 hours. However, individuals with diverticular disease had faster transit times than those without the disease. Gear et al., (1979) proposed that high dietary fiber intake is protective against diverticular disease. The authors explained that bowel may become either hyperactive producing rapid transit times or nonresponsive producing slow transit times. The hyperactive bowel will result in a colon of narrow diameter with a high intraluminal pressure. This condition is susceptible to formation of diverticula. The hypoactive bowel will result in constipation. Littlewood et al., (1981) reported that fiber supplementation reduces rapid transit time as well as accelarate slow transit time.

Painter and Burkitt (1971) reported that bran alleviates the symptoms of diverticular disease. They used bran in the diets of 70 diverticular patients and found that bran relieved or abolished abdominal pain and distention in over 80% of the patients.

Constipation

Records on transit time and stool weight of various ethnic group in United Kingdom and other countries (South Africa, India, and Uganda) showed that dietary fiber affected stool consistency, volume, and intestinal transit time. Diets containing unrefined high fiber foods result in bulky, soft stools that pass through the intestines quickly,

while consumption of refined low-fiber foods result in small firm stools that pass through the intestines slowly (Burkitt and Walker, 1972).

In one study, forty pregnant women from Cambridge, United Kingdom, in their third trimester participated in a study on the effect of fiber supplementation. Subjects were given 10 g dietary fiber supplements every day in the form of either two corn-based biscuits, or as 23 g wheat bran, or no supplements for two weeks. The fiber supplemented groups had incresed stool frequency and softer stool consistency (Anderson and Whichlow, 1985).

In another study, intestinal transit time of subjects eating their normal diets was measured. After four weeks of eating either their normal diets supplemented with 38 g unprocessed bran or high-fiber diets containing wholemeal bread, intestinal transit time was measured again. Subjects with slow transit time had a significant speeding of transit time when they ate high fiber diets (a decrease in transit time from 3.8 to 2.4 days). Subjects whose transit time was initially rapid had a slowing of transit time (an increase in transit time from 1.0 to 1.72 days). The result suggests that increasing dietary fiber intake may be benefit people with constipation, people with overly rapid colonic transit time, and people with diverticular disease who have alternating constipation and diarrhea (Harvey et al., 1973).

A study on the effect of cellulose supplementation on bowel behavior was done at the Haryana Agricultural University in India. Nine college women were given low

fiber diet (2.8 g of cellulose) and high fiber diet (23.5 g of cellulose) for three weeks. Cellulose supplementation increased stool weight of the subjects by 80 g per day. On the low fiber diet, the stool was hard and firm. When fiber was added, due to the increased bulk and the water holding capacity of cellulose, there was a significant increase in dry and wet stool weight. Stool frequency increased from 5.1 to 8.2 times per week with cellulose supplementation. All the subjects on low fiber diet had constipation, while none of the subjects on high fiber diet had constipation. Thus, cellulose supplementation relieved constipation (Bhat et al., 1981).

Kelsay and Clark (1984) studied fiber intakes, stool frequency, and stool weights of 29 subjects (13 men and 16 women) consuming self-selected diets. Mean neutral detergent fiber intake of men and women was 9.5 and 7.7 g per day, respectively. Stool weight was significantly correlated with neutral detergent fiber and stool frequency.

Dietary Fiber Content of Foods

Accurate knowledge of the total dietary fiber content of foods and diets is very important because of the health benefits of dietary fiber (Anderson and Bridges, 1988). Foods vary greatly in fiber content and composition. Therefore, understanding of dietary fiber content of grains, fruits, and vegetables that are commonly eaten is important. Table I through III (p. 23 through p. 25) show the grams of fiber per 100 g of food in some commonly consumed foods.

TABLE I

DIETARY FIBER CONTENT OF GRAIN GROUP*

	Fiber (g)/100 g
Breakfast Cereals	
All-Bran	29.9
Cheerios-type	3.8
Cornflakes	1.1
Oatmeal, regular, quick, and instant, cooked	0.9
Rice Krispies	0.2
Shredded Wheat	9.3
Bread, Pasta, and Flours	
Macaroni, cooked	0.8
Rice, Brown, cooked	1.2
Rice, polished, cooked	0.3
Spaghetti, cooked	0.8
White Bread	1.6
Whole Wheat Bread	5.7
Wheat Flour	
Brown	7.3
White	2.9
Wholemeal	8.9

*Lanza and Butrum, 1986.

TABLE II

DIETARY FIBER CONTENT OF FRUIT GROUP*

	Fiber (g)/100 g
Raw	
Apple (with skin)	2.5
Apple (without skin)	2.1
Apricot, fresh	1.7
Apricot, dried	8.1
Banana	2.1
Blueberry	2.7
Grape	1.3
Grapefruit	1.3
Orange	2.0
Peach (with skin)	2.1
Peach (without skin)	1.4
Pear (with skin)	2.8
Pear (without skin)	2.3
Plum	1.7
Prune	11.9
Raisin	8.7
Raspberry	5.1
Strawberry	2.0
Juices	
Apple	0.3
Grape	0.5
Grapefruit	0.4
Orange	0.4
Canned Fruits	
Apple (applesauces)	1.18
Peach	1.02

*Lanza and Butrum, 1986; Lanza et al., 1987.

TABLE III

DIETARY FIBER CONTENT OF VEGETABLE GROUP*

	Fiber (g)/100 g
Cooked	
Broccoli	2.8
Carrot	3.0
Green Bean	2.6
Pea	4.5
Potato (with skin)	1.7
Potato (without skin)	1.0
Spinach	2.3
Raw	
Celery, diced	1.5
Cucumber	0.8
Green Pepper, sliced	1.3
Lettuce, sliced	1.5
Onion, sliced	1.3
Spinach	4.0
Tomato	1.5
Canned	
Carrot	3.01
Green Bean	2.11
Potato	1.06
Tomato	0.77
Frozen	
Carrot	2.40
Green Bean	2.10
Potato	1.48

*Ross et al., 1985; Lanza and Butrum, 1986; Lanza et al., 1987.

It is apparent from the preceeding lists that dietary fiber content of foods vary considerably because of preparation method and degree of processing.

Pattern of Dietary Fiber Intake

Dietary fiber intake patterns in Western societies and in other parts of the world and among vegetarians and non-vegetarians will be reviewed in the following section.

Europe

United Kingdom. Dietary fiber intakes were measured in a random sample of the population (63 men and women aged 20 to 80) of Cambridgeshire, England using food tables from The British Department of Health and Social Security. Mean dietary fiber intake was 19.9 g per day. There was no difference in mean dietary fiber intakes between men and women. The major sources of dietary fiber were vegetables and cereals. Vegetables contributed 41.3% (8.2 g) and cereals 30.5% (5.8 g) to the total intake. Dietary fiber intake was also estimated from the British National Food Survey for 1976 and found to be 19.7 g per day (Bingham et al., 1979).

Dietary fiber intakes were measured among Cambridge, England adults (105 men and 112 women aged 18 to 57) between 1977 and 1979. The fiber intake was estimated using British food composition tables. The mean dietary fiber intake was 20 g per day for men and 16 g per day for women. The important sources of dietary fiber were vegetables, bread

and breakfast cereals (Nelson, 1985). Again, the results were similar to those other studies. These data suggest that fiber intake is approximately 20 g per day in the United Kingdom.

Dietary patterns in Islands and Highlands of Scotland are different from the rest of the United Kingdom. The differences are due to local tradition and food availability. The diets of 118 residents of Westray and Rousay in the Orkney Islands, Scotland (78 men and 40 women) were studied over two non-consecutive weeks. The mean dietary fiber intakes was 17.7 g. The intake was slighty lower than 22.2 g for the British population as a whole estimated by Wenlock et al., (1984). This may have been due to the low consumption of vegetables other than potatoes and to the low bread consumption. Only 3% of the bread consumed was whole wheat. Dietary fiber intake of Westray men was 21.4 g and Rousay men was 22.3 g. Dietary fiber intake of Westray and Rousay women was 16.1 and 14.2 g, respectively (Barber et al., 1986).

Netherlands. Dietary fiber intakes of 44 men and 56 women aged 25 to 65 from the Dutch population were measured using a seven-day record method and Dutch food composition tables. Mean dietary fiber consumption was 24 g per day. Mean dietary fiber intake of men was 27.5 g per day and women was 21.3 g per day. The major sources of dietary fiber were vegetables and potatoes (41%). The next major sources were cereals (32%). Fruits contributed 15% of the

total fiber intake. Dietary fiber intake was lower during the weekend (men, 24.5 g per day; women, 19.7 g per day) than during weekdays (men, 28.7 g per day; women, 21.9 g per day) (Van Staveren et al., 1982).

Dietary fiber intake of the Dutch population was estimated from 1972 to 1974 using FAO Food Disappearance Tables and dietary fiber values derived from U.S. Department of Agriculture and McCance and Widdowson's Food Composition Tables. The mean dietary fiber intake was 22.1 g per day. The major sources of dietary fiber were cereals (53.4%), roots and tubers (20.6%), and fruits (20.9%). Vegetables contributed 18.9% of the total fiber intake (Bright-See and McKeown-Eyssen, 1984).

Denmark and Finland. Dietary fiber intakes of Denmark and Finland were estimated from FAO Food Disappearance Tables from 1972 to 1974 and fiber composition tables from U.S. Department of Agriculture and McCance and Widdowson's Food Composition Tables. The mean dietary fiber intake of the people in Denmark and in Finland was 32.5 and 23.1 g per day, respectively. The major sources of dietary fiber were cereals in both countries. Cereals provided 60.9% of the dietary fiber in Denmark and 55.5% in Finand. The next major sources were roots and tubers which provided 14.0% of dietary fiber in Denmark and 20.8% in Finland (Bright-See and Mckeown-Eyssen, 1984).

Denmark and Finland are somewhat different from other European countries. In these countries 60 to 70% of dietary

fiber is supplied by cereals (mainly from rye flour) where unrefined rye flour bread is eaten in large amounts. Vegetables were the major source of dietary fiber in Britain and in the Netherlands (Bingham, 1985).

Asia

Japan. Dietary fiber intakes in Japan were estimated using data on food consumption in the Japanese National Nutrition Survey reports and British food tables (Minowa et al., 1983). Dietary fiber intake from rice has decreased from 7.7 g per day in 1965 to 5.1 g per day in 1979. The decline in fiber intake is due to rapidly Westernizing dietary patterns (Ohi et al., 1983). The total dietary fiber intake has decreased from 21.2 g per day in 1965 to 19.4 g per day in 1979. City dwellers have lower intakes of dietary fiber (17.7 g per day) with rice supplying 4.4 g of dietary fiber per day. Town and village dwellers have higher intakes (19.8 g per day) with rice supplying 5.3 g of dietary fiber per day.

India. Dietary fiber intakes were measured among 18 college women (aged 18 to 20) living in the girls' hostel of Punjabi Agricutural University. The subjects consumed a typical Punjabi mixed diet. The mean neutral detergent fiber intake was 35.8 g per day. Of the total neutral detergent fiber intake, dietary cellulose, hemicellulose, and lignin contributed 39.7%, 55.2%, and 5.0%, respectively. High intake of hemicellulose apparently was due to the high

consumption of cereals (Kochar, 1985).

Africa

Nigeria. Dietary fiber intakes of 250 urban and 50 rural Yorba Nigerian women were estimated to be 62.0 and 69.3 g per day, respectively. In the urban population, over 36% (23.2 g) of daily dietary fiber intake was from grain and cereals. Roots and tubers provided 28.9% or 18.3 g of total dietary fiber while legumes and pulses provided 28.8% or 18.3 g of total dietary fiber. Leafy vegetables and fruits supplied 5.6% or 3.7 g of total dietary fiber. In rural populations, 44.5% (30.8 g) of daily dietary fiber was derived from roots and tubers. Vegetables and fruits provided 22.2% or 15.2 g of total dietary fiber while legumes and pulses contributed 18.1% or 12.6 g of total dietary fiber. The remaining 15.2% or 10.5 g of total dietary fiber was from grain and cereal. Dietary fiber intake from grain, cereal, legumes, and pulses was much higher in the urban (41.5 g) than in the rural (23.1 g) population. Dietary fiber intake from roots, tubers, and vegetables and fruits were much higher in rural (46.0 g) than in urban (22.0 g) populations (Mbofung et al., 1984).

North America

United states. Marlett and Bokram (1981) asked 57 male and 143 female students at the University of Wisconsin-Madison to record food intakes for two consecutive days to estimate dietary fiber intake. The mean dietary fiber

intake was 15.36 g per day. Men consumed 19.9 g and women consumed 13.4 g per day. The major sources of dietary fiber were vegetables (41%), followed by cereals and legumes (32%) and fruits (22%).

In another study, dietary fiber intakes were measured using data from the Nationwide Household Food Consumption Survey of U.S. population from 1965 to 1966. The mean dietary fiber intake was 19.1 g (Ahren and Boucher, 1978).

Dietary fiber intake of older women, aged 58 to 89, was estimated using the dietary history method. Mean dietary fiber intake was 14 g per day. Cooked vegetables contributed the largest portion of dietary fiber (21%) followed by bread (19%), while fruits contributed 15% of the total daily dietary fiber (Johnson et al., 1980).

The Health and Nutrition Examination Survey (HANES) done by the United States Department of Health, Education, and Welfare between 1971 and 1974 measured nutritional status of 20,749 subjects from the United States. All subjects were from the civilian noninstitutionalized population and were aged 1 to 74 years. Food consumption data was obtained using a dietary interview consisting of a 24-hour recall of food consumption and a food frequency questionnaire. This evaluation measured frequency of intake of various foods. Table IV (p. 32) and Table V (p. 33) are from this report and list in detail servings consumed by young adult women and men.

TABLE IV

FREQUENCY OF INTAKE OF SELECTED FOOD GROUPS, ACCORDING TO FEMALE RACES*

Race and Food Group	Frequency of Intake					
	4 times a day or more	3 times a day	2 times a day	Once a day	1-6 times a week	Seldom or never
<u>White</u>	Percent Distribution					
Bread	0.4	12.4	30.9	38.1	16.8	1.4
Cereals	0.0	0.0	0.1	7.5	39.2	53.1
Legumes, Seeds, and Nuts	0.0	0.0	0.5	4.5	53.8	41.1
Fruits and Vegetables	3.7	18.1	36.1	34.3	7.5	0.3
<u>Black</u>						
Bread	1.2	18.9	31.3	27.3	20.3	1.0
Cereals	0.0	0.1	0.0	6.0	35.5	58.3
Legumes, Seeds, and Nuts	0.0	0.5	0.0	5.4	57.3	36.8
Fruits and Vegetables	3.2	11.3	28.5	39.1	17.0	1.0

*U.S. Department of Health, Education, and Welfare, 1979.

TABLE V

FREQUENCY OF INTAKE OF SELECTED FOOD GROUPS, ACCORDING TO MALE RACE*

Race and Food Group	Frequency of Intake					
	4 times a day or more	3 times a day	2 times a day	Once a day	1-6 times a week	Seldom or never
White	Percent Distribution					
Bread	1.6	22.4	34.2	30.5	10.7	0.5
Cereals	0.0	0.1	0.1	9.0	37.4	53.5
Legumes, Seeds, and Nuts	0.0	0.1	0.5	8.0	63.7	27.8
Fruits and Vegetables	2.8	13.1	37.1	36.7	10.0	0.3
Black						
Bread	5.2	32.7	33.2	18.6	10.2	0.0
Cereals	0.0	0.0	0.1	5.9	37.2	56.8
Legumes, Seeds, and Nuts	0.0	0.0	0.1	6.9	64.3	28.7
Fruits and Vegetables	3.8	7.3	26.4	38.4	23.2	0.8

*U.S. Department of Health, Education, and Welfare, 1979.

Discussed below are some of the major food group intakes. Most white females consumed fruits and vegetables once (34.3%) or twice (36.1%) a day. Most white females also consumed breads once (38.1%) or twice (30.9%) a day. Fifty-three percent of white females seldom or never consumed cereals. Most black females consumed fruits and vegetables once (39.1%) or twice (28.5%) a day. Percent of black females consuming breads once or twice a day was 27.3% and 31.3%, respectively. Most black females seldom or never consumed cereals (58.3%). Most white males consumed fruits and vegetables once (36.7%) or twice (37.1%) a day. Those consuming breads once a day totaled 30.5%. Approximately 34% of white males consumed cereals seldom or never (53.5%) or one to six times a week (37.4%). Most black males consumed fruits and vegetables once (38.4%) or twice (26.4%) a day. Approximately 33.2% and 32.7% of black males consumed breads two or three times a week, respectively. A total of 56.8% seldom or never consumed cereals (United States Department of Health, Education, and Welfare, 1979).

Vegetarians

Davies et al., (1985) measured dietary fiber intakes of 17 vegetarians (consuming predominantly plant based foods), 17 vegans (consuming solely plant based foods), and 17 omnivores in Great Britain between 1978 and 1979. Food intakes were measured for seven days. Mean dietary fiber intake of omnivores, vegetarians, and vegans was 23, 37, and 47g per day, respectively. The vegans ate significantly

more cereals fiber (19.8 g) than the omnivores (11.6 g). The amount of cereal fiber consumed by vegetarians was 15.8 g. Vegans consumed the most cereal fiber and the high dietary fiber intakes of both vegetarian groups was due to their preference for unrefined foods and high intakes of cereals, particularly bread.

In another study, dietary fiber intakes were measured among 189 omnivores and 55 vegetarians of Oxford, United Kingdom using a dietary questionnaire. Mean dietary fiber intake of omnivores was 21.4 g per day. Cereals, vegetables, and fruits provided 37%, 45%, and 12% of total dietary fiber, respectively. Mean dietary fiber intake of vegetarians was 41.5 g per day. Cereals, vegetables, and fruits provided 40%, 35%, and 23%, respectively (Gear et al., 1979).

Hardinge et al., (1958) studied dietary fiber intake of 88 non-vegetarians, 86 lacto-ovo-vegetarians (consuming milk and eggs), and 26 "pure" vegetarians (vegans, who do not consume foods of animal origin) in the U.S. The vegans consumed more dietary fiber than lacto-ovo-vegetarians and non-vegetarians. Dietary fiber intake of the vegan males and females was 23.9 and 20.7 g per day, respectively. Lacto-ovo-vegetarian males and females consumed 16.3 and 12.6 g per day, respectively. Males and females of non-vegetarian consumed 10.7 and 8.4 g per day, respectively. The high dietary fiber intake of vegetarians was due to high intake of unrefined and natural foods such as vegetables, fruits, legumes, and nuts. Lacto-ovo-vegetarians consumed

less dietary fiber than vegans because their diets contained fiber-free (diary products and eggs) and low fiber foods (refined foods). Non-vegetarians consumed lowest amount of dietary fiber because of their dietary patterns. They consumed 30% of their energy from meat, milk, and eggs that are devoid of fiber and ate refined foods that have little fiber.

Burr et al., (1981) reported that dietary fiber intake of 25 vegetarians and 46 non-vegetarians living in Cambridge, England was 33.0 and 21.3 g per day. Vegetarians consumed 21.4, 6.3, and 3.7% of energy from cereals, nuts and seeds, and pulse, respectively. Cereals, nuts and seeds, and pulses contributed 17.5, 0.9, and 1.0% of energy in non-vegetarian diet, respectively. These dietary fiber intake surveys are presented in Table VI (P. 37).

Conclusion

These data show that mean dietary fiber intakes range from 14 to 35 g per day in the areas reviewed except in Africa (Nigeria) where fiber intake averaged 60 to 70 g per day. The average dietary fiber intake of vegetarians (in England), about 40 g per day, is higher than the fiber intake of omnivores.

