FOOD GROUPS OF DIETARY FIBER BY ELDERLY PARTICIPANTS IN A CONGREGATE MEAL PROGRAM

By

ELIZABETH ZACHARIAH

Bachelor of Science
University of Kerala
Trivandrum, India
1970

Master of Science
University of Kerala
Trivandrum, India
1973

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Thesis approved:

Thesis Adviser

Dean of the Graduate College

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TABLE OF CONTENTS

Chapter		Page
I.	INTRODUCTION	1
	Statement of the Problem	3
	Objectives of the Study	4
	Hypotheses	5
	Limitations of the Study	5
	Definition of Terms	6
II.	REVIEW OF LITERATURE	8
	Demographics of the Elderly	8
	Nutritonal Status Of the Elderly	9
	Factors Affecting Nutritional Status of the Elderly	14
	Nutrition Recommendations	16
	Methods of Assessing Dietary Intake	21
	Congregate Meal Program	23
	Dietary Fiber	24
	Dietary Fiber and Disease Relationship	33
	Adverse Effect of High Fiber Diets	37
	Dietary Intake of Fiber and Minerals	37
	Summary	40
III.	METHODS AND PROCEDURES	41
	Data Collection	41
	Analyses of Data	42
	Statistical Analyses	44
IV.	RESULTS AND DISCUSSION	45
	Description of Subjects	45
	Analyses of Data	46
	Dietary Fiber Intake	47
	Dietary Fiber and Food Groups	49
	Dietary Intake of Minerals	51
	Age and Gender in Relation to Dietary Fiber Intake	55
	Summary	59

Chapter Page

V. SUMMARY, CONCLUSIONS AND RECOMMENDATIONS 60

Summary 60
Conclusions and Recommendations 63

BIBLIOGRAPHY. 65

APPENDIX A 74

APPENDIX B 77

LIST OF TABLES

Table		Page
I.	Recommended Dietary Allowances, 1980	18
II.	Estimated Safe and Adequate Dietary Intakes of Minerals (1980) for Adults . . .	19
III.	Physiochemical, Physiologic and Clinical Aspects of Fiber	30
IV.	Number and Percentages of Subjects According to Age and Gender.	46
V.	Mean and Standard Deviation of Dietary Fiber Intake According to Food Groups. . . .	48
VI.	Correlation Coefficient and Level of Significance of Dietary Fiber Intake From Different Food Groups	50
VII.	Mean Intake and Percentage of RDA and ESA of Selected Minerals Consumed by Elderly Subjects	52
VIII.	Correlation Coefficients and Level of Significance Between Dietary Fiber Intake From Various Food Groups and Intake of Selected Minerals	54
IX.	Dietary Fiber Intake From Various Food Groups According to Gender	56
X.	Mean Intake of Dietary Fiber by Elderly According to Age	58

CHAPTER I

INTRODUCTION

The proportion of the elderly population of the United States is constantly increasing. In 1987, about 29 million (12.2%) of the the population was 65 years of age or older (USDC, 1989). It is projected that by the year 2030, approximately 57 million (17%) of Americans will be over the age of 65 (Bidlack, Smith, 1988). People's concern for the elderly portion of the population increases with the realization that they account for an increasing share of medical expenses (Chernoff, 1987; Kohrs, 1982). The nutritional status of the elderly has been noted to be at risk in a number of surveys.

Dietary fiber has emerged in the past two decades as a factor in nutrition and medicine that appears to have complex and far reaching effects on the physiology and health of human beings. Low fiber diets have been associated with an increase in the incidence of diabetes, gastrointestinal disorders, heart disease, colorectal cancer, and obesity.