Little information was available for many areas, such as much of Africa and parts of Asia. This is due to continuing problems in dietary fiber analysis and food consumption assessment. More standardized and well-

TABLE VI

DIETARY FIBER INTAKE STUDIES

Author	Subject	Survey Method	Results
Ahren and Boucher, 1978	U.S. population	Data from nationwide food consumption survey of U.S. population from 1965 to 1966	19.1 g per day
Barber et al., 1986	40 adult men and adult women at Westray and Rousay in the Orkney Island, Scotland	Dietary record of two non-consecutive weeks using the semi-weighed methodology	16.1 g per day for Westray women and 14.2 g per day for Rousay women; 21.4 g per day for Westray men and 22.3 g per day for Rousay men
Bingham et al., 1979	32 adult men and 31 adult women in Cambridgeshire, England	One week dietary record using food weighing method	19.9 g per day (20.1 g per for men and 19.8 g per day in for women)
Bright-See and McKeown-Eyssen, 1984	Denmark population Dutch population Finland population	FAO Food Disappearance Report from 1972 to 1974	32.5 g per day 22.1 g per day 23.1 g per day

TABLE VI (Continued)

Author	Subject	Survey Method	Results
Burr et al., 1981	25 vegetarians and 46 non-vegetarians	7 day weighed dietary record	33.0 g per day for vegetarians and 21.3 g per day for non-vegetarians
Davies et al., 1985	17 vegetarians, 17 vegans, and 17 omnivores in United Kingdom	Dietary record of seven consetive days using weighed inventory method	37 g per day for vegetarians, 47 g per day for vegans, and 23 g per day for omnivores
Gear et al., 1979	189 omnivores and 55 vegetarinas in Oxford, United Kingdom	Dietary questionnaire	21.4 g per day for omnivores and 41.5 g per day for vegetarians

TABLE VI (Continued)

Author	Subject	Survey Method	Results
Hardinge et al., 1958	26 vegans, 86 lacto-ovo-vegetarians, 88 non-vegetarians	Dietary history	23.9 and 20.7 g per day for vegan males and and females, 16.3 and 12.6 g per day for lacto-ovo-vegetarian males and females, and 10.7 and 8.4 g per day for non-vegetarian males and females
Johnson et al., 1980	59 elderly women in Oakland county, Michigan	Dietary interview using food models	14 g per day
Kochar, 1985	18 women (aged 18 to 20) in India	Consumption of typical Punjabi mixed diet for one week	35.84 g per day

TABLE VI (Continued)

Author	Subject	Survey Method	Results
Marlett and Boklam, 1985	57 male and 143 female college students at the University of Wisconsin-Madison	Dietary record of two consecutive days	15.36 g per day (19.9 g per day for men and 13.4 g per day for women)
Mbofung et al., 1984	250 urban and 150 rural women in Yorba, Nigeria	Seven day dietary record using food weighing method	62.0 g per day for urban women and 69.3 g per day for rural women
Minowa et al., 1983	Japanese population	Food consumption data in the National Survey Reports	19.4 g per day
Nelson, 1985	105 adult men and 112 adult women in Cambridge	Dietary record of seven consecutive days using semi-weighed method	20.0 g per day for men and 16.0 g per day for women
Van Staveren et al., 1982	44 adult men and 56 adult women in Netherlands	Seven day dietary record	24.0 g per day (27.5 g per day for men and 21.3 g per for women

validated studies are needed to assess dietary fiber intake (Bingham, 1986).

Recommended Dietary Fiber Intake

Based on epidemiological and experimental researches, the National Cancer Institute has suggested that, to prevent colon cancer, the total dietary fiber intake should be 20 to 30 g per day with upper limit of 35 g (Butrum et al., 1988). After reviewing research studies, Stephen (1981), a researcher in the United Kingdom, recommended that the level of total dietary fiber intake should be increased from 20 to 40 g per day, while Mendeloff (1977), a researcher in United States, suggested that the total dietary fiber intake should range 30 to 60 g per day to prevent diverticular disease, coronary heart disease, constipation, colon cancer, and diabetes. Kromhout et al., (1982) reported that 37 g of dietary fiber intake per day would be beneficial in preventing chronic diseases in Western countries.

CHAPTER III

METHODS AND PROCEDURES

Sample and Population

The subjects were students (26 men and 105 women) enrolled in FNIA 1113 at the Oklahoma State University who voluntarily returned their first dietary assignment. The assignment was a required part of the class but allowing it to be used for research was voluntary. This study followed guidelines of the Oklahoma State University Institutional Review Board and was approved by this group. The class, Basic Human Nutrition, is an introductory level course and students did not have any other college level nutrition training before this class. The data in this study is from on dietary records collected during the Spring and Fall semesters of 1986 and 1987.

Procedures

Food record determinations were from either 114 two-day (23 men and 91 women) or 17 four-day (3 men and 14 women) food record. Forms for recording dietary intakes were distributed to all students for the first dietary assignment of the semester (Appendix C, p. 132). Students were instructed to record the amount, in household measures, of

all food and beverage items, including sauces and condiments, that were consumed. At the end of the semester, students who wished to participate voluntarily in this study returned the dietary intake records to the instructor of the class.

Dietary Analysis

Dietary data was coded by lab technicians from the two-day and four-day food records using the Food Processor II (ESHA Research, Salem, Oregon, 1988) computer program dietary codes. The Food Processor II dietary data and dietary fiber data is based on total dietary fiber values from Southgate, journal articles, and published data from the United States Department of Agriculture and unpublished information from the United States Department of Agriculture Human Nutrition Information Service. This program determines the amount of nutrients including dietary fiber in each food consumed and the total nutrient intake of each student each day. Records with obvious errors and inconsistence were not used. Sixteen records were removed before coding and computer analysis were completed.

Sources of Dietary Fiber

Dietary fiber contributions of specific food groups were determined by classifying all food items eaten by students into food groups. The food groups used in this analysis were grains, fruits, vegetables, legumes, nuts and seeds, combination, and "other". The grain group included

foods made from grains such as bread, ready-to-eat cereal, cooked cereal, pasta, rice, muffins, noodles, and hominy grits. The fruit group consisted of all fresh, dried, and canned fruits,and fruit juices. The vegetable group included raw and cooked vegetables. The legume group included pinto, kidney, navy beans, peanuts, and mixed nuts (which are generally mostly peanuts). The nuts and seeds group included pecans, pistachios, and sunflower seeds. The combination gruop included sandwiches, some soups, premixed salads such as tuna salad or waldorf salads, pizzas, pasta dishes, and breaded or fried meat, fish, and poultry. The "other" group included sweets, fats and oils, chips, fried potatoes (french fries and hash browns), alcoholic beverages, and condiments. Total weight in grams of each food group and the grams of fiber in each food group were calculated to determine intake and dietary fiber contributions of each food group. Numbers of servings from all food groups were estimated to determine dietary patterns of the students. Examples of amount of one (1) serving in each food group is as follows:

Grain Group

	Amount in one (1) serving
Bread	1 slice
Cereal	1 ounce (28 g)
Cereal, Cooked	1/2 Cup
Crackers	1 ounce (28 g)

	Amount in one (1) serving
Hamburger Bun	1/2 each
Hotdog Bun	1/2 each
Noodle, Cooked	1/2 Cup
Pancake	1 each
Pasta, Cooked	1/2 Cup
Rice, Cooked	1/2 Cup
Waffle	1 each

Fruit and Vegetable Group

	Amount in one (1) serving
Fruit or Vegetable, Cooked	1/2 Cup
Fruit or vegetable, Raw	1 Cup
Cucumber	56 g
Lettuce	1/4 head or 56 g
Tomato	1/2 medium
Fruit Juice	1/2 Cup
Raw Fruit in Hand	
ex. Apple	1 each
Apricot	2 each
Banana	1 each
Peach	1 each
Soup	
ex. Minestrone	1 Cup
Tomato	1 Cup
Vegetable Beef	1 Cup
Vegetarian	1 Cup

Legume Group

	Amount in one (1) serving
Beans, Dried, Cooked	1 Cup
Mixed Nuts	6 T
Peanuts	6 T

Nuts and Seeds Group

	Amount in one (1) serving
Pecans	1-1/3 Cup
Pistachios	1/2 Cup
Sunflower Seeds	6 T

Combination Group

	Amount in one (1) serving
Meats	2 ounces (56 g)
Fish Sticks	3 ounces (84 g) or 3 sticks
Lasagna	7-1/2 ounces
Macaroni, Cheese	1 Cup
Pizza	1/8 of large (15")
Pot Pie	1 each
Sandwich	1 each
Spaghetti & Meat Balls	1/2 Cup

"Other" Group

	Amount in one (1) serving
Candy	1 ounce (28 g)

	Amount in one (1) servings
Chips	
ex. Corn Chips	1 ounce (28 g)
Potato Chips	1 ounce (28 g)
Cookies	10 g
Fried Potatoes	100 g
Graham Crackers	1 ounce (28 g)
Salad Dressing	1/4 Cup
Sandwich Condiments	1 T
Sauces, Condiment Style	1/4 Cup
Soup, Beef and vegetable (from canned)	1 Cup

Breads and cereals in the grain group were classified into refined or whole wheat flour groups to estimate consumption of whole grain breads and cereals vs refined breads and cereals.

Statistical Analysis

The data were analyzed using the SAS computer program (Kalt et al., 1985). Descriptive statistics, percentages, means, ranges, standard deviations, and correlation coefficients were obtained to evaluate the results of this survey of food intake. Dietary factors evaluated were fiber, macronutrients, energy, fatty acids, cholesterol, servings of each food group consumed, grams of fiber from each food group, and percentage of fiber provided by each food group.

CHAPTER IV

RESULTS

Intakes of total fiber, fiber from food groups, servings of food from each food group and macronutrients will be discussed individually.

Fiber Intake

Mean fiber intake of the students was 13.1 g per day, with men consuming 15.8 g and women consuming 12.4 g per day. The concentration of fiber per 1,000 kcal consumed was 7.5 g, with men consuming 6.2 g and women 7.8 g per 1,000 kcal (Table VII, p. 49). Fiber intake was positively correlated with intake of total energy (kcal) ($r=0.39$, $p<0.0001$), protein ($r=0.36$, $p<0.0001$), carbohydrate ($r=0.55$, $p<0.0001$) and polyunsaturated fatty acids ($r=0.23$, $p<0.008$) but not with total fat (Table VIII, P. 50). Fiber intake was also positively correlated with intake of grains ($r=0.49$, $p<0.0001$), fruits ($r=0.47$, $p<0.0001$), vegetables ($r=0.40$, $p<0.0001$), legumes ($r=0.19$, $p<0.03$), and nuts and seeds ($r=0.22$, $p<0.02$) but not with combination foods like pizza and pasta dishes or snacks or chips (Table IX, p. 53). Fiber intake was negatively correlated with percent of calories from fat ($r=-0.38$, $p<0.0001$), % of kcal from saturated fatty acids ($r=-0.39$, $p<0.0001$) and % of kcal from

TABLE VII

MEAN NUTRIENT INTAKES IN COLLEGE MEN AND WOMEN

	Men (Mean ± S.D.) n = 26	Women (Mean ± S.D.) n = 105	Total Sample (Mean ± S.D.) n = 131
Fiber (g)	15.8 ± 7.6	12.4 ± 8.5	13.1 ± 8.4
Fiber per 1,000 kcal, g/1,000 kcal	6.2 ± 2.3	7.8 ± 4.9	7.5 ± 4.5
Calories (kcal)	2546.4 ± 639.0	1697.0 ± 548.5	1866.0 ± 659.5
Protein (g)	103.4 ± 28.9	64.2 ± 22.5	72.0 ± 28.5
Carbohydrate (g)	297.2 ± 79.5	206.9 ± 77.7	224.8 ± 85.7
Total Fat (g)	106.2 ± 33.4	70.2 ± 27.3	77.4 ± 31.9
Saturated Fatty Acids (g)	41.9 ± 12.5	26.5 ± 11.0	29.5 ± 12.9
Monounsaturated Fatty Acids (g)	37.3 ± 14.1	24.4 ± 10.2	27.0 ± 12.1
Polyunsaturated Fatty Acids (g)	18.4 ± 8.4	13.0 ± 6.0	14.0 ± 6.9
Cholesterol (mg)	418.5 ± 247.5	268.1 ± 181.2	298.0 ± 204.1
Cholesterol per 1,000 kcal, mg/1,000 kcal	161.7 ± 77.0	159.8 ± 102.1	160.2 ± 95.9

TABLE VIII

CORRELATION COEFFICIENTS FOR
SELECTED VARIABLES
(for fiber, carbohydrate, fat, and cholesterol)

	Fiber (g)	Fiber Concentration (g/1,000 kcal)	Carbo-hydrate (g)	Total Fat (g)	Cholesterol (mg)	Cholesterol Concentration (mg/1,000 kcal)
Fiber (g)	r=1 00 p=0 00	r=0 75 p<0 0001	r=0 55 p<0.0001	NS*	NS*	NS*
Calorie (kcal)	r=0 39 p<0 0001	r=-0 22 p<0 02	r=0 89 p<0 0001	r=0.87 p<0 0001	r=0 56 p<0.0001	NS*
Protein (g)	r=0 36 p<0.0001	NS*	r=0 61 p<0.0001	r=0 72 p<0.0001	r=0.71 p<0.0001	r=0 28 p<0 002
Carbohydrate (g)	r=0 55 p<0 0001	NS*	r=1 00 p=0 00	r=0.59 p=0 00	r=0 31 p<0 0003	r=-0 20 p<0 02
Total Fat (g)	NS*	r=-0 41 p<0 0001	r=0 59 p<0 0001	r=1 00 p=0 00	r=0 60 p<0 0001	NS*
Saturated Fatty Acid (g)	NS*	r=-0 44 p<0 0001	r=0 53 p<0 0001	r=0 92 p<0 0001	r=0 62 p<0 0001	NS*
Monounsaturated Fatty Acid (g)	NS*	r=-0 40 p<0 0001	r=0 52 p<0 0001	r=0 95 p<0.0001	r=0 64 p<0.0001	r=0 19 p<0 03
Polyunsaturated Fatty Acid (g)	r=0 23 p<0 008	r=-0 21 p<0.02	r=0 48 p<0 0001	r=0 80 p<0 0001	r=0 34 p<0 0001	NS*
% kcal Protein	NS*	r=0 26 p<0 003	r=-0.37 p<0 0001	r=-0 25 p<0 004	r=0 20 p<0 03	r=0 49 p<0 0001
% kcal Carbohydrate	r=0 39 p<0 0001	r=0 48 p<0 0001	r=0 36 p<0 0001	r=-0 44 p<0 0001	r=-0 40 p<0 0001	r=-0 48 p<0 0001
% kcal Total Fat	r=-0 38 p<0 0001	r=-0 55 p<0 0001	r=-0.26 p<0 003	r=0.56 p<0.0001	r=0 31 p<0 0004	r=0 28 p<0 002
% kcal Saturated Fatty Acid	r=-0 39 p<0 0001	r=-0 50 p<0 0001	r=-0.24 p<0 006	r=0 41 p<0 001	r=0 30 p<0 0006	r=0 28 p<0 001
% kcal Monounsaturated Fatty Acid	r=-0 34 p<0 0001	r=-0 49 p<0 0001	r=-0 25 p<0 0004	r=0 51 p<0 0001	r=0 36 p<0 0001	r=0 35 p<0 0001

TABLE VIII (Continued)

	Fiber (g)	Fiber Concentration (g/1,000 kcal)	Carbo-hydrate (g)	Total Fat (g)	Cholesterol (mg)	Cholesterol Concentration (mg/1,000 kcal)
% kcal Polyunsaturated Fatty Acid	NS*	r=-0.18 p<0 05	NS*	r=0.33 p<0 0001	NS*	NS*
Grains (g)	r=0.49 p<0 0001	r=0 31 p<0 0003	r=0.41 p<0 0001	NS*	NS*	r=-0 29 p<0 0009
Fruits (g)	r=0 47 p<0 0001	r=0 34 p<0 0001	r=0.41 p<0 0001	NS*	NS*	NS*
Vegetables (g)	r=0 40 p<0 0001	r=0 36 p<0 0001	r=0.22 p<0.01	NS*	NS*	NS*
Legumes (g)	r=0 19 p<0 03	NS*	NS*	r=0 26 p<0 004	NS*	NS*
Nuts & Seeds (g)	r=0 22 p<0 02	NS*	NS*	NS*	NS*	NS*
Fried Potatoes and Chips (g)	NS*	NS*	r=0 26 p<0 003	r=0 34 p<0 0001	NS*	NS*
Fiber from Grains (g)	r=0 82 p<0 0001	r=0 72 p<0 0001	r=0 30 p<0 0005	NS*	NS*	r=-0 19 p<0 03
Fiber from Fruits (g)	r=0.59 p<0 0001	r=0 51 p<0.0001	r=0.36 p<0.0001	NS*	NS*	NS*
Fiber from Vegetables (g)	r=0 49 p<0 0001	r=0 50 p<0 0001	r=0 19 p<0 03	NS*	NS*	NS*
Fiber from Legumes (g)	r=0 23 p<0 0008	NS*	NS*	r=0 26 p<0 003	NS*	NS*
Fiber from Nuts & Seeds (g)	r=0 22 p<0 02	NS*	NS*	NS*	NS*	NS*
Fiber from Fried Potatoes and Chips (g)	NS*	NS*	r=0.21	r=0 29 p<0 02	NS* p<0.0008	NS*
Combination, Number of Servings	NS*	r=-0.21 p<0 02	r=0 23 p<0 008	r=0 34 p<0 0001	r=0.27 p<0 002	NS*

TABLE VIII (Continued)

	Fiber (g)	Fiber Concentration (g/1,000 kcal)	Carbo-hydrate (g)	Total Fat (g)	Cholesterol (mg)	Cholesterol Concentration (mg/1,000 kcal)
"Other," Number of Servings	NS*	r=-0 23 p<0 01	r=0 53 p<0 0001	r=0 52 p<0 0001	NS*	r=-0 18 p<0.05
Fried Potatoes and Chips, Number of Servings	NS*	NS*	r=0.21 p<0.01	r=0 34 p<0 0001	NS*	r=-0 20 p<0 02
Refined Flour, Number of Servings	NS*	r=-0.34 p<0 0001	r=0 32 p<0 0002	r=0 33 p<0 0001	NS*	NS*
Whole Wheat Flour, Number of Servings	r=0 70 p<0 0001	r=0 56 p<0 0001	r=0 32 p<0 0002	NS*	NS*	NS*

NS* Not Significant

TABLE IX

CORRELATION COEFFICIENTS FOR
SELECTED VARIABLES
(for specific food groups)

	Grains (g)	Fruits (g)	Vegetables (g)	Nuts and Seeds	Fried Potatoes and Chips (g)	Fried Potatoes and Chips Number of Servings	Fiber from Grains (g)	Fiber from Fruits (g)	Fiber from Vegetables (g)
Fiber (g)	r=0 49 p<0 0001	r=0 47 p<0.0001	r=0 40 p<0 0001	r=0 22 p<0 02	NS*	NS*	r=0 82 p<0 0001	r=0 59 p<0.0001	r=0.49 p<0 0001
Calorie (kcal)	r=0 29 p<0.0006	r=0 23 p<0 008	NS*	NS*	r=0 32 p<0 0002	r=0 29 p<0.0007	NS*	NS*	NS*
Protein (g)	r=0 24 p<0 006	r=0.23 p<0.009	NS*	NS*	NS*	NS*	NS*	NS*	NS*
Carbohydrate (g)	r=0 41 p<0.0001	r=0.41 p<0 0001	r=0 22 p<0 02	NS*	r=0 26 p<0 003	r=0.21 p<0 02	r=0 30 p<0 0005	r=0.36 p<0 0001	r=0 19 p<0 03
Total Fat (g)	NS*	NS*	NS*	NS*	r=0 34 p<0 0001	r=0 34 p<0.0001	NS*	NS*	NS*
Saturated Fatty Acid (g)	NS*	NS*	NS*	NS*	r=0.27 p<0 002	r=0 26 p<0 003	NS*	NS*	NS*
Monounsaturated Fatty Acid (g)	NS*	NS*	NS*	NS*	r=0 29 p<0 0009	r=0 25 p<0.004	NS*	NS*	NS*

TABLE IX (Continued)

Polyunsaturated Fatty Acid (g)	r=0.19 p<0.04	NS*	NS*	NS*	r=0 47 p<0 0001	r=0 50 p<0 0001	NS*	NS*	NS*
% kcal Protein	NS*	NS*	NS*	NS*	r=-0 35 p<0 0001	r=-0 38 p<0 0001	NS*	NS*	NS*
% kcal Carbohydrate	r=0 32 p<0 0002	r=0 42 p<0.0001	r=0 23 p<0 01	NS*	NS*	NS*	r=0 36 p<0 0001	r=0 48 p<0 0001	r=0 24 p<0 007
% kcal Total Fat	r=-0 35 p<0 0001	r=-0 40 p<0 0006	r=-0.29 p<0 0006	NS*	NS*	NS*	r=-0 35 p<0.0001	r=-0 46 p<0 0001	r=-0 31 p<0 0003
% kcal Saturated Fatty Acid	r=-0 33 p<0.0001	r=-0 32 p<0.0002	r=-0.24 p<0 006	NS*	NS*	NS*	r=-0 31 p<0 0004	r=-0 39 p<0 0001	r=-0 25 p<0 005
% kcal Monounsaturated Fatty Acid	r=-0 30 p<0 0005	r=0 30 p<0.0005	r=-0.24 p<0 007	NS*	NS*	NS*	r=-0.32 p<0 0002	r=-0 37 p<0 0001	r=-0 25 p<0 005
% kcal Polyunsaturated Fatty Acid	NS*	r=-0 27 p<0 002	NS*	NS* p<0 002	r=0 28 p<0.0001	r=0 34	NS* p<0.003	r=-0 27	NS*
Grains (g)	r=1 00 p=0 00	r=0 21 p<0 02	NS*	NS*	NS*	NS*	r=0 60 p<0 0001	r=0 27 p<0 003	r=0 18 p<0 05
Fruits (g)	r=0.21 p<0 02	r=1.00 p=0.00	NS*	NS*	NS*	NS*	r=0.18 p<0 05	r=0 83 p<0 0001	r=0 36 p<0 0001
Vegetables (g)	NS*	r=0 35 p<0 0001	r=1.00 p=0 00	r=0 21 p<0 02	r=0.22 p<0 02	r=0 21 p<0 02	r=0.17 p<0 05	r=0 35 p<0 0001	r=0 88 p<0 0001

TABLE IX (Continued)

Legumes (g)	NS*	NS*	NS*	NS*	NS*	r=0 19 p<0 04	NS*	NS*	NS*
Nuts and Seeds (g)	NS*	r=0 28 p<0 0001	r=0 21 p<0 02	r=1 00 p=0 00	NS*	NS*	NS*	r=0 34 p<0 0001	r=0 21 p<0 02
Fried Potatoes and Chips (g)	NS*	NS*	r=-0 22 p<0 02	NS*	r=1 00 p=0 00	r=0 86 p<0 0001	NS*	r=-0 19 p<0 03	r=-0 22 p<0 02
Fiber from Grains (g)	r=0 60 p<0 0001	r=0 18 p<0 05	r=0 17 p<0 05	NS*	NS*	NS*	r=1 00 p=0 00	r=0 29 p<0 001	r=0 26 p<0 003
Fiber from Fruits (g)	r=0 27 p<0 003	r=0 83 p<0 0001	r=0 35 p<0 0001	r=0.34 p<0 0001	r=-0 19 p<0.03	r=-0 17 p<0 05	r=0.29 p<0 001	r=1 00 p=0 00	r=0 39 p<0.0001
Fiber from Vegetables (g)	r=0 18 p<0 05	r=0 36 p<0 0001	r=0 88 p<0 0001	r=0 21 p<0 02	r=-0 22 p<0.02	r=-0 22 p<0 02	r=0 26 p<0 003	r=0 39 p<0 0001	r=1 00 p=0 00
Fiber from Legumes (g)	NS*	NS*	NS*	NS*	NS*	r=0 19 p<0 03	NS*	NS*	NS*
Fiber from Nuts & Seeds (g)	NS* NS*	r=0 27 p<0 002	r=0 20 p<0 03	r=0 99 p<0 0001	NS*	NS*	NS*	r=0 35 p<0 0001	r=0.21 p<0.02
Fiber from Fried Potatoes and Chips (g)	NS*	NS*	r=-0 22 p<0.02	NS*	r=1.00 p=0 00	r=0 86 p<0 0001	NS*	r=-0 18 p<0 04	r=-0 26 p<0 004
Combination, Number of Servings	r=-0 17 p<0 05	NS*	NS*	NS*	NS*	NS*	NS*	NS*	NS*

TABLE IX (Continued)

"Other," Number of Servings	NS*	NS*	NS*	NS*	r=0 49 p<0 0001	r=0 51 p<0 0001	NS*	NS*	NS*
Fried Potatoes and Chips, Number of Servings	NS*	NS*	r=-0 21 p<0 02	NS*	r=0 86 p<0 0001	r=1 00 p=0 00	NS*	r=-0 17 p<0 05	r=-0 22 p<0 02
Refined Flour Number of Servings	r=0 39 p<0 0001	NS*	r=-0 18 p<0 05	NS*	NS*	NS*	r=-0 22 p<0 02	NS*	NS*
Whole Wheat Flour, Number of Servings	r=0 46 p<0 0001	r=0 19 p<0 03	r=0 20 p<0 03	NS*	NS*	NS*	r=-0 82 p<0.0001	r=0 25 p<0.005	r=0 20 p<0 02

NS* Not Significant

monounsaturated fatty acids ($r=-0.34$, $p<0.0001$). Fiber concentration (grams of fiber per 1,000 kcal consumed) was negatively correlated with energy ($r=-0.22$, $p<0.02$) and % kcal from fat ($r=-0.55$, $p<0.0001$).

Figure I (p. 58) shows the distribution of fiber intake among students. Dietary fiber intake of the students ranged from 1.7 to 71.3 g, with a mean intake of 13.1 g and standard deviation of $\pm$ 8.4 g. More than half of the students consumed less than the mean dietary fiber intake per day. Only 40% of students had intakes above the mean, while 59% had intakes below the mean.

Sources of Dietary Fiber

Fiber contribution of foods are presented in Table X (p. 59). The average number of servings of specific food groups is presented in Table XI (p. 60).

Grains

Grains were the major source of dietary fiber contributing 4.6 g fiber per day (5.1 g of dietary fiber for men and 4.5 g of dietary fiber for women). A positive correlation between grains and fiber was found ($r=0.49$, $p<0.0001$). The average consumption of grain was 3.2 servings per day. Women consumed 3.0 servings per day while men consumed 4.4 servings of grains per day. Most bread products were made from refined flour.

Figure II (p. 61) shows the distribution of intake of grains among students. Fourteen percent of the students did

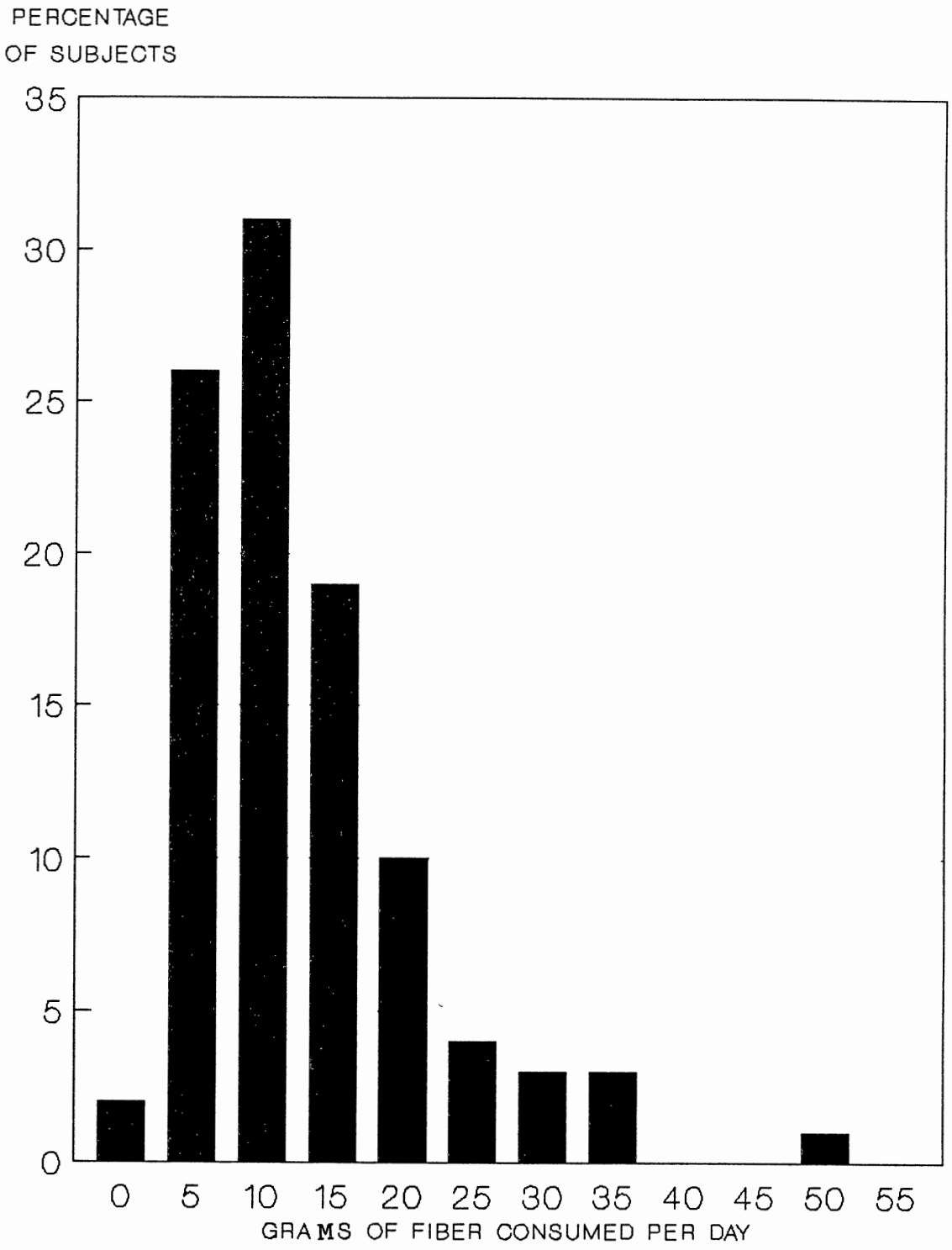

Figure I Subject Distribution of Fiber Intake

TABLE X

FIBER CONTRIBUTION OF VARIOUS FOOD GROUPS
(g/day)

	Men (Mean ± S.D.) n = 26	Women (Mean ± S.D.) n = 105	Total Sample (Mean ± S.D.) n = 131
Grains	5.1 ± 5.9	4.5 ± 5.9	4.6 ± 5.9
Fruits	3.0 ± 3.3	1.7 ± 2.4	2.0 ± 2.6
Vegetables	2.4 ± 2.2	2.4 ± 2.2	2.4 ± 2.2
Legumes	1.1 ± 2.2	0.7 ± 2.4	0.8 ± 2.4
Nuts and Seeds	0.04 ± 0.2	0.04 ± 0.2	0.04 ± 0.2
Combination Foods*	2.3 ± 2.3	1.5 ± 1.7	1.7 ± 1.8
"Other" Foods**	1.7 ± 1.8	1.4 ± 1.5	1.5 ± 1.6
Fried Potatoes and Chips	0.7 ± 1.4	0.4 ± 0.7	0.5 ± 0.9

*Combination foods are foods eaten mixed together such as soups and pasta dishes.
**"Other" foods are sweets, condiments, fried potatoes, and chips.

TABLE XI

MEAN WEIGHT AND NUMBER OF SERVINGS OF VARIOUS FOOD GROUPS EATEN BY COLLEGE MEN AND WOMEN

	Men (Mean ± S.D.) n = 26		Women (Mean ± S.D.) n = 105		Total Sample (Mean ± S.D.) n = 131	
	Weight (g)	No. of Servings	Weight (g)	No. of Servings	Weight (g)	No. of Servings
Grains	171.7 ± 119.4	4.4 ± 2.8	116.7 ± 78.7	3.0 ± 2.0	127.6 ± 90.5	3.2 ± 2.2
Refined Flour	---	3.0 ± 1.9	---	1.8 ± 1.6	---	2.0 ± 1.7
Whole Wheat Flour	---	1.0 ± 1.7	---	0.7 ± 1.3	---	0.8 ± 1.4
Fruits	272.3 ± 298.7	2.2 ± 2.5	156.1 ± 157.1	1.3 ± 1.2	179.2 ± 197.6	1.5 ± 1.6
Vegetables	152.1 ± 129.6	1.8 ± 1.7	146.1 ± 122.6	1.6 ± 1.6	147.3 ± 123.5	1.7 ± 1.6
Legumes	15.2 ± 30.6	0.2 ± 0.5	9.5 ± 27.2	0.1 ± 0.2	10.7 ± 27.8	0.1 ± 0.3
Nuts and Seeds	0.6 ± 2.9	0.004 ± 0.02	0.5 ± 2.5	0.007 ± 0.04	0.5 ± 2.6	0.05 ± 0.03
Combination Foods*	217.0 ± 146.6	1.9 ± 1.2	176.5 ± 154.4	1.3 ± 1.2	184.5 ± 153.2	1.4 ± 1.2
Other Foods**	356.6 ± 402.8	4.1 ± 2.3	193.9 ± 230.9	2.9 ± 2.3	226.2 ± 279.5	3.2 ± 2.3
Fried Potatoes and Chips	40.4 ± 65.5	0.8 ± 1.1	25.2 ± 35.3	0.5 ± 0.8	28.2 ± 43.2	0.6 ± 0.9

*Combination foods are foods eaten mixed together such as soups and pasta dishes.
**"Other" foods are sweets, desserts, condiments, fried potatoes, and chips.

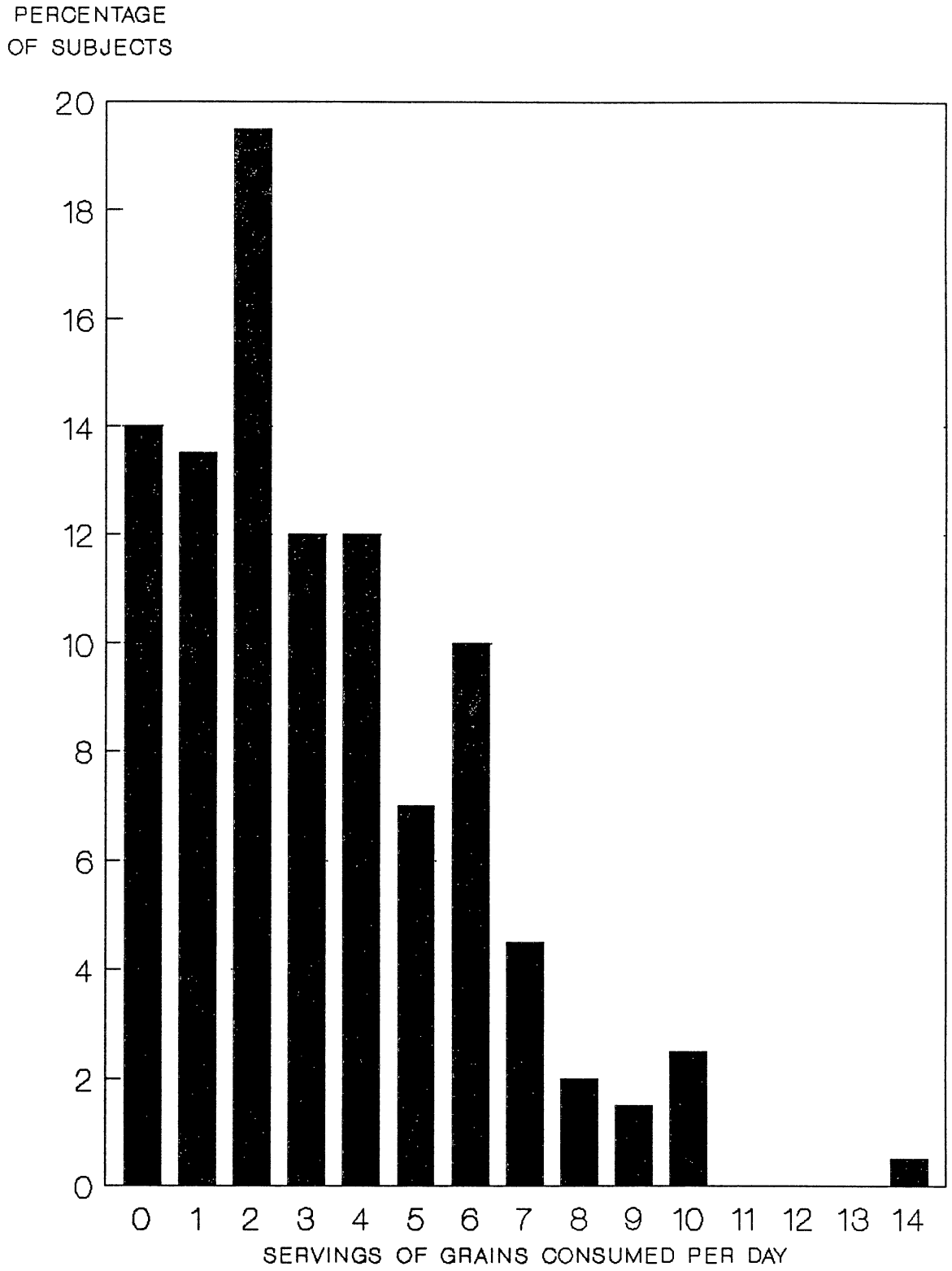

Figure II Subject Distribution of Intake of Servings of Grains

not consume any servings of grains, while 0.5% consumed 14 servings of grains per day and only forty percent consumed more than four servings of grains (recommended minimum servings) per day. Number of servings of refined flour was not correlated with fiber intake, however, was correlated with fat intake ($r=0.33$, $p<0.0001$). Conversely, number of servings of whole wheat flour was positively correlated with fiber ($r=0.70$, $p<0.0001$). Grain fiber was correlated with fruit fiber ($r=0.29$, $p<0.001$) and vegetable fiber ($r=0.26$, $p<0.003$). Number of servings of refined flour was negatively correlated with fiber from vegetables ($r=-0.22$, $p<0.02$) and grams of vegetabes ($r=-0.18$, $p<0.05$), while number of servings of whole wheat flour was positively correlated with both grams of fruits ($r=0.19$, $p<0.03$), fiber from fruits ($r=0.25$, $p<0.005$), grams of vegetables ($r=0.20$, $p<0.03$), and fiber from vegetables ($r=0.20$, $p<0.02$).

Refined flour contributed 2.0 servings of grains while whole wheat flour contributed 0.8 servings per day.

Figures III (p. 63) and IV (p. 64) show the distribution of intake of refined and whole wheat flour. About 45% of the students consumed less than 2 servings of refined flour per day; while 70% of the students consumed less than 0.5 servings of whole wheat flour per day. Of the 3.2 servings of grains consumed per day 2.8 were from wheat. This is typical for US diets, in which wheat products provide most of grain consumed. The remaining 0.4 servings were from other grains such as corn, oat, barley, and rice. Men consumed 3.0 servings of refined flour and 1.0 serving