Nutrition and Your Health: Dietary Guidelines for Americans, 2nd ed. U.S. Department of Agriculture and Department of Health and Human Services, 1985 does not make

specific recommendation about the amount of fiber. It encourages people to eat foods with adequate fiber. The Committee on Diet, Nutrition, and Cancer recommends including whole grains, fruits and vegetables in the daily diet. The National Cancer Institute suggests that Americans double the amount of fiber they currently eat to 20 to 30 g/day; but cautions against consumption over 35 g/day (Cronin and Shaw, 1988). The Surgeon General's Report on Nutrition and Health (DHHS, 1988) recommends that Americans increase consumption of whole grain foods and cereal products, vegetables, and fruits. National Research Council suggests that adults consume 5 or more daily servings of vegetables and fruits and 6 or more daily servings of breads, cereals, and legumes (NAS/NRC, 1989). Thus the various recommendations are consistant in recommending foods that are good sources of fiber; but no precise recommendation has been made on the amount of dietary fiber. However, it is generally agreed that fiber be obtained from a variety of food sources.

The increasing proportion of the U.S. population surviving to older ages and their chronic diseases and disabilities are of great concern today. This is due to the fact that elderly are the greatest consumers of health care resources in the United States. They use 40% of acute care facilities in hospitals and purchase 25% of all prescription drugs. Thus the elderly account for more than half of the federal health care budget (Chernoff, 1987).

According to a publication of the Department of Health and Human Services:

> Between 1985 and 2020, the population 65 years and older is likely to increase by almost 2 percent a year, an average of 750,000 additional older persons annually. The oldest old - persons 85 years of age and older - are projected to increase at an even faster rate, by about 3 percent a year (Report to Congress, 1987).

Proper nutrition is needed in maintaining good health and in retarding the onset of or progress of major age-associated chronic diseases. A well nourished older person should be more capable of coping with the stress associated with aging. Thus the elderly being more vulnerable to dietary deficiencies and having less physical reserve to cope with stress, probably have a greater need for an adequate diet.

There is increased incidence of constipation, diverticulosis, colon cancer, diabetes mellitus, hypertension, and atherosclerosis among the elderly. Even though dietary fiber is not a nutrient, it helps to alleviate some of these problems (Brodribb, 1977; Anderson, 1985).

Statement of the Problem

Improved medical care and good nutrition have allowed the elderly to increase their life span. An increased life span could be enjoyed only when it is possible to maintain a good quality of life. To maintain maximum quality of life,

proper nutrition is important. Lack of fiber in the diet is related to the existence of various diseases in developed countries (Burkit, 1973, Trowel, 1976, Kromhout et. al, 1982). Dietary fiber has been shown to be beneficial to health (Anderson, 1985). Older people are poorly informed about the required nutrients, their functions in the body, and the good food sources. Furthermore, even those who recognize the need for particular nutrients, may not include those foods in their diets because of cost or convenience. Congregate meal programs offer opportunities to integrate nutrition education with a served meal. It is, therefore, worthwhile to identify the food sources of dietary fiber and minerals in the elderly.

Objectives of the Study

The objectives of this study were to:

1. determine the total dietary fiber intake of the elderly according to various food groups.
2. assess the adequacy of total dietary fiber and selected mineral intake in a group of elderly.
3. determine the correlation between the dietary intake of fiber and selected minerals of the elderly.
4. identify the relationship between the total dietary intake of fiber and the variables, gender and age.

Hypotheses

This study proposed to test the following null hypotheses:

1. There will be no significant difference in the dietary fiber intake contributed by different food groups.
2. There will be no significant correlation between the dietary fiber intake and adequacy of calcium, copper, iron, magnesium, phosphorus, potassium, selenium, sodium, and zinc.
3. There will be no significant correlation between the dietary fiber intake and the age and gender of the subjects.

Limitations of the Study

1. This study is limited to the elderly volunteers who participated in the Congregate Meal Program that was conducted during Summer, 1987 in Stillwater, Oklahoma.
2. These results cannot be extrapolated to the population of the elderly due to the limited sample size and selection of volunteers.
3. Food intake data information was limited by the use of the 24-hour recall method of dietary survey.
4. Food composition values were limited to the information available in the Food Processor II data bank.