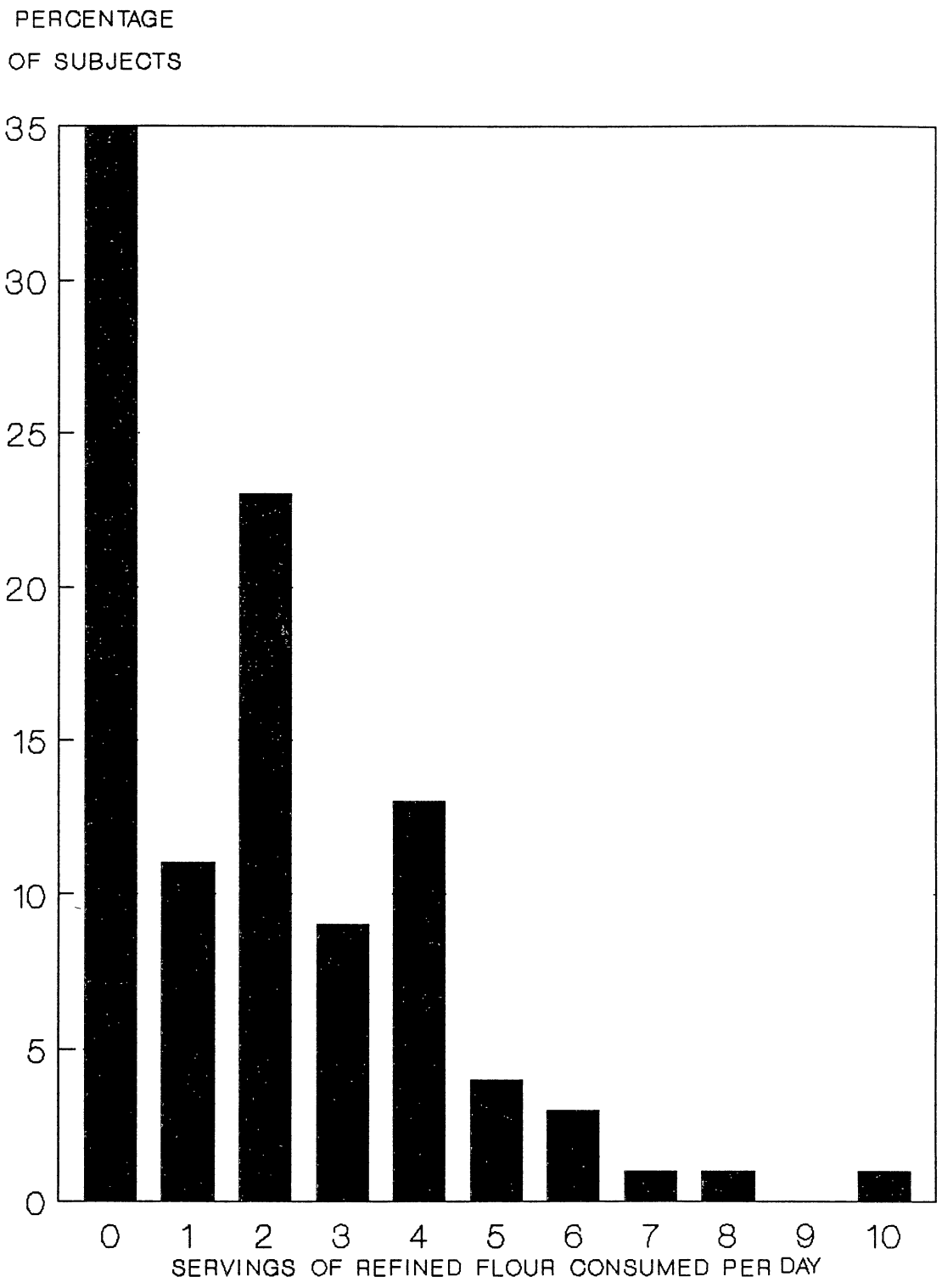

Figure III Subject Distribution of Intake of Refined Flour

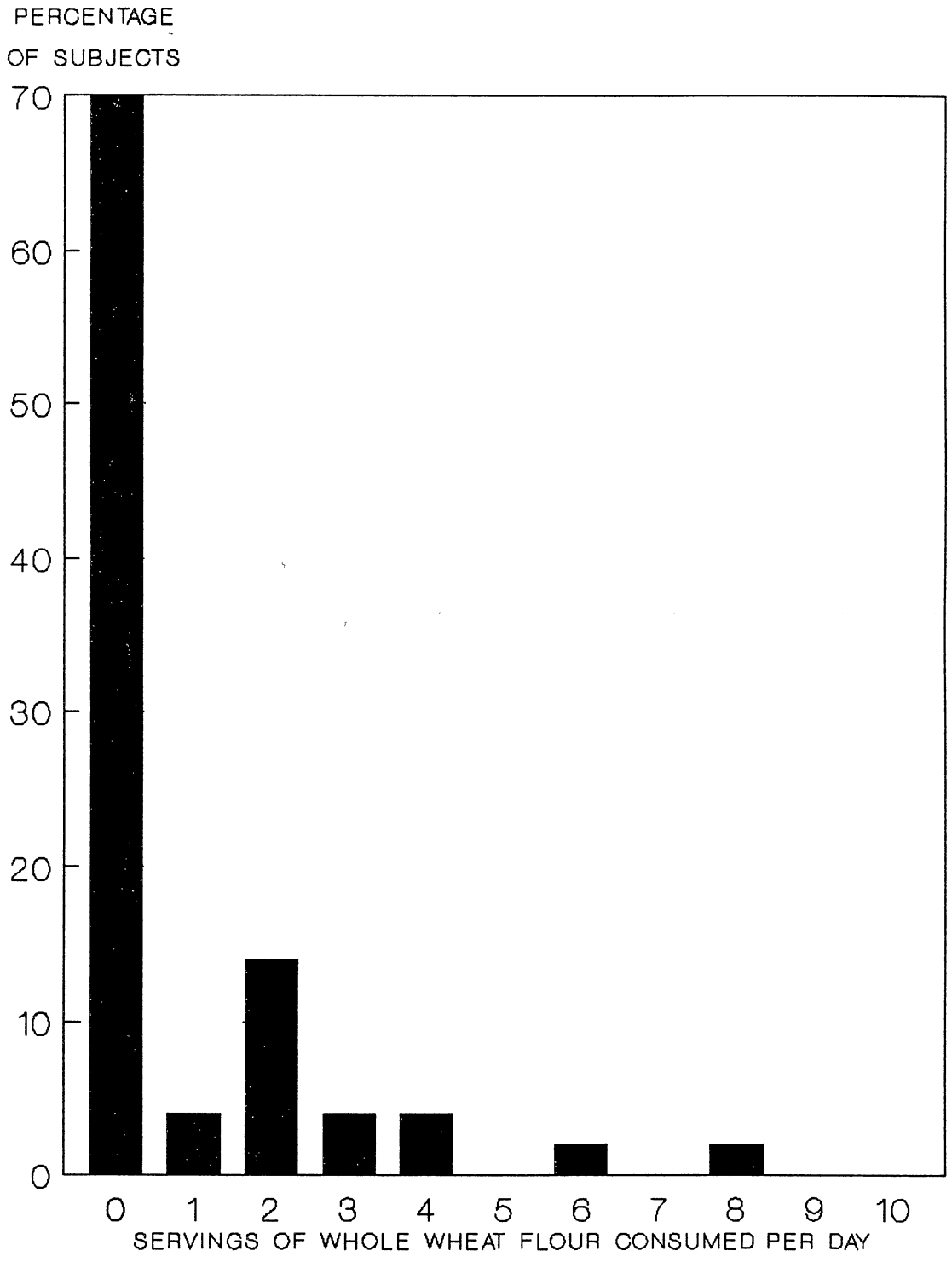

Figure IV Subject Distribution of Intake of Whole Wheat Flour

of whole wheat flour (33% of breads from whoe grain) while women consumed 1.8 servings of refined flour and 0.7 servings of whole wheat flour (38% of breads from whole grains) per day.

Vegetables and Fruits

The second major source of fiber in the diet was foods in the vegetable and fruit group. Vegetables provided 2.4 g of fiber per day while fruits provided 2.0 g of fiber per day. The average fiber intake from vegetables and fruits for men was 2.4 g and 3.0 g per day, respectively; while women ate 2.4 g and 1.7 g of fiber from vegetables and fruits, respectively. Grams of fruits were positively correlated with grams of vegetables ($r=0.35$, $p<0.0001$), grains ($r=0.21$, $p<0.02$), and nuts and seeds ($r=0.28$, $p<0.001$). However, grams of vegetables consumed was negatively correlated with fried potatoes and chips ($r=-0.22$, $p<0.02$).

The average vegetable consumption was 147.3 g or 1.7 servings per day. Men ate 1.8 serving of vegetables per day while women ate 1.6 servings of vegetables per day.

The average consumption of fruits was 179.2 g or 1.5 servings per day, with men consuming 2.2 servings and women consuming 1.3 servings of fruits per day.

Figures V (p. 66) and VI (p. 67) show the distribution of intake of servings of fruits and vegetables. Forty-six percent of the students did not consume any servings of fruits per day. Forty percent of the students consumed more

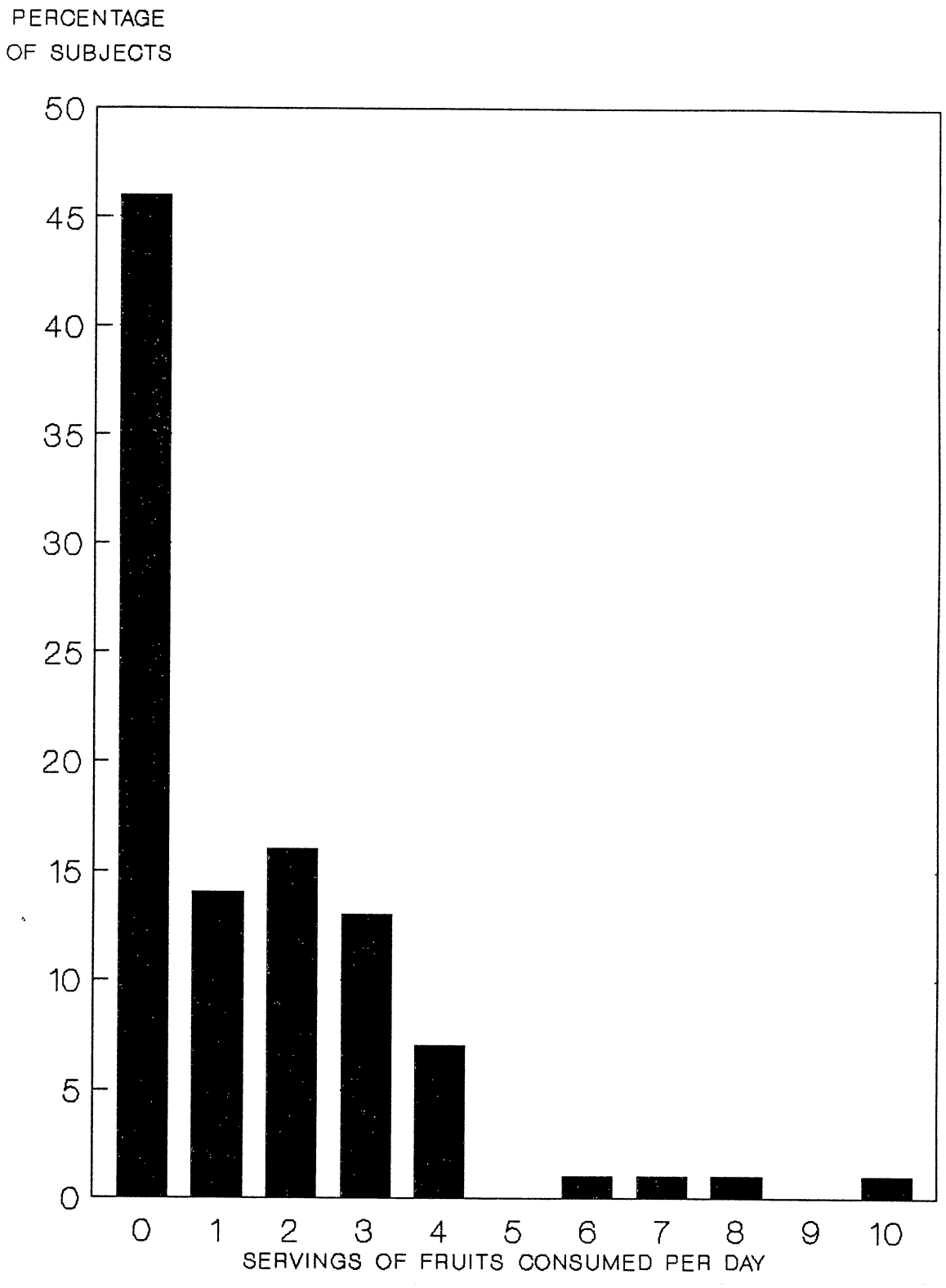

Figure V Subject Distribution of Intake of Servings of Fruit

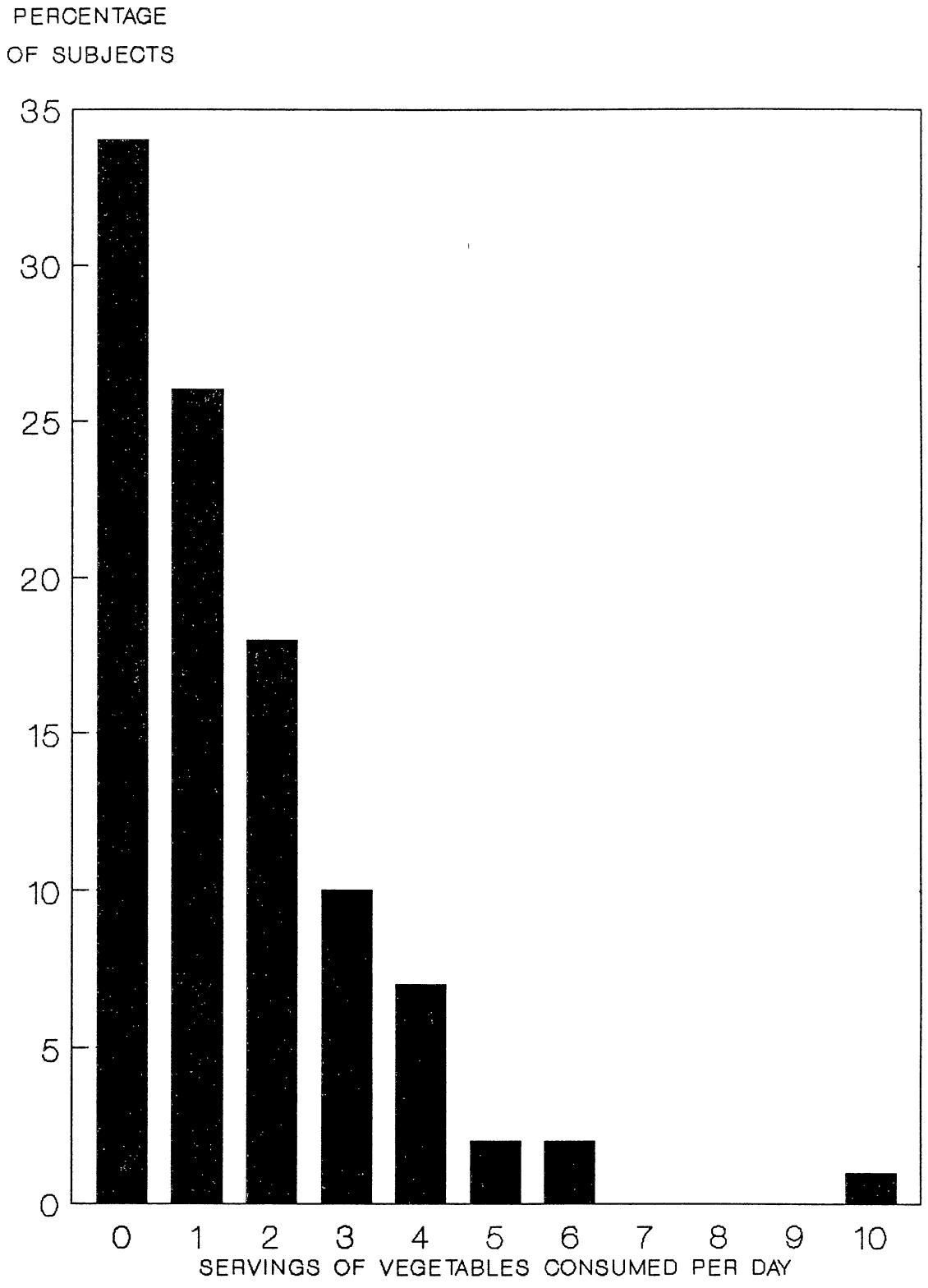

Figure VI Subject Distribution of Intake of Servings of Vegetables

than 1.5 servings of fruits per day but 60% consumed less. The majority of students (60%) consumed less than 1.7 servings of vegetables per day and 34% did not consume any servings of vegetables. Forty percent of the students consumed 2 or more servings of vegetables per day.

Legumes

The average fiber intake from legumes for all students was 0.8 g per day. A positive correlation was seen ($r=0.19$, $p<0.03$) between legume intake and intake of fiber. The average fiber consumption from legumes for men and women was 1.1 g and 0.7 g per day, respectively.

The average daily consumption of legumes was 10.7 g or 0.1 servings. Men and women consumed 0.2 servings and 0.1 servings per day, respectively.

Nuts and Seeds

The fiber intake from nuts and seeds for all students was 0.04 g per day, with both men and women consuming 0.04 g per day. Intake of nuts and seeds was positively correlated with fiber intake ($r=0.22$, $p<0.02$).

Nuts and seeds consumption was very low, with only 0.5 g or 0.006 servings per day.

Combination

An average of 1.7 g of fiber per day was from combination foods such as soups and pasta dishes, with men consuming 2.3 g of fiber and women consuming 1.5 g of fiber

per day from this source. The average intake of combinations was 1.4 servings per day. The average daily intake of these foods for men and women was 1.9 servings and 1.3 servings, respectively. Combination foods tend to be mostly either "fast foods" or highly processed foods. This survey shows that college students consumed an average, more than one serving of these refined and processed foods per day.

Servings of combinations were correlated with fat ($r=0.34$, $p<0.0001$) and carbohydrate intake ($r=0.23$, $p<0.008$) but not with fiber.

"Other"

Foods in the "other" category including snacks, desserts, condiments, and fried potatoes and chips provided 1.5 g of fiber per day, with men consuming 1.7 g and women consuming 1.4 g of fiber per day from these foods. Fried potatoes and chips provided 0.5 g of fiber per day. Men ate 0.7 g of fiber from fried potatoes and chips, with women consuming 0.4 g of fiber from these foods.

"Other" foods contributed 226.2 g or 3.2 servings per day. Of this, fried potatoes and chips provided 28.2 g or 0.6 servings per day.

Men and women consumed 4.1 servings and 2.9 servings of "other" foods per day, respectively. Men consumed 40.4 g or 0.8 servings of fried potatoes and chips per day compared to 25.2 g or 0.5 servings of fried potatoes and chips consumed by women.

Servings of "other" foods were positively correlated with fat ($r=0.52$, $p<0.0001$) but not with fiber. Servings of fried potatoes and chips also were positively correlated with fat ($r=0.34$, $p<0.0001$) and with carbohydrate ($r=0.21$, $p<0.02$). They were also positively correlated with intake of polyunsaturated fatty acids ($r=0.50$, $p<0.0001$).

Energy and Nutrient Intake

Mean daily intakes of energy and nutrients are presented in Table VII (p. 49). Percentage of energy derived from each nutrient is presented in Table XII (p. 71).

Percent of kcal from the macronutrients was as follows; protein 16.0%; carbohydrate 48.7%; and fat 36.7%. Mean energy intake of the students was 1,866 kcal per day. Men consumed 2,546.4 kcal and women consumed 1,697.0 kcal per day.

Protein

Mean daily protein consumption of the students was 72.0 g. Men consumed an average of 103.4 g of protein per day or 17% of kcal from protein while women consumed 64.2 g of protein or 16% of energy from protein.

Positive correlations between protein and fat ($r=0.72$, $p<0.0001$), protein and cholesterol ($r=0.71$, $p<0.0001$), and protein and carbohydrate ($r=0.61$, $p<0.0001$) were found.

Figures VII (p. 72) and VIII (p. 73) show the distribution of intake and percentage of kcal from protein

TABLE XII

PERCENTAGE OF CALORIES FROM NUTRIENTS
(%)

	Men (Mean ± S.D.) n = 26	Women (Mean ± S.D.) n = 105	Total Sample (Mean ± S.D.) n = 131	U.S. Dietary Goals*
Protein	16.6 ± 2.6	15.8 ± 4.4	16.0 ± 4.1	12
Carbohydrate	46.9 ± 6.7	49.1 ± 9.4	48.7 ± 8.9	58
Total Fat	37.3 ± 6.2	36.6 ± 8.2	36.7 ± 7.8	30
Saturated Fatty Acids	14.8 ± 2.8	13.9 ± 4.0	14.1 ± 3.8	10
Monounsaturated Fatty Acids	13.0 ± 2.8	12.8 ± 3.5	12.8 ± 3.4	10
Polyunsaturated Fatty Acids	6.4 ± 2.3	6.8 ± 2.3	6.7 ± 2.3	10

*Schlenker, 1984.

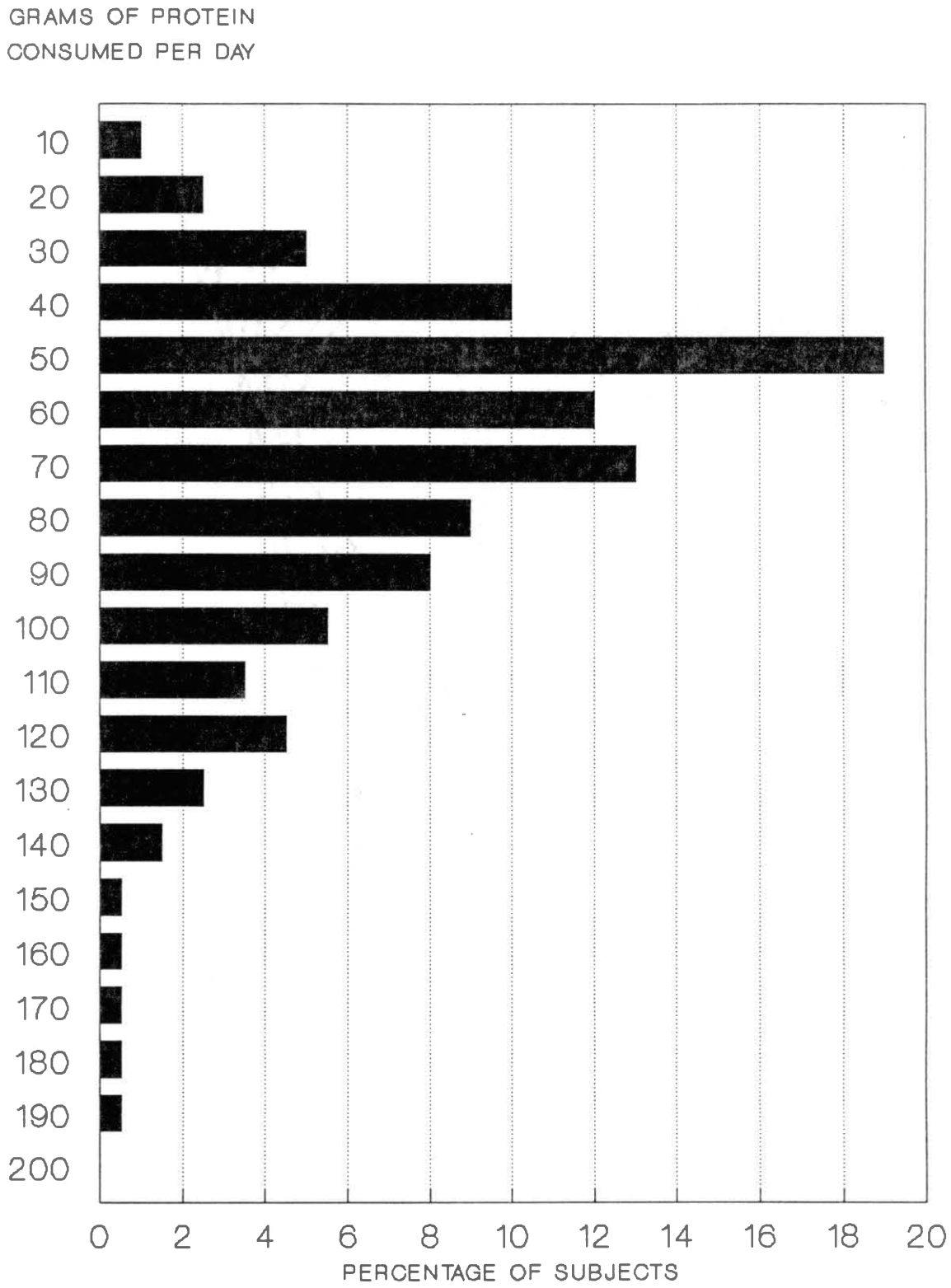

Figure VII. Subject Distribution of Protein Intake

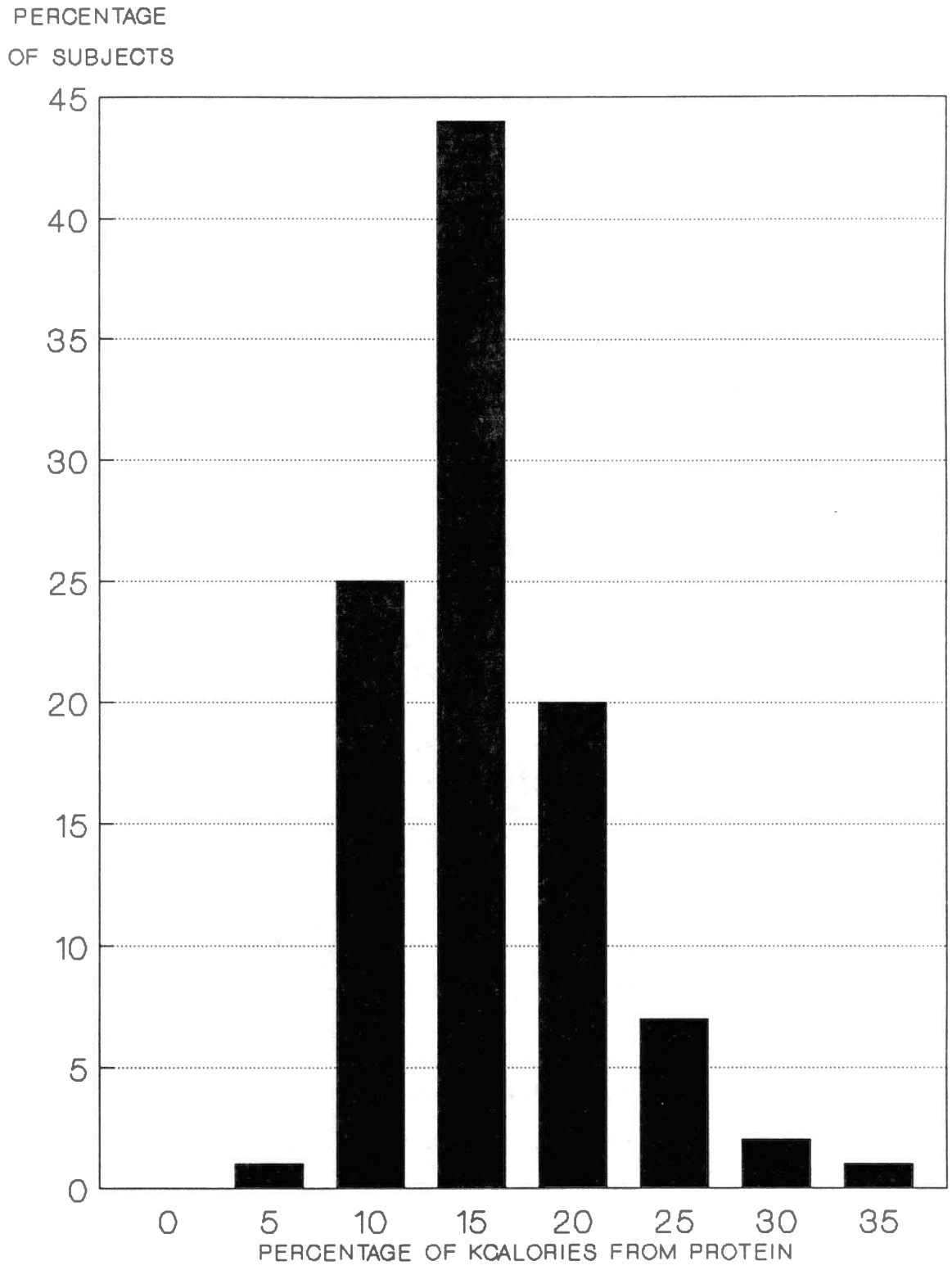

Figure VIII. Subject Distribution of Protien Intake as a Percentage of kcal

among students. About 70% of the students consumed less than the mean intake of 16% of kcal from protein and 26% consumed less than the Dietary Goal level of 12%.

Carbohydrate

Mean carbohydrate intake was 224.8 g per day. Men consumed 297.2 g of carbohydrate or 47% of kcal per day while women consumed 206.9 g of carbohydrate or 49% of kcal per day. Carbohydrate was positively correlated with fat ($r=0.59$, $p<0.0001$) and total cholesterol ($r=0.31$, $p<0.0003$) but was negatively correlated with cholesterol concentration ($r=-0.20$, $p<0.02$). Percent of kcalories from carbohydrate was positively correlated with fiber ($r=0.39$, $p<0.0001$) and fiber concentration ($r=0.48$, $p<0.0001$), but was negatively correlated with total fat ($r=-0.44$, $p<0.0001$), cholesterol ($r=-0.40$, $p<0.0001$), and cholesterol concentration ($r=-0.48$, $p<0.0001$).

Figures IX (p. 75) and X (p. 76) show the distribution of intake and percentage of kcal from carbohydrate among students. Again, the majority consumed less than the mean with many students consuming very low level of carbohydrate. Only 19% of the students consumed more than 58% of kcal from carbohydrate (the Dietary Goal level).

Fat

The average daily fat intake was 77.4 g, with men consuming 106.2 g and women consuming 70.2 g. Both men and women received 37% of their energy from fat. Percent of

Figure IX. Subject Distribution of Carbohydrate Intake

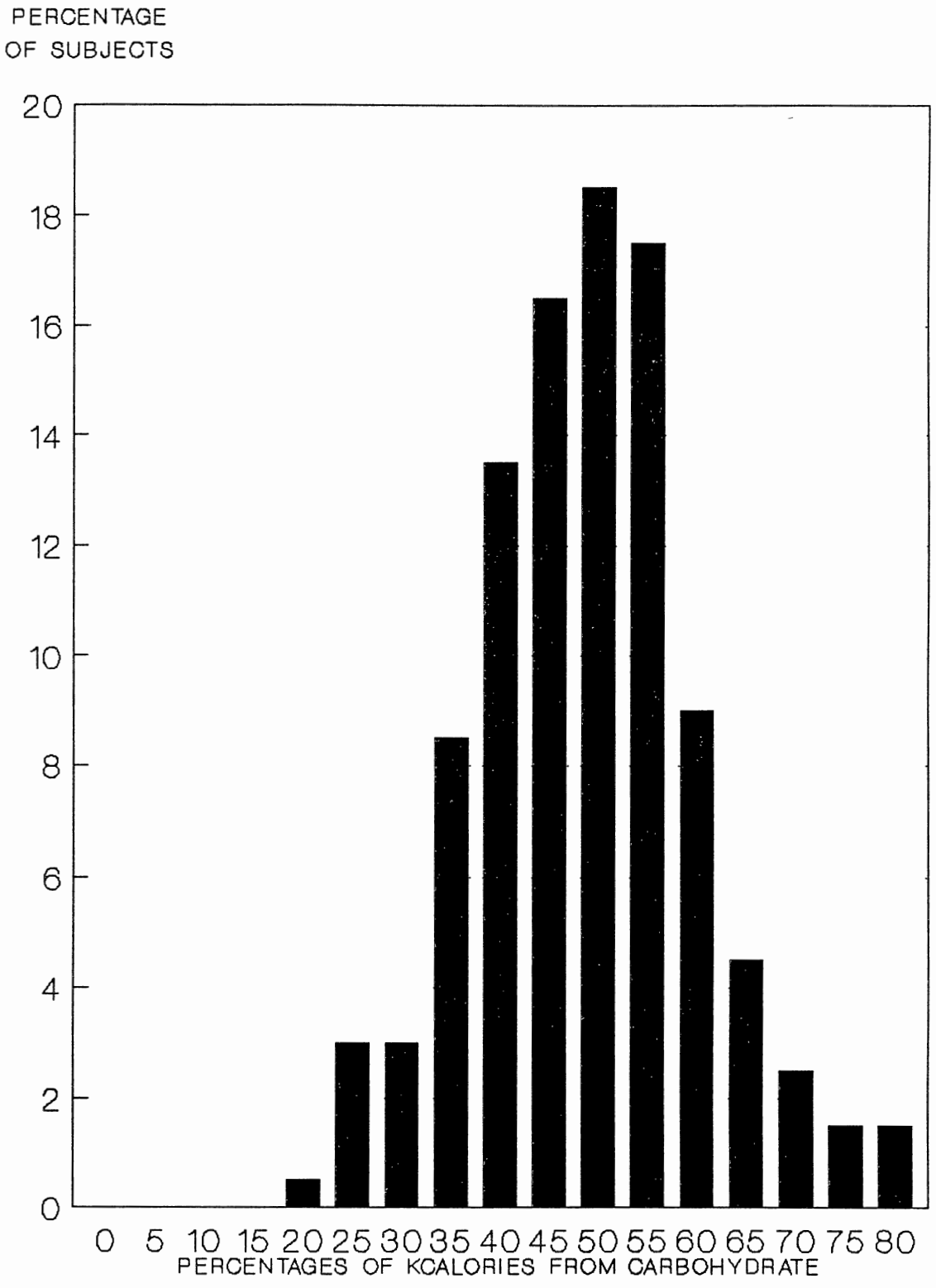

Figure X Subject Distribution of Carbohydrate Intake as a Percentage of kcal

kcal from fat was negatively correlated with grams of fiber ($r=0.38$, $p<0.0001$), fiber concentration ($r=-0.55$, $p<0.0001$), and carbohydrate ($r=-0.26$, $p<0.003$). Percent of kcal from fat was negatively correlated with grams of grains ($r=-0.35$, $p<0.0001$), grams of fruits ($r=-0.40$, $p<0.0001$), and grams of vegetables ($r=-0.29$, $p<0.0006$). Fat calorie was also negatively correlated with fiber from grains ($r=-0.35$, $p<0.0001$), fruits ($r=-0.46$, $p<0.0001$), and vegetables ($r=-0.31$, $p<0.0003$).

Figures XI through XVIII (p. 78 through p. 85) show the distribution of intake of total fat and fatty acids among students. Less than 20% of the students consumed less than 30% of kcal from fat which is the Dietary Goal level. Approximately 48% consumed more than 35% of kcal from fat and 2% consumed 60% of kcal from fat. About 74 and 67.5% of the students consumed more than 10% of kcal from saturated and monounsaturated fatty acids. The majority (82%) of the students consumed less than 10% of kcal from polyunsaturated fatty acids.

Saturated fatty acids provided 14% of energy while monounsaturated and polyunsaturated fatty acids provided 13% and 7% of energy, respectively, while current Dietary Goal recommendation being 10% of calories for each fatty acids source. The average saturated, monounsaturated, and polyunsaturated fatty acid consumption was 29.5 g, 27.0 g, and 14.1 g per day, respectively, for a fatty acid ratio of 1:0.9:0.5, while a recommended ratio is 1:1:1. Mean daily saturated, monounsaturated, and polyunsaturated fatty acids

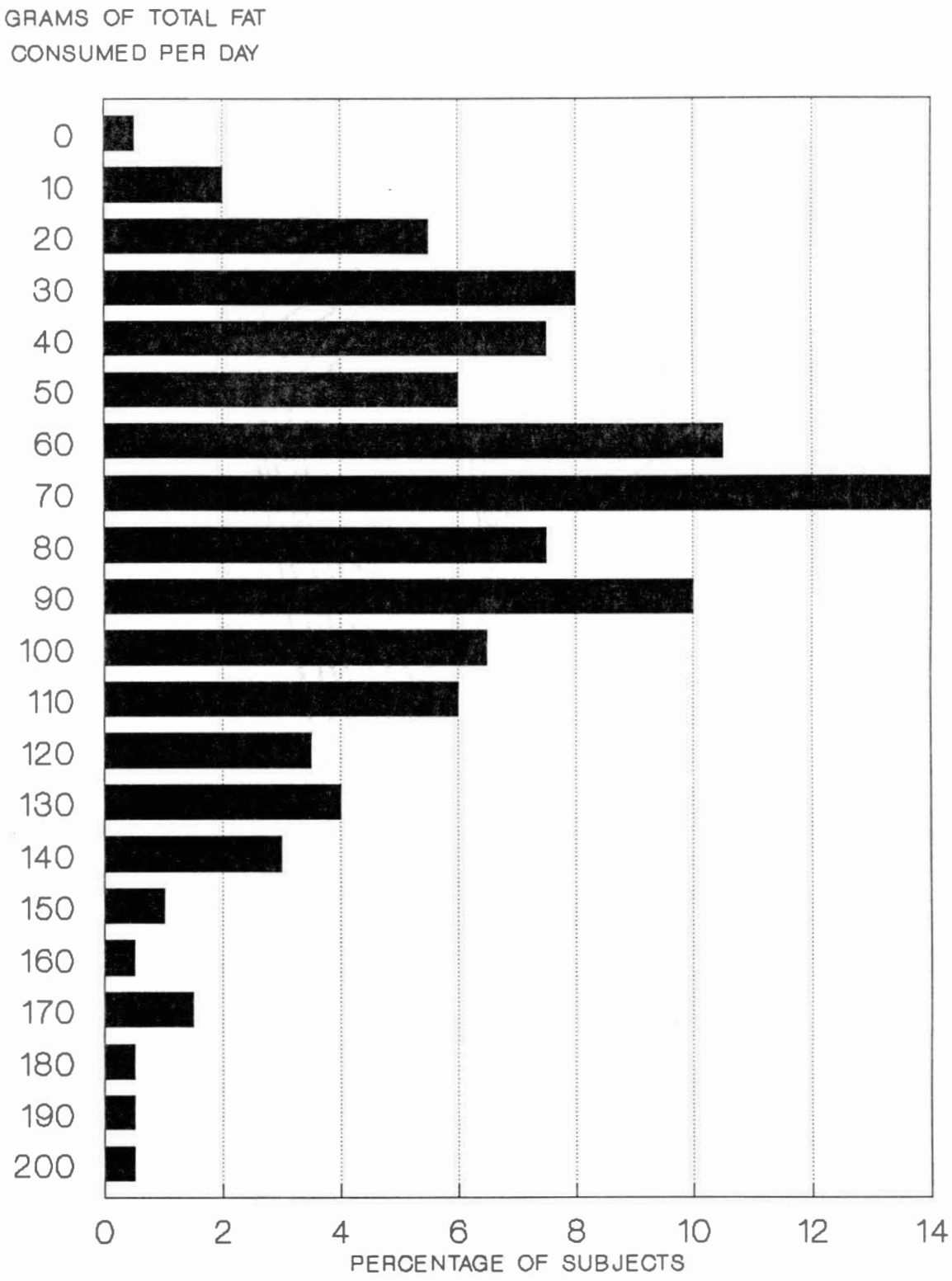

Figure XI. Subject Distribution of Fat Intake

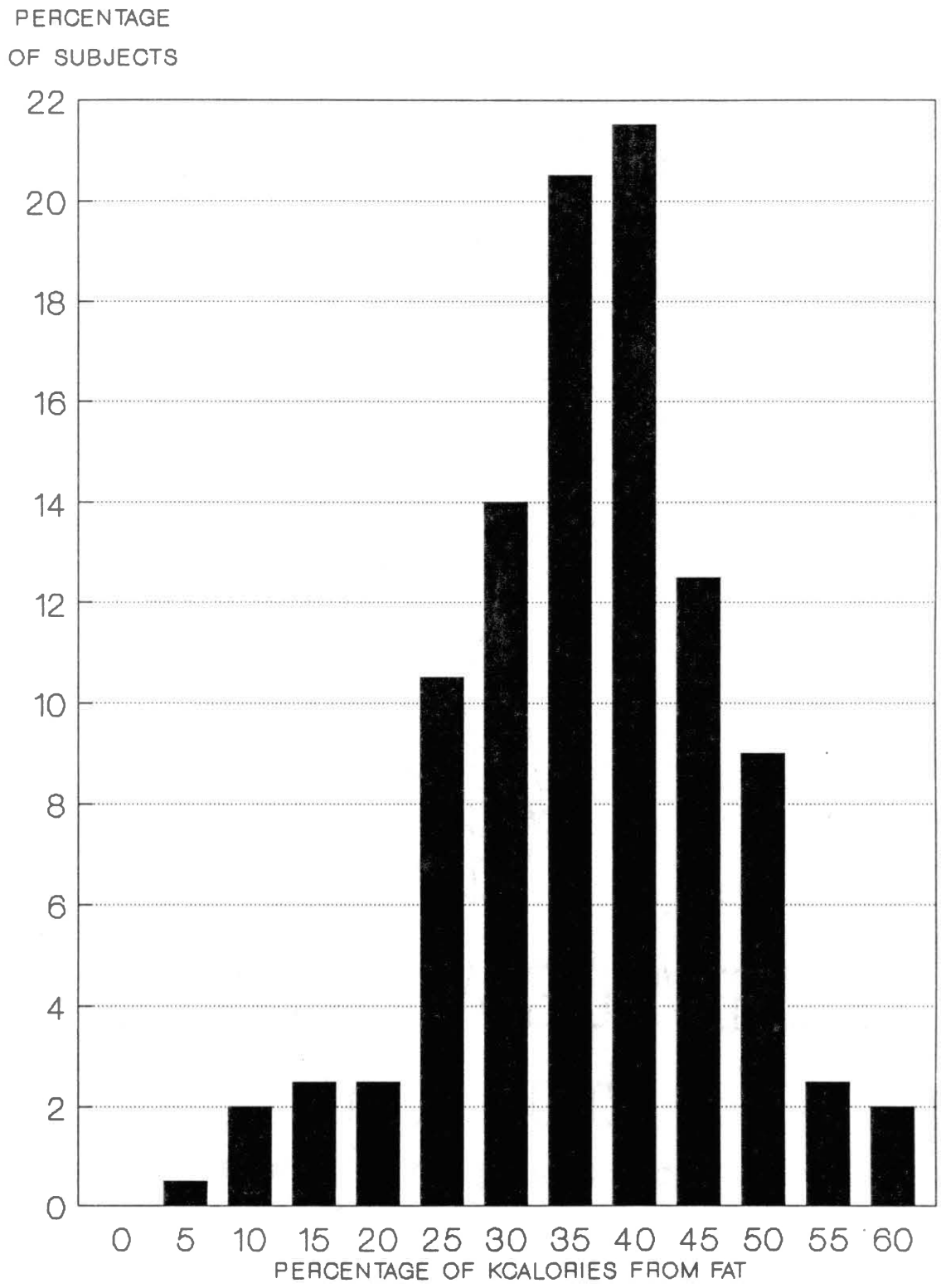

Figure XII. Subject Distribution of Fat Intake as a Percentage of kcal

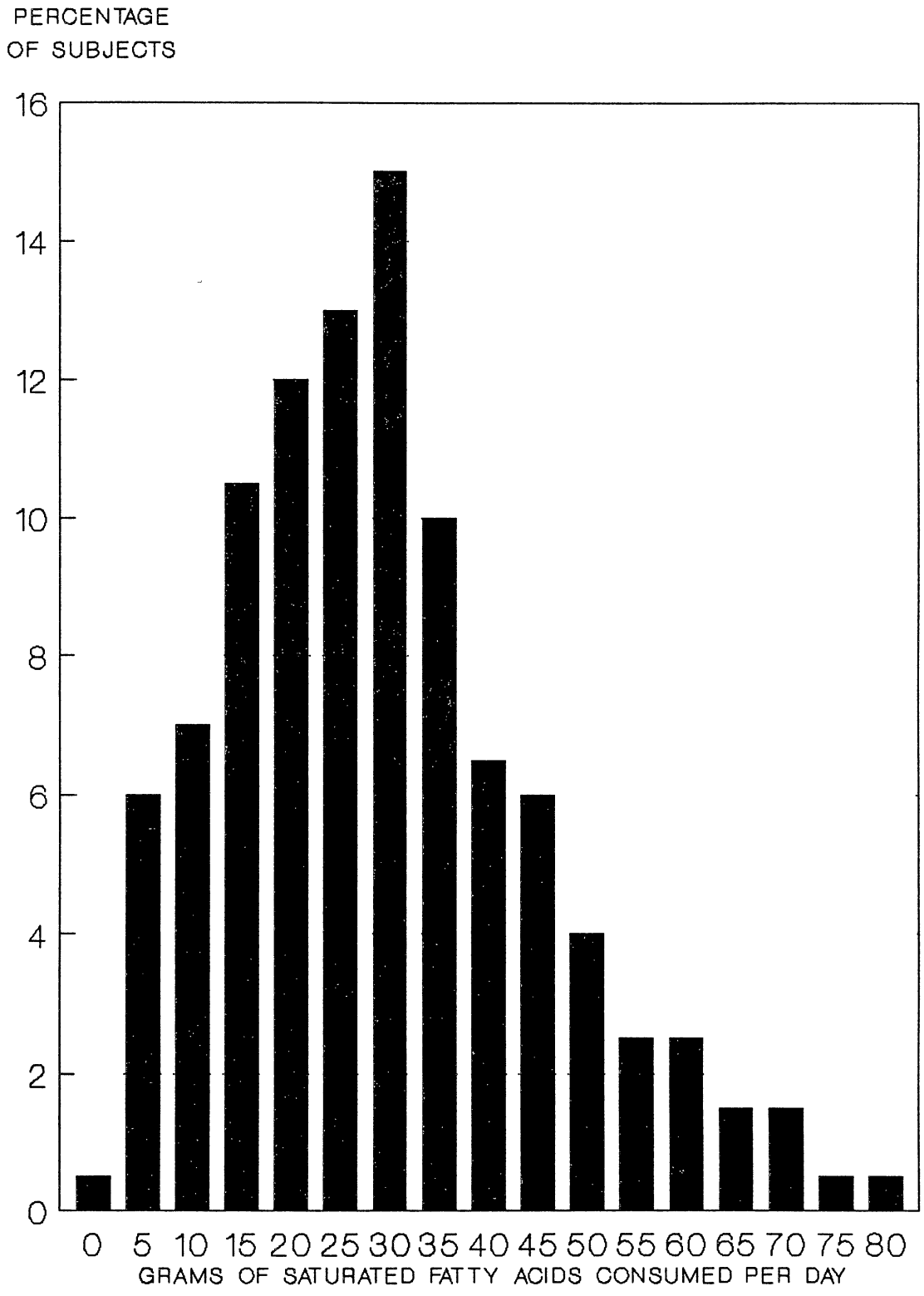

Figure XIII Subject Distribution of Saturated Fatty Acid Intake

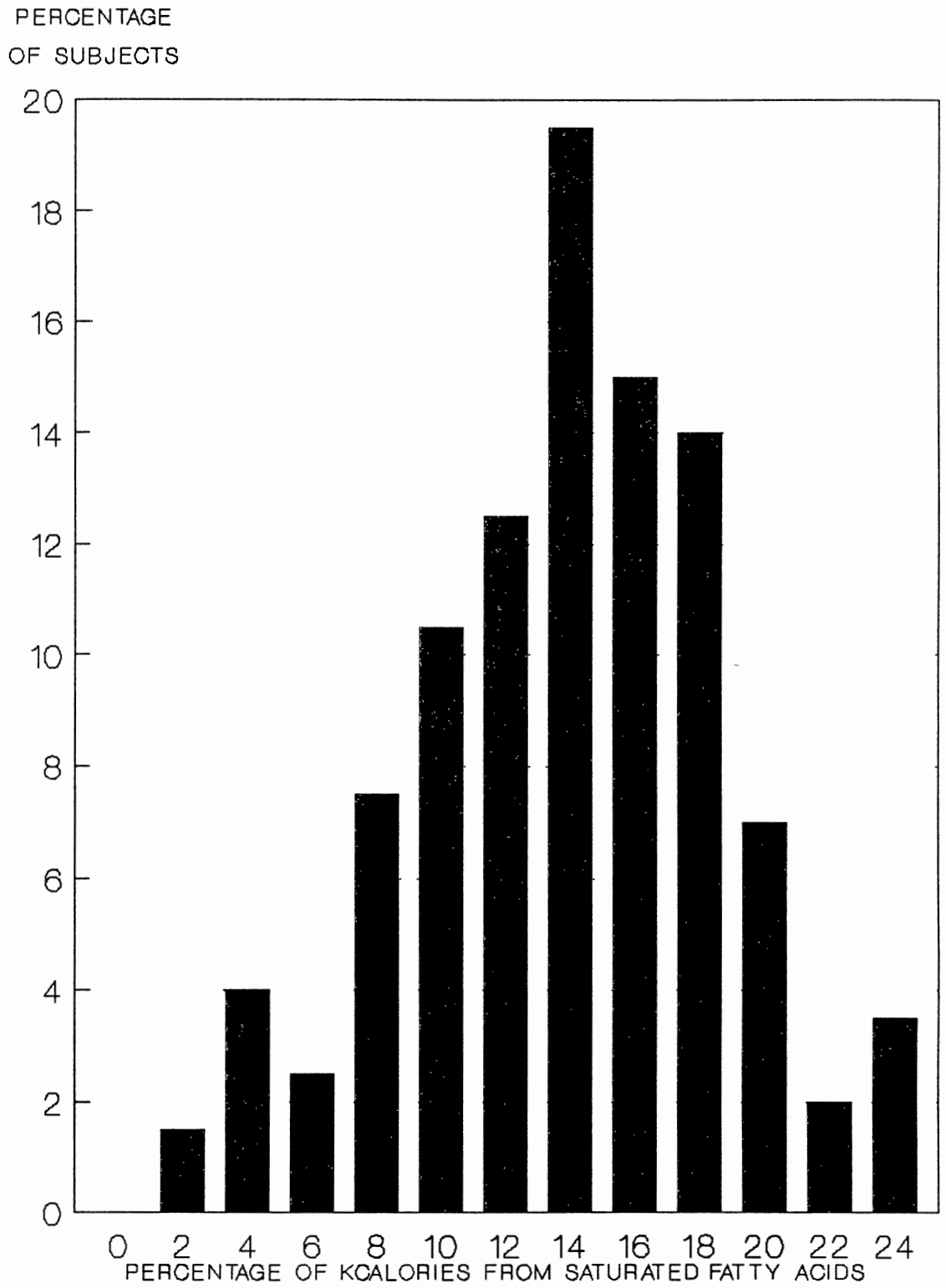

Figure XIV Subject Distribution of Saturated Fatty Acid Intake as a Percentage of kcal

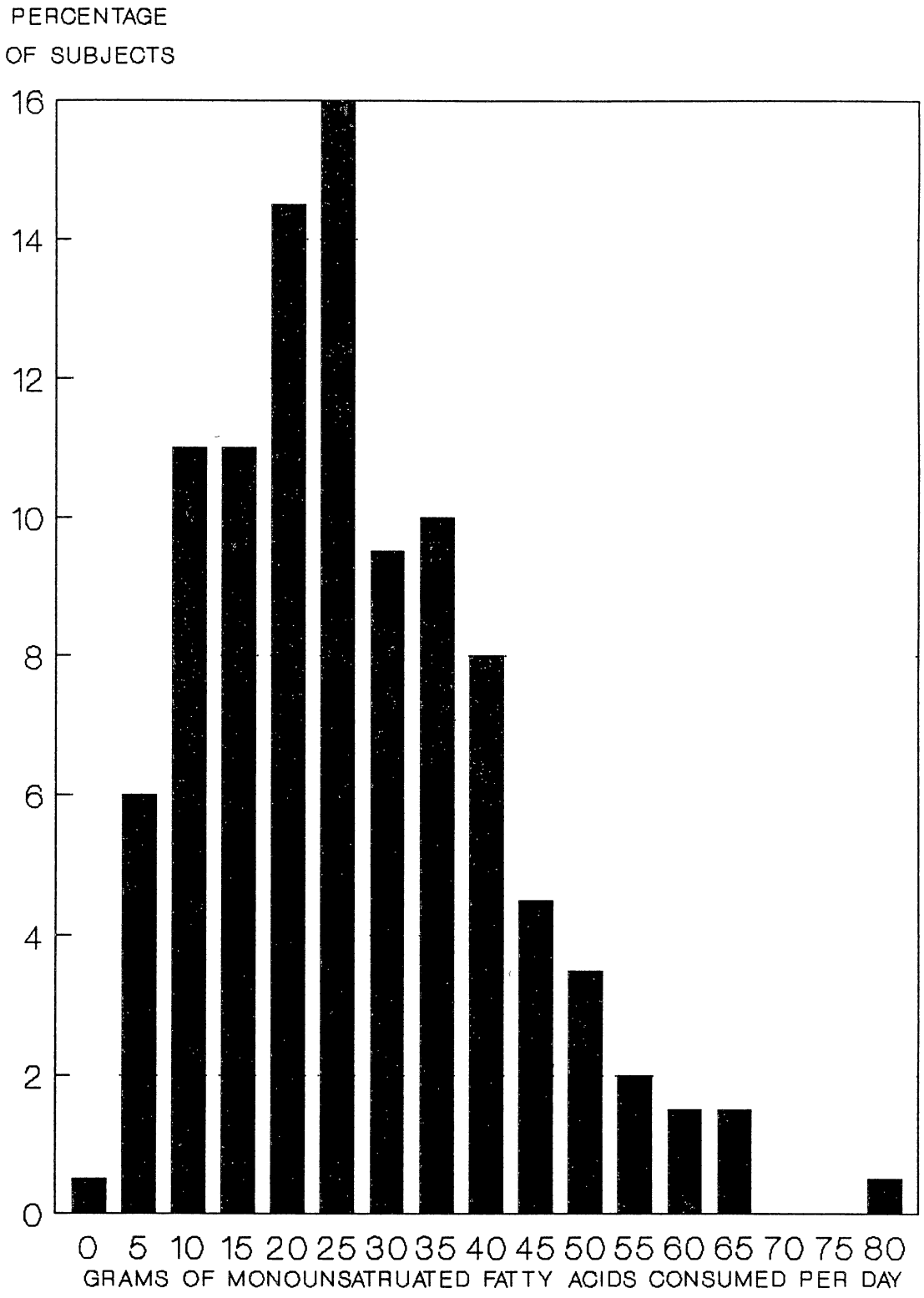

Figure XV Subject Distribution of Monounsaturated Fatty Acid Intake

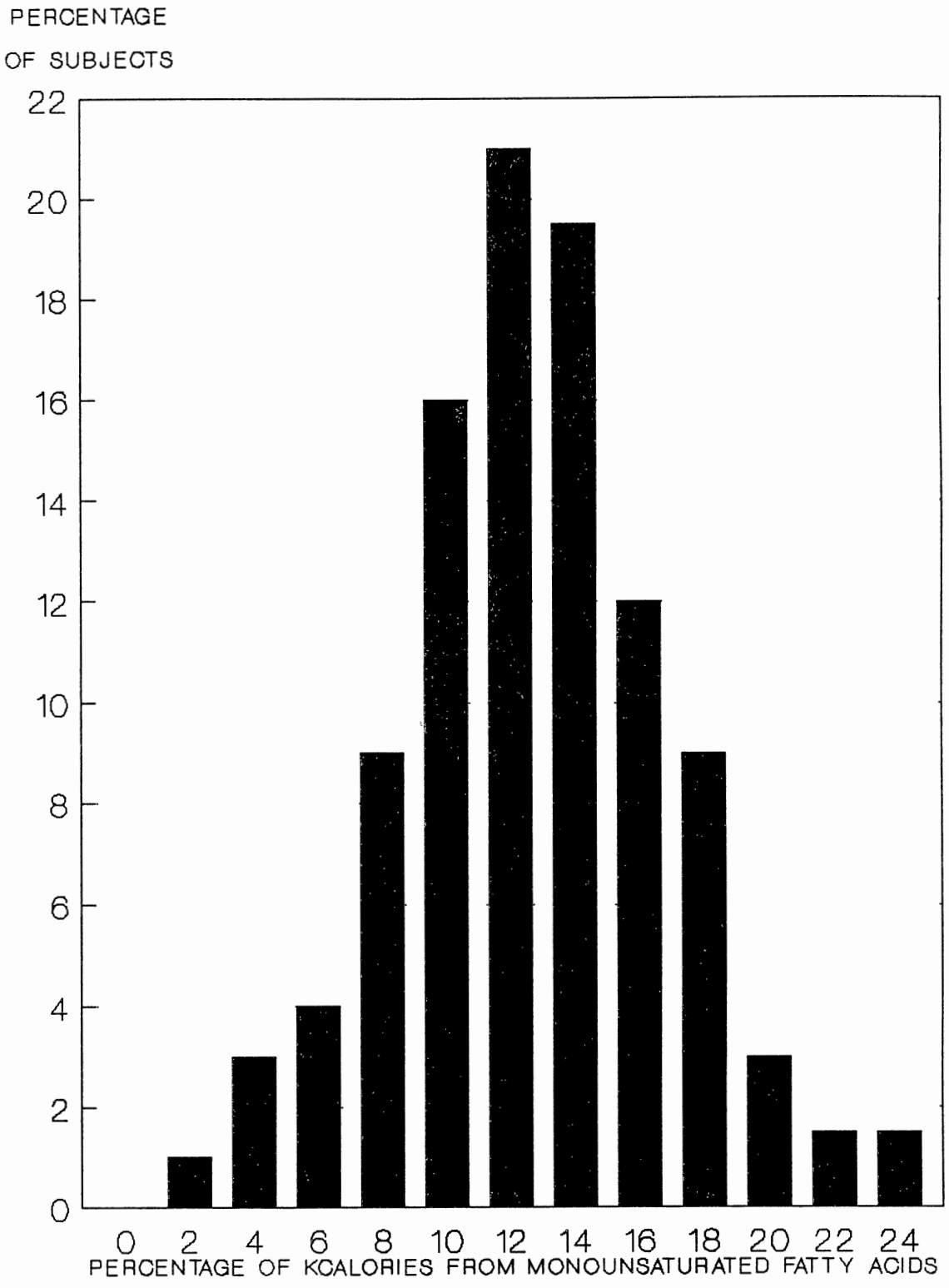

Figure XVI Subject Distribution of Monounsaturated Fatty Acid Intake as a Percentage of kcal

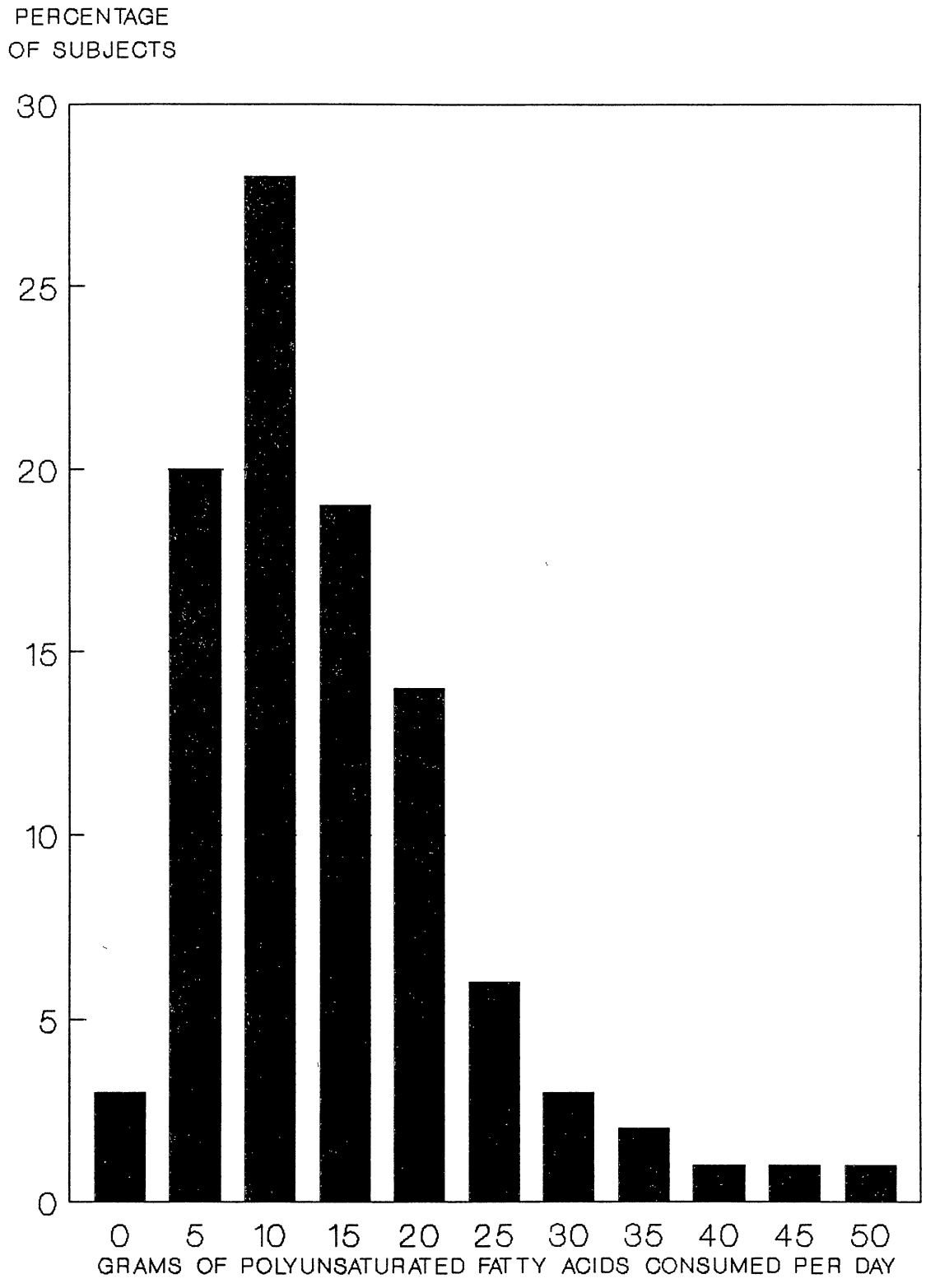

Figure XVII Subject Distribution of Polyunsaturated Fatty Acid Intake

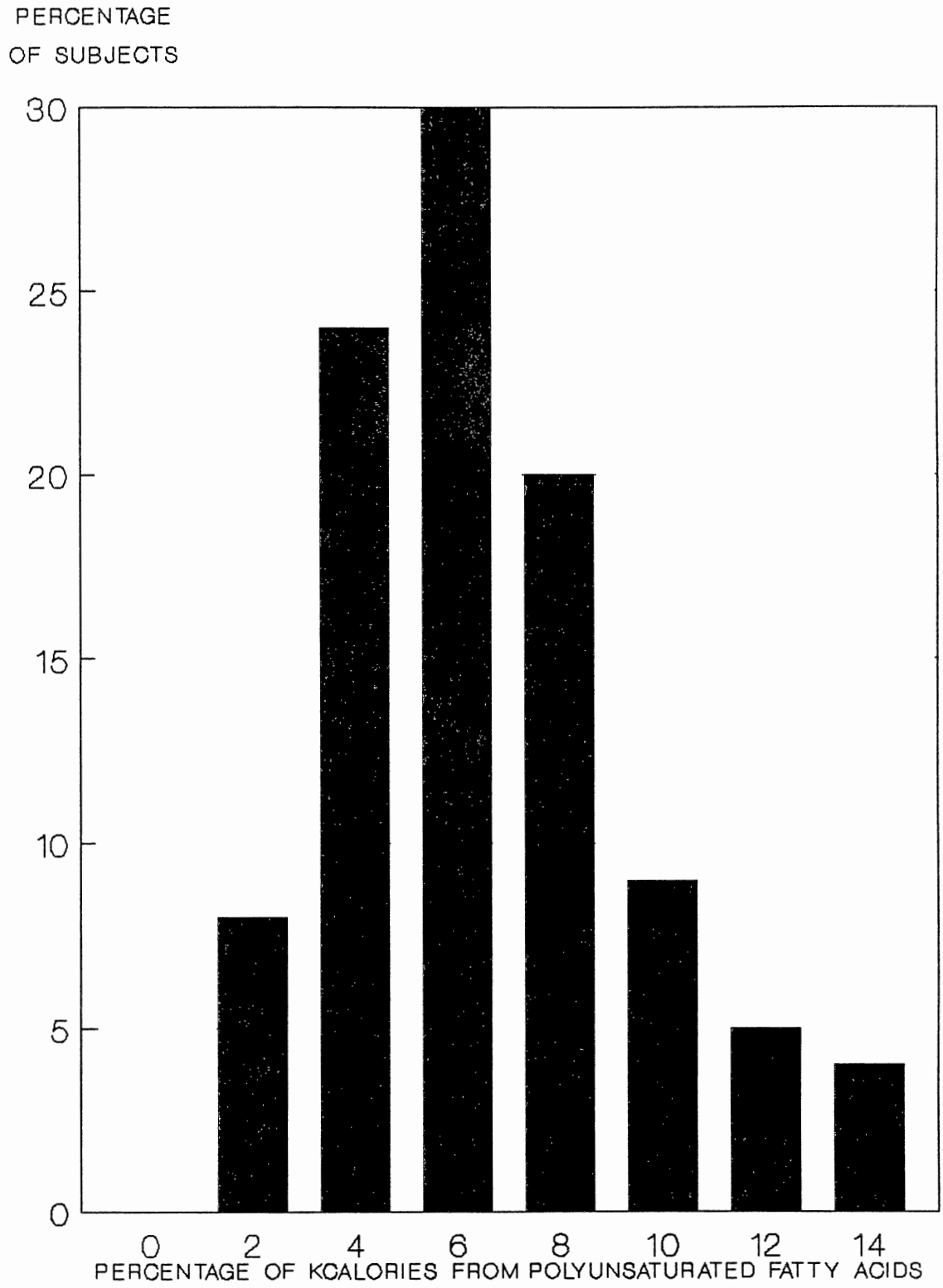

Figure XVIII Subject Distribution of Polyunsaturated Fatty Acid Intake as a Percentage of kcal

consumption of men was 41.9, 37.3, and 18.4 g, respectively. The fatty acid ratio was 1:0.9:0.4. Mean saturated, monounsaturated, and polyunsaturated fatty aicd consumption of women was 26.5, 24.4, 13.0 g, respectively (the fatty acid ratio was 1:0.9:0.5).

Percent of kcal from saturated and monounsaturated fatty acids were negatively correlated with fiber ($r=-0.39$, $p<0.0001$) ($r=-0.34$, $p<0.0001$) and fiber concentration ($r=-0.50$, $p<0.0001$) ($r=-0.49$, $p<0.0001$).

Cholesterol

Mean daily cholesterol intake was 298.0 mg or 160.2 mg per 1,000 kcal. Men consumed 418.5 mg or 161.7 mg per 1000 kcal while women consumed 268.1 mg or 159.8 mg per 1000 kcal per day. Current U.S. Dietary Goals are to consume no more than 300 mg per day, while some health experts state that intake should be no more than 100 mg per 1,000 kcal.

Cholesterol concentration was negatively correlated with % of kcal from carbohydrate ($r=-0.48$, $p<0.0001$) and grams of grains ($r=-0.29$, $p<0.0009$), fiber from grain ($r=-0.19$, $p<0.03$) and "other" servings ($r=-0.18$, $p<0.05$) but was positively correlated with protein ($r=0.28$, $p<0.002$), % of kcal from fat ($r=0.28$, $p<0.002$), saturated ($r=0.28$, $p<0.001$), and monounsaturated fatty acids ($r=0.35$, $p<0.0001$).

Figure XIX (p. 87) shows the distribution of intake of cholesterol among students. About 66% of the students

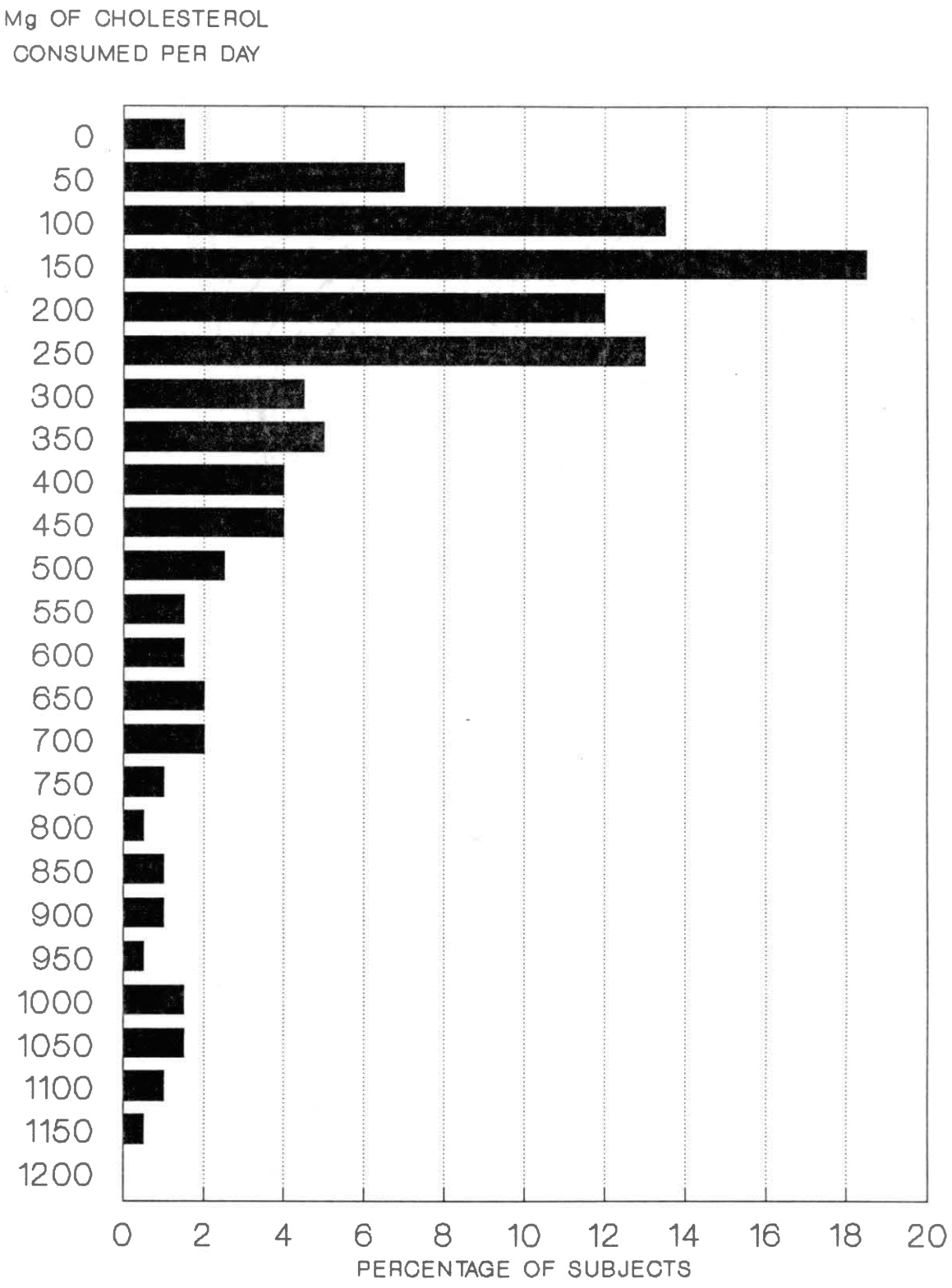

Figure XIX. Subject Distribution of Cholesterol Intake

consumed less than 300 mg of cholesterol per day. One-half percent consumed 1200 mg of cholesterol per day.

CHAPTER V

DIETARY FIBER CONSUMPTION PATTERNS OF COLLEGE STUDENTS

Young Ok Yang and Christa F. Hanson

Abstract

Dietary intakes were recorded by one hundred and thirty-one college students for two or four days. Records were analyzed for macronutrients and dietary fiber. Total servings and dietary fiber provided by grains, fruits, vegetables, legumes, nuts and seeds, combination, and "other foods" were determined. Mean daily dietary fiber intake of the college students was 13.1 g. Grains were the major sources of dietary fiber (4.6 g of fiber per day) followed by vegetables (2.4 g of fiber per day) and fruits (2.0 g of fiber per day). Grains provided 3.2 servings per day; while vegetables and fruits provided 1.7 and 1.5 servings per day, respectively. Mean energy intake of the students was 1,866 kcal per day: protein, carbohydrate, and fat contributed 16.0, 48.7, and 36.7% of energy, respectively. Saturated fatty acids provided 14% of energy. The majority of the students in this study consumed diets very different from the recommended dietary goals of 12%, 58%, and 30% of energy from protein, carbohydrate, and fat, respectively.

Introduction

Epidemiological observations indicate that heart disease, diabetes, obesity, colon cancer, and many other disorders in Western countries are related to a low intake of dietary fiber (Burkitt, 1969; Bingham et al., 1979; Mbofung et al., 1984; Lanza et al., 1987). U.S. dietary recommendations are to increase the intake of complex carbohydrate (grains, fruits, and vegetables) to increase intake of dietary fiber.

Various studies have measured fiber intake of populations throughout the world. Bingham et al., (1979) calculated dietary fiber intake of British population using weighed food records and found that the mean intake was 19.9 g per day. Marlett and Bokram (1981) reported that mean dietary fiber intake of Wisconsin students was 15.4 g per day. Dietary fiber intake of the U.S. population measured by the Nationwide Household Food Consumption Survey was 19.1 g per day (Ahren and Boucher, 1978). Bright-See and McKeown-Eyssen (1984) reported that mean dietary fiber intake of Danish, Dutch, and Finnish populations were 32.5, 22.1, and 23.1 g per day, respectively. These data were calculated from FAO Food Disappearance Reports from 1972 to 1974. Levels and types of dietary fiber are essential in determining the various physiological effects of fiber intake (Bingham et al., 1979). Different chemical components of dietary fiber appear to have different physiological effects. For example, pectin and other gummy

fiber components are effective in lowering serum cholesterol, delaying glucose absorption, slowing small intestine passage time, and increasing fecal output of bile acids; while wheat bran and other particulate type of fiber high in cellulose stimulates colonic function, speed passage through the gastrointestinal tract, and increase fecal bulk (Van Staveren et al., 1982; Eastwood and Passmore, 1983). Therefore both quantity and source of dietary fiber is important in evaluating fiber in the diet.

The purpose of this study was to assess the dietary fiber and macronutrient intake of college students. The objectives were to determine the level of dietary fiber intake of college students, to determine the food sources of dietary fiber in college student diets, and to evaluate the food consumption patterns.

Materials and Methods

This study used records collected in the Spring and Fall semesters of 1986 and 1987 from students (26 men and 105 women) enrolled in Basic Human Nutrition at Oklahoma State University, Stillwater, OK. Students recorded amounts, in household measures, of all food and beverage items that they consumed for two or four days. Nutritional analysis was calculated from the two-and four-day food records using the Food Processor II computer program (ESHA Research, Salem, Oregon, 1988). Dietary fiber contributions of specific food groups were determined by classifying items eaten by students into the following food groups; grains,

fruits, vegetables, legumes, nuts and seeds, combination, and "other". Combination foods were food mixtures like soups and pasta dishes, and "other" foods were sweets, desserts, and high fat food like condiments, and chips. Grams of fiber in each food group was calculated to determine the dietary fiber contributions of each food group. Total number of servings from each food group was estimated to determine food consumption patterns. Serving sizes used are as follows:

Grain Group

	Amount in one (1) serving
Bread	1 slice
Cereal	1 ounce (28 g)
Cereal, Cooked	1/2 Cup
Crackers	1 ounce (28 g)
Hamburger or Hotdog Bun	1/2 each
Noodle or Pasta, Cooked	1/2 Cup
Pancake or Waffle	1 each

Fruit and Vegetable Group

	Amount in one (1) serving
Fruit or Vegetable, Cooked	1/2 Cup
Fruit or Vegetable, Raw	1 Cup
Raw Fruit in Hand	1/2 Cup
Soup	1 Cup

Legume Group

	Amount in one (1) serving
Beans, Dried, Cooked	1 Cup
Mixed Nuts	6 T
Peanuts	6 T

Nuts and Seeds Group

	Amount in one (1) serving
Pecans	1-1/3 Cup
Pistachios	1/2 Cup
Sunflower Seeds	6 T

Combination Group

	Amount in one (1) serving
Meats	2 ounces (56 g)
Fish Sticks	3 ounces (84 g) or 3 sticks
Pizza	1/8 of large (15")
Sandwich	1 each
Spaghetti & Meat Balls	1/2 Cup

"Other" group

	Amount in one (1) serving
Candy or Chips	1 ounce (28 g)
Cookies	10 g
Fried Potatoes	100 g

Amount in one (1) serving

Salad Dressing or

Condiment Style sauces ..... 1/4 Cup

Sandwich Condiments ..... 1 T

Descriptive statistics including means, standard deviations, ranges, and correlation cofficients using SAS, Statistical Analysis System, (SAS, 1985) were used to evaluate dietary relationships.

Results

Fiber Intake

Mean fiber intake was 13.1 g per day and the concentration of fiber per 1,000 kcal consumed was 7.5 g (Table VII, p. 49). Fiber intake was positively correlated with energy ($r=0.39$, $p<0.0001$), protein ($r=0.36$, $p<0.0001$), carbohydrate ($r=0.55$, $p<0.0001$) and polyunsaturated fatty acids ($r=0.23$, $p<0.008$) (Table VIII, P. 50). However, fiber intake was negatively correlated with calories from fat ($r=-0.38$ $p<0.0001$) and percent kcal from saturated fatty acids ($r=-0.39$, $p<0.0001$) and monounsaturated fatty acids ($r=-0.34$, $p<0.0001$).

Fiber intake also was positively correlated with intake of grains ($r=0.49$, $p<0.0001$), fruits ($r=0.47$, $p<0.0001$), vegetables ($r=0.40$, $p<0.0001$), legumes ($r=0.19$, $p<0.03$), and nuts and seeds ($r=0.22$, $p<0.02$) but not with "other" foods or combination foods (Table IX, p. 53). Fiber concentration was negatively correlated with energy ($r=-0.22$, $p<0.02$) and

% kcal from fat ($r=-0.55$, $p<0.0001$).

Sources of Dietary Fiber

Fiber contribution of food groups are presented in Table X (p. 59). The average number of servings of food eaten is presented in Table XI (p. 60).

Grains. Grains were the major source of dietary fiber, with the average consumption being 3.2 servings per day. Of the breads and cereals consumed, refined flour contributed 2.0 servings of grains while whole wheat flour contributed 0.8 servings per day. This is typical for U.S. diets, in which wheat products provide most of grain consumed. The remainder (0.4 servings) was from grains such as corn, oat, barley, and rice.

A positive correlation between grain and fiber was found ($r=0.49$, $p<0.0001$). However, the positive correlation was between whole wheat flour and fiber ($r=0.70$, $p<0.0001$), with no correlation between refined flour and fiber. Refined flour intake was positively correlated with fat ($r=0.33$, $p<0.0001$).

Grain fiber was positively correlated with fruit fiber ($r=0.29$, $p<0.001$) and vegetable fiber ($r=0.26$, $p<0.003$). Although refined flour was negatively correlated with grams of vegetables ($r=-0.18$, $p<0.05$), whole wheat flour was positively correlated with both grams of fruits ($r=0.19$, $p<0.03$) and vegetables ($r=0.20$, $p<0.03$).

Vegetables and Fruits. The second greatest source of

fiber was vegetables providing 2.4 g of fiber per day; while fruits provided 2.0 g of fiber per day. The average vegetable consumption was 1.7 servings per day and the average consumption of fruits was 1.5 servings per day for a total mean of 3.2 servings of fruits and vegetables per day. Grams of fruits were positively correlated with grams of vegetables ($r=0.35$, $p<0.0001$), grains ($r=0.21$, $p<0.02$), and nuts and seeds ($r=0.28$, $p<0.001$). However, grams of vegetables consumed were negatively correlated with fried potatoes and snack chips ($r=-0.21$, $p<0.02$).

Legumes. The average fiber intake from legumes was 0.8 g per day. This amount provided only 0.1 servings. A positive correlation was found between legume intake and intake of fiber ($r=0.19$, $p<0.03$). Legumes are among the most concentrated sources of fiber (both soluble and insoluble).

Nuts and Seeds. Nuts and seeds consumption was very low, with only 0.5 g or 0.006 servings per day and a fiber intake from nuts and seeds of 0.04 g. Intake of nuts and seeds was positively correlated with fiber intake ($r=0.22$, $p<0.02$).

Combination. Combination foods provided 1.7 g of fiber and 1.4 servings per day. Servings of combination foods were positively correlated with fat ($r=0.34$, $p<0.0001$) and carbohydrate intake ($r=0.23$, $p<0.008$) but not with fiber.

"Other" Food. Foods in the "other" category provided 1.5 g of fiber and 3.2 servings per day. Of these foods, fried potatoes and snack chips provided 0.5 g of fiber per day and subjects consumed 0.6 servings (28.2 g) per day. Servings of "other" foods were positively correlated with fat ($r=0.52$, $p<0.0001$) but not with fiber. Servings of fried potatoes and snack chips also were positively correlated with fat ($r=0.34$, $p<0.0001$) and carbohydrate ($r=0.21$, $p<0.02$).

Energy and Nutrient Intake

Intakes of kcal and nutrients are presented in Table VII (p. 49) and percentage of kcal derived from each macronutrient is presented in Table XII (p. 71). Percentages of kcal from the macronutrients were; protein 16.0%, carbohydrate 48.7%, and fat 36.7%. Mean kcal intake was 1,866 kcal per day.

Protein. Mean protein consumption was 72.0 g per day. Positive correlations between protein and fat ($r=0.72$, $p<0.0001$), protein and cholesterol ($r=0.71$, $p<0.0001$), and protein and carbohydrate ($r=0.61$, $p<0.0001$) were found.

Carbohydrate. Mean carbohydrate intake was 224.8 g per day. Carbohydrate was positively correlated with fat ($r=0.59$, $p<0.0001$) and total cholesterol ($r=0.31$, $p<0.0003$) but was negatively correlated with cholesterol concentration ($r=-0.20$, $p<0.02$). Thus, students consumed carbohydrate foods that also were high in fat and cholesterol but as

total carbohydrate consumption increased, the cholesterol concentration in the diet was less than with a lower carbohydrate diet. Percent of kcal from carbohydrate was positively correlated with fiber ($r=0.39$, $p<0.0001$) and fiber concentration ($r=0.48$, $p<0.0001$), but was negatively correlated with total fat ($r=-0.44$, $p<0.0001$), cholesterol ($r=-0.40$, $p<0.0001$), and cholesterol concentration ($r=-0.48$, $p<0.0001$).

Fat. Average daily fat intake was 77.4 g. Percent of kcal from fat was negatively correlated with grams of fiber ($r=-0.38$, $p<0.0001$), fiber concentration ($r=-0.55$, $p<0.0001$), carbohydrate ($r=-0.26$, $p<0.003$), grams of grains ($r=-0.35$, $p<0.0001$), grams of fruits ($r=-0.40$, $p<0.0001$), and grams of vegetables ($r=-0.29$, $p<0.0006$). Fat calories also were negatively correlated with fiber from grains ($r=-0.35$, $p< 0.0001$), fruits ($r=-0.46$, $p<0.0001$), and vegetables ($r=-0.31$, $p<0.0003$).

Saturated fatty acids provided 14% of kcal; while monounsaturated and polyunsaturated fatty aicds provided 13% and 7% of kcal, respectively. Current Dietary Goal recommendation is 10% of kcal for each fatty aicd source. The average saturated, monounsaturated, and polyunsaturated fatty aicds consumption was 29.5, 27.0, and 14.1 g per day, respectively, for a fatty acids ratio of 1:0.9:0.5, while the recommended ratio is 1:1:1.

Percent of kcal from saturated and monounsaturated fatty aicds was negatively correlated with fiber ($r=-0.39$,

$p<0.0001$, $r=-0.34$, $p<0.0001$) and fiber concentration ($r=-0.50$, $p<0.0001$, $r=-0.49$, $p<0.0001$).

Cholesterol. Cholesterol intake was 298.0 mg (160.2 mg per 1,000 kcal). Current U.S. Dietary Goals are to consume no more than 300 mg per day, while other health experts state that intake should be no more than 100 mg per 1,000 kcal.

Discussion

The mean daily dietary fiber intake of 13.1 g found in this study was lower than current dietary fiber intake recommendations, which vary from 20 and 60 g (Mendeloff, 1977; Stephen, 1981; Butrum et al., 1988) and lower than various worldwide survey estimates of 14 to 70 g per day (Table VI, p. 37). However, the fiber concentration (g per 1,000 kcal) of 7.5 g is similar to the fiber concentration found in countries with eating habits like the United States (Ahren and Boucher, 1978; Nelson, 1985).

Bingham et al., (1979) reported that the dietary fiber intake of a British population was 19.9 g (9.1 g per 1,000 kcal) per day. Nelson (1985) also reported that a British population consumed 17.9 g of dietary fiber (7.5 g per 1,000 kcal) per day. Dietary fiber intake of Danish, Dutch, and Finish populations from FAO Food Disappearance Reports from 1972 to 1974 was 32.5, 22.1, and 23.1 g per day, respectively (Bright-See and McKeown-Eyssen, 1984).

Marlett and Bokram (1981) reported that mean daily

dietary fiber intake of Wisconsin students was 15.36 g (9.6 g per 1,000 kcal) per day. In other studies in the U.S., Ahren and Boucher (1978) reported that dietary fiber intake of U.S. population in Nationwide Household Food Consumption Survey was 19.1 g (7.2 g per 1,000 kcal) per day. Dietary fiber intake measured in the Nationwide Household Food Consumption Survey was higher than that measured in the college populations but dietary fiber intake per 1,000 kcal in the college populations of 9.6 (Marlett and Bokram, 1981) and 7.5 g (current study) was higher than 7.2 g they observed. Lanza et al., (1987) found that the dietary fiber intake of a U.S. population, in the Second National Health and Nutrition Examination Survey (HANES II - 1976 and 1980) was 11.2 g or 6.0 g per 1,000 kcal. Butrum et al., (1988) reported that dietary fiber intake of the U.S. population was 10 to 15 g, similar to that of the college students evaluated here. The result from the study of Ahren and Boucher (19.1 g of dietary fiber per day) was higher than that of Lanza et al., (1987) (11.2 g of dietary fiber per day) possibly because they used different analysis methods. Ahren and Boucher (1978) used "U.S. diet" homogenates made up by arbitrary selection of food items from the 1965-1966 USDA Household Food Consumption Survey lists. Analysis was done by official methods of the Association of Official Agricultural Chemists (AOAC). Lanza et al., (1987) used dietary fiber table of Lanza and Butrum compiled from literature reports.

The differences between the dietary fiber intake of our

study and previous studies apparently vary depending on food consumption patterns in different countries and on total energy intake. Table XIII (p. 102) shows the proportions of fiber available from various food groups in Britain and U.S. studies. Of the dietary fiber in the Wisconsin students diet, 41% of dietary fiber was supplied by vegetables, 32% by cereals, 22% by fruits, and 5% by miscellaneous sources such as nuts, peanut butter, and popcorn. This compares to 18.3% of the dietary fiber in the Oklahoma students diet supplied by vegetables, 35.1% by grains, 15.3% by fruits, and 30.9% by miscellaneous sources (composed of 13% by combination foods, 11.5% by "other" foods, 6.1% by legumes, and 0.3% by nuts and seeds). According to the British National Food Survey, 49% of the dietary fiber in the British diet was provided by vegetables, 29.9% by cereals, and only 9.8% by fruits, and 11.8% by miscellaneous sources, which were nuts and mainly cereal based combination foods (Southgate et al., 1978). Bingham et al.,(1979) reported that 41.3% of dietary fiber in British diet was supplied by vegetables, 30.5% by cereals, 28.2% from fruits and mixed sources such as pies.

Grains were the major sources of dietary fiber in our study while vegetables were the major sources of dietary fiber in previous studies. The Oklahoma students consumed a greater proportion of dietary fiber from miscellaneous sources like combination foods and snack foods than the subjects in previous studies. Because combination foods were not classified as to amount of grain, vegetable, or

TABLE XIII

DIETARY FIBER CONTRIBUTION OF VARIOUS FOOD GROUPS (%)

	Grains	Vegetables	Fruits	Legumes	Nuts and Seeds	Combination Foods*	"Other" Foods**	Reference
United Kingdom	30.0	49.0	10.0	←		12.0	→	Southgate et al., 1978
United Kingdom	30.5	41.3	←			28.2	→	Bingham et al., 1979
Wisconsin Students	32.0	41.0	22.0	←		5.0	→	Marlett and Bokram, 1981
Oklahoma Students	35.1	18.3	15.3	6.1	0.3	13.0	11.5	Yang, Y.O. M.S. Thesis

*Combination foods are foods eaten mixed together such as soups and pasta dishes.
**"Other" foods are sweets, desserts, condiments, fried potatoes, and chips.

fruit, this may have affected these results.

The low total dietary fiber intake found in our study was due to food consumption patterns of the students. Only 3.2 servings of grains per day were consumed by the students, and vegetables and fruits consumption was similar: 3.2 servings (1.7 of vegetables and 1.5 servings of fruits). Nuts and seeds and legumes together provided 0.1 servings per day. Just 0.8 servings of grains were from whole wheat flour. This is typical in the U.S. where Lanza et al., (1987) found that only 12% of the U.S. population consumed whole wheat bread. Combination and "other" foods provided 1.4 and 3.2 servings per day, respectively. This low dietary fiber intake of the students is similar to the patterns of the U.S. population in the Health and Nutrition Examination Survey II (HANES II) surveyed by the United States Department of Health, Education, and Welfare between 1976 and 1980. Only 1.5 servings of vegetables were consumed daily. The consumption of fruits was lower: 0.68 servings per day, while nuts, beans, and legumes provided 0.29 servings per day. The Basic Four Food Group recommendations are that at least 4 servings of grains as well as fruits and vegetables should be consumed daily. Neither the Oklahoma students nor the U.S. population consumed adequate amounts of the Basic Four Food serving recommendations. Thus, the low fiber intake found in our study is due to an inadequate intake of whole grains, fruits, and vegetables. Legumes and nuts and seeds intake also is very low.

Average kcal intake of our subjects was 1,866 kcal, with a mean energy intake of men, 2,546.4 kcal and of women, 1,697.0 kcal. Marlett and Bokram (1981) reported that mean energy intake of college men and women was 2,384 and 1,409 kcal, respectively. HANES II reported that mean energy intake of men and women was 2,990 kcal and 1,686 kcal per day, respectively (Lanza et al., 1987). Generally, the kcal intake of women in other developed countries is much higher than that seen in the U.S. Bingham et al., (1981) found that the British consumed 2,416 kcal for men and 1,972 kcal for women and Van Staveren et al., (1982) found the Dutch to consume 2,790 kcal for men and 2,040 kcal for women. The 1989 Recommended Energy Intake (Recommended Dietary Allowance, 1989) estimates males age 19 to 24 need an average of 2,900 kcal per day and females of the same age range, 2,200 kcal per day. The mean intake for both male and female students was below the Recommended Dietary Allowance (RDA) mean. Proportion of kcal from macronutrient groups also is important in determining dietary adequacy. Contributions of nutrients (% of kcal) to dietary intake are presented in Table XIV (p. 105). In our study, protein supplied 16.0%, carbohydrate 49%, and fat 37% of energy in Oklahoma student diet. According to the National Food Supply Statistics of 1976 from U.S. Department of Agriculture (USDA), 11% to 12% of energy in U.S. diet was supplied by protein, 46% by carbohydrate, and 42% by fat (Page and Friend, 1978). Bingham et al., (1981) reported that 13% of energy intake

TABLE XIV

CONTRIBUTION OF NUTRIENTS (% kcal) TO DIETARY INTAKE

	Protein (%)	Fat (%)	Carbohydrate (%)	Reference
United Kingdom	13.0	40.0	39.0	Bingham et al., 1981
United Kingdom	14.0	38.0	42.0	Thomson et al., 1985
Netherland	14.0	40.0	46.0	Van Staveren et al., 1982
United States	11.0 - 12.0	42.0	46.0	Page and Friend, 1978
Oklahoma Students	16.0	36.7	48.7	Yang, M.S. Thesis
U.S. Dietary Goals	12.0	30.0	58.0	Schlenker, 1984

was from protein, 39% from carbohydrate, and 40% from fat in the British diet. Thomson et al., (1985) studied dietary intake patterns of British population and found that about 14% of energy was from protein, 42% from carbohydrate, and 38% from fat. In 1982, Van Staveren et al., found that protein, carbohydrate, and fat contributed 14%, 46%, and 40% of energy in Dutch diet, respectively. In our study, the proportion of energy from protein and carbohydrate is higher and fat is lower compared to other studies.

The U.S. Dietary Goal for saturated, monounsaturated, and polyunsaturated fatty acids is a ratio of 1:1:1. Our results showed a ratio of 1:0.9:0.5. The polyunsaturated versus saturated fatty acids (P:S) ratio of the Oklahoma students is the same as that found in the U.S. population of 0.5:1 (Bierman and Chait, 1988). Saturated fatty acids contributed 14% of total energy while monounsaturated and polyunsaturated fatty acids contributed 13% and 7% of energy, respectively, while the current U.S. Dietary Goal is 10% of energy from each fatty acid. Thomson et al., (1982) reported that saturated fatty acids counted for 17.5%, monounsaturated fatty acids 14.8%, and polyunsaturated fatty acids 4.9% of energy in British diet with a P:S ratio of 0.30. In 1985, Thomson et al., found that saturated, monounsaturated, and polyunsaturated fatty acids contributed 16.3%, 13.9%, and 4.6% of energy again with a P:S ratio of 0.30 in British diet.

Based on the results of this study a reduction in saturated fatty acids and an increase in polyunsaturated

fatty acids apparently could be achieved by decreasing intake of "other" and combination foods and increasing consumption of fruits and vegetables and whole grains.

In our study, mean cholesterol consumption of the college students was 298.0 mg, with men consuming 418.5 mg and women consuming 268.1 mg per day. Based on the typical U.S. populations, men consumed 540 mg while women consumed 325 mg of cholesterol per day (Bierman and Chait, 1988). The Dietary Goal for cholesterol is consumption of no more than 300 mg per day. Therefore, cholesterol and saturated fatty acids consumption should be decreased, particulary in men, to reduce the incidence of diseases such as hyperlipidemia and atherosclerosis.

In conclusion, the dietary fiber intake of the college students in this study averaged 13.1 g and was considerably lower than the U.S. recommended intake range of 20 to 30 g. The low fiber intake was associated with a low intake of grains, especially whole grains, fruits, and vegetables. In these self-reported students' diets, there is considerable range for increasing the consumption of dietary fiber intake by improved food group choices. There is a need for change in the diets of these students as well as all typical U.S. diets to meet U.S. Dietary Goals.

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CHAPTER VI

SUMMARY AND CONCLUSIONS

This study evaluated dietary fiber intake patterns of college students at Oklahoma State University. Dietary fiber and macronutrient intake were calculated from two-and four-day food records using the Food Processor II computer program. Sources of dietary fiber were determined by calculating the dietary fiber contributions of each food group. The food groups used for this purpose were grains, fruits and vegetables, legumes, nuts and seeds, combination, and "other". Total weight in grams of each food group and numbers of servings from all food groups were also measured to determine the food consumption pattern of these college students.

Assumptions about dietary fiber intake, food group sources of dietary fiber, levels of macronutrient intake, and patterns of food group consumption were stated in hypotheses found in the introduction of this thesis. Each hypothesis will be evaluated based on the findings of this study. Fiber provided by each of the food groups is listed in Table XV (p. 111). Student intakes and dietary recommendations and goals are listed in Table XVI (p. 112).

Hypothesis one stated that there will be no difference between the fiber consumption of college students and the

TABLE XV

FIBER CONSUMPTION PATTERNS
OF COLLEGE STUDENTS

	Fiber	
	(g/day)	(%)
Fruits	2.0 ± 2.6	15.3
Vegetables	2.4 ± 2.2	18.3
Grains	4.6 ± 5.9	35.1

*Legumes and nuts and seeds, which are included in the meat group provided 0.8 ± 2.4 g (6.1%) and 0.04 ± 0.2 g (0.3%) of fiber per day, espectively.
Combination foods, which provided varying amounts of vegetables and grains provided 1.7 ± 1.8 g (13.0%) of fiber per day.
"Other" foods (sweets, oils, and condiments) provided 1.5 ± 1.6 g (11,5%) of fiber per day.

TABLE XVI

COMPOSITION OF COLLEGE STUDENT DIET

	Actual Student Intake (% of kcal)	One Standard Deviaton	Dietary Goals (% of kcal)*
Fiber	13.1 ± 8.4 g	21.5 g	20-60 g
Protein	16.0 ± 4.1	11.9	12
Carbohydrate	48.7 ± 8.9	57.6	58
Total Fat	36.7 ± 7.8	28.9	30
Saturated Fatty Acids	14.1 ± 3.8	10.3	10
Monounsaturated Fatty Acids	12.8 ± 3.4	9.4	10
Polyunsaturated Fatty Acids	6.7 ± 2.3	9.0	10

*Schlenker, 1984.

TABLE XVI (Continued)

Basic Four Food Group*	Number of Servings	Recommended
Fruits	1.5 ± 1.6	
Vegetables	1.7 ± 1.6	
Total Fruits and Vegetables	3.2	4-5
Grains	3.2 ± 2.2	4-5

*Combination foods which provide varying amounts of vegetables and grains, provided 1.4 ± 1.2 servings per day of a mixture of food group items.

currently recommended dietary fiber intake.

The National Cancer Institute recommended a total dietary fiber intake of 20 to 30 g with upper limit of 35 g (Butrum et al., 1988). Mean dietary fiber intake of these college students was 13.1 ± 8.4 g. This dietary fiber intake of 13.1 g was nearly one standard deviation lower than the minimum recommendation of National Cancer Institute. Therefore, most students consumed far less than the currently recommended minimum level. Our result was also lower than the levels of 20 to 40 g and 30 to 60 g per day suggested by Stephen (1981) and Mendeloff (1977), respectively. According to Figure I (p. 58), over 78% of the students consumed less than 20 g of dietary fiber per day. For the reasons stated above the first null hypothesis is rejected.

Hypothesis two stated that there will be no difference between the quantity of dietary fiber provided by fruits, vegetables, and grains.

Of the total dietary fiber intake, grains contributed 4.6 ± 5.9 g, fruits 2.0 ± 2.6 g, vegetables 2.4 ± 2.2 g. Percent of dietary fiber contributed from each food group was as follows; grains 35.1%, fruits 15.3%, vegetables 18.3%, legumes 6.1%, nuts and seeds 0.3%, combination 13.0%, and "other" 11.5%. Grains were the major source of dietary fiber, contributing approximately twice the fiber of vegetables or fruits. Vegetables and fruits were the second source of dietary fiber. Combination and "other" group contributed considerable amount of dietary fiber, providing

24.5% of the total fiber eaten per day. Positive correlations were found between fiber intake and intake of grains ($r=0.49$, $p<0.0001$). However, the correlation between fiber and whole wheat flour was $r=0.70$ ($p<0.0001$) while the correlation between white flour and fiber was $r=-0.09$ ($p<0.33$). Lanza et al., (1987) found that only 12% of the U.S. population consumed whole wheat bread. Our study found that of the bread products chosen, students consumed 2 servings per day of refined flour and 0.8 servings of whole grain. Positive correlations were also found between fiber intake and intake of fruits ($r=0.47$, $p<0.0001$) and vegetables ($r=0.40$, $p<0.0001$). Positive relationships between fiber intake and intake of legumes ($r=0.19$, $p<0.03$) and nuts and seeds ($r=0.22$, $p<0.02$) were seen also. However, combination foods like pizza and "other" foods like sweets and chips were not correlated with fiber intake. Therefore, the second hypothesis is rejected because grains were the greatest source of fiber with vegetables and fruits following. Fruits provided less than half as much fiber as did grains. Also, although not correlated with fiber intake, combination and "other" foods combined provided nearly one-fourth of all the fiber consumed per day.

Hypothesis three stated that there will be no difference between the number of Basic Four Food Group servings of grains, fruits, and vegetables consumed by college students and the recommended number of servings. However, the students consumed only 3.2 servings of grains per day; while fruits and vegetables provided a total of 3.2

servings per day. The students also consumed 0.1 servings of legumes and 0.006 servings of nuts and seeds. Combination and "other" foods contributed 1.4 and 3.2 servings per day, respectively. Most of students consumed fewer servings of each of these food groups than the USDA recommended minimum Basic Four Food Group servings which are 4 grains and 4 total fruits and vegetables. According to Figure II (p. 61), over 59% of the students consumed less than 4 servings of grains per day. Over 60% of the students consumed less than either 2 servings of fruits per day or 2 servings of vegetables per day. Forty-six percent of the subjects consumed no fruit and 34% of the subjects no vegetable (Figure V, p. 66 and Figure VI, p. 67).

The U.S. population evaluated in HANES II (Lanza et al., 1987) consumed an average of 1.5 servings of vegetables per day. Fruit consumption was lower, at 0.68 servings per day. Nuts, beans, and legumes provided 0.29 servings per day. Our students consumed more servings of grains, fruits, and vegetables than the U.S. population in HANES II. Men, consuming 4.4 servings of grains and 4.0 servings of fruits and vegetables, met the minimum recommended dietary food group servings of these foods while women, consuming 3.0 and 2.9 servings of grains and fruits and vegetables, did not meet the recommended dietary ıntake levels. Therefore, we fail to reject the null hypothesis for male subjects but reject for females.

Hypothesis four stated that there will be no difference between the proportions of macronutrients--carbohydrates,

proteins, and fats--consumed by college students and the recommended proportions.

Mean energy intake of the students was 1,866 kcal per day. Men consumed 2,546.4 kcal while women consumed 1,697.0 kcal per day. Food and Nutrition Board Recommended Dietary Allowance state that energy intake for for age between 19 and 22 should be 2,500 to 3,300 kcal for men and 1,700 to 2,500 kcal for women (Food and Nutrition Board, 1985). Average kilocalories consumed by men reached the minimum recommended levels of energy intake but women's intake was slightly lower than the minimum recommended level of intake. The mean energy intake of the college men was lower than 2,990 kcal for men but the intake of the college women was higher than 1,686 kcal for women in HANES II.

Percent of energy derived from macronutrients was as follows; protein 16.0%, carbohydrate 48.7%, and fat 36.7%. The percent of saturated, monounsaturated, and polyunsaturated fatty acids consumed was 14.1, 12.8, and 6.7%, respectively; while recommended values are 10, 10, and 10% of kcal, respectively. The fatty acid ratio was 1:0.9:0.5; while the recommended ratio is 1:1:1. The mean cholesterol intake of the students was 298.0 mg with men consuming 418.5 mg and women consuming 268.1 mg per day. Current dietary recommendations are no more than 300 mg of cholesterol per day. As can be seen from this discussion and table, the average student diet contained too much protein, too much fat, and too little carbohydrate. It was also inbalanced in fatty acids, with too much saturated and

monosaturated fatty acids and too little polyunsaturated fatty acids. Cholesterol intake was within the desired range for women, but not for men. Only 16% of the students met Dietary Goals of 12% of kcal from protein and 84% consumed more than 12% of kcal from protein (Table XVI, P. 112). According to Figure VIII (p. 73), 74% of the students consumed more than the recommended 12% of their kcal from protein. Nineteen percent of the students consumed the current dietary recommendation of 58% of kcal from carbohydrate or more (Table XVI, p. 112) while most consumed less than 55% of kcal from carbohydrate (Figure X, p. 76). Over 68% of the students consumed more than the Dietary Goals of 30% of kcal from fat (Figure XII, P. 79). Figures XIV (p. 81) and XVI (p. 83) show the distribution of saturated and monounsaturated fatty aicds as a percent of kcal consumed. The majority of the students, approximately 73.5 and 67.5%, consumed more than 10% of kcal from saturated and monounsaturated fatty acids, respectively. More than 82% consumed less than 10% of kcal from polyunsaturated fatty acids (Figure XVIII, p. 85). According to Figure XIX (p. 87), 30.5% of the students consumed more than the Dietary Goal of 300 mg of cholesterol per day. Therefore, we reject the null hypothesis that there is no difference between the student diets and the dietary goals.

In conclusion, dietary fiber intake of college students was 13.1 g which is well below the minimum recommendation of 20 g per day. This low intake is due to a lower than

recommended intake of grains, fruits, and vegetables and a high intake of refined foods in the form of white refined flour, combination foods and "other" foods. A greater consumption of whole wheat flour would greatly enhance fiber intake. Fiber intake also would be increased by increasing the consumption of fruits and vegetables. Similar to typical U.S. diets, total fat intake was higher than recommended and diets contained an excess of kcal from saturated fatty acids. Also total carbohydrate intake was too low and much of the carbohydrate was from processed foods and refined flour. Considerable continued nutrition education is needed to teach people good food choices, particularly the need for increased consumption of "natural" foods in the form of fruits, vegetables, and whole grains and other complex carbohydrate foods. Continued studies involving newer methods of analysis for dietary fiber and its component fractions are needed. Food tables containing more accurate and complete values of dietary fiber are also needed.

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APPENDIXES

APPENDIX A

INSTRUCTIONS FOR FOOD RECORD SHEETS

D-1

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 prepared can be assumed to contain 1/2 tsp. butter or margerine 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 THE DIETARY ASSIGNMENTS IN PENCIL. CORRECTIONS ARE NEATER AND EASIER TO MAKE WHEN PENCIL IS USED.

APPENDIX B

DEMONSTRATION OF COMMON SERVING SIZES

D-2

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 (8oz.) 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.

FRUITS

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

DESSERT

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

MISCELLANEOUS

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

APPENDIX C

24-HOUR FOOD INTAKE RECORD FORM

D-3

FOOD RECORD SHEET NAME_____

DAY_____ DATE_____ ROLL NO._____

FOOD	AMOUNT	BASIC FOUR FOOD GROUP
BREAKFAST		
LUNCH		
DINNER		
SNACKS		

TYPICAL? EXPLAIN

APPENDIX D

INFORMED CONSENT FORM

Survey of Food Habits and Nutrient Intake of
College Students of Two Campuses

Informed consent of Subject Involved in the Above Named Project.

I agree to participate in the research entitled, "Survey of Food Habits and Nutrient Intake of College Students of Two Campuses." I am aware of the fact that the only information I will need to provide will be demographic information and a copy of my food record sheets (page D3-D6) which I completed for the required course project in FNIA 1113.

I am also aware that there is no penalty to me or to my grade in FNIA 1113 if I choose not to participate. If I decide at any time to withdraw from this project I need only request in writing to my section instructor that my food records be withdrawn. There is no penalty for withdrawing from the project.

Signed:_____

Student ID #:_____

Date:_____

VITA

Young Ok Yang

Candidate for the Degree of

Master of Science

Thesis: DIETARY FIBER CONSUMPTION PATTERNS OF COLLEGE STUDENTS

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