Definition of Terms

The following terms were defined as appropriate for this study:

Elderly - Men and women of 65 years of age or more or their spouses regardless of age.

Dietary fiber - It is the constituent of plant cells that is not digested by human digestive enzymes (Trowel, 1976; Slavin, 1987; Shneeman, 1987). It includes both soluble and insoluble fiber.

Crude fiber - The residue of plant food which remains after treatment with a solvent, hot acid, and then hot alkali (Trowel, 1976; Southgate, 1977).

Cellulose - Cellulose is the major component found in the cell walls of plants. It is made up of D-glucose units joined by β 1-4 glucoside linkages. Even though it is insoluble in water, it does bind water in the gastrointestinal tract (Anderson and Chen, 1979; Schneeman, 1986; Slavin, 1987).

Lignin - It is the non-carbohydrate fraction in the plant cell wall. It is hydrophobic with a constipating effect, resistant to microbial degradation and absorbs bile acids (Van Soest and McQueen, 1973; Eastwood, 1974; Schneeman, 1986, Slavin, 1988).

Pectin - Pectin consists of polymeric galactouronic acid, arabinose and galactose. It is very hydrophilic and can form gels (Anderson and Chen, 1979).

Hemicellulose - Hemicellulose is a complex carbohydrate that constitutes secondary plant cell wall thickening. It has a xylose backbone and is extractable with alkali. Being hydrophilic, it has water-holding capacity (Van soest, 1978; Anderson and Chen, 1979).

Neutral Detergent Fiber (NDF) - This is the organic residue which results after treatment with hot neutral detergent solution. The types of fiber measured by this method are cellulose, insoluble hemicellulose, and lignin (Van Soest, 1978).

Acid Detergent Fiber (ADF) - Acid detergent fiber is an organic residue which results after treatment with boiling acid containing detergent. This mainly contains lignin and cellulose fractions of plants (Van Soest, 1978).

Vegans - They are people who rely on grains, fruits, vegetables, nuts and seeds. Vegans refuse any source of animal protein.

Recommended Dietary Allowances (RDA) - These are recommendations for the average daily amounts of nutrients that population groups should consume over a period of time (FNB,RDA, 1980).

Adequacy of nutritient intake - Two thirds of the Recommended Dietary Allowances have been considered adequate (Guthrie, 1983).

24-hour recall - This method has been used to obtain information concerning food and beverages consumed within the past 24 hours.

CHAPTER II

REVIEW OF LITERATURE

As the elderly portion of the population in the United States is growing rapidly, public interest in its health and wellness has increased. Dietary fiber has been found to have an important role in alleviating some of the health problems of the elderly. This chapter reviews the demographics of the elderly, their nutritional recommendations, the role and function of fiber in their diet, usual intake of dietary fiber and trace minerals and the food sources of dietary fiber and trace minerals.

Demographics of the Elderly

Since the turn of the century, the elderly population in the U.S. has steadily increased. This rapidly growing segment of the American population includes about 12.2% of the total population or about 29 million people. Further projections into the 21st century indicate that the elderly will continue to increase to about 20% of the population by the year 2025. Even more significant is the projection that by the year 2050, there will be about one million people over the age of 100 in the United States (Bidlack, et. al, 1986; Chernoff, 1987). To study the nutritional status of

the elderly, it is essential to focus on all aspects of aging phenomenon and be aware of the biological and social changes experienced by the elderly. The coexistance of many factors including age-related physiological changes, and presence of chonic diseases can limit nutrient uptake and nutritional status of the elderly.

Nutritional Status of the Elderly

National studies such as the Ten-State Nutrition Survey, the National Health and Nutrition Examination surveys (NHANES) I and II and the 1978 U. S. Department of Agriculture, Food Cosumption Survey have revealed that substantial number of the elderly are lacking in specific nutrients. According to these surveys, the elderly are consuming less than the recommended levels of calories, vitamin B and calcium (Bidlack and Smith, 1988). But there is controversy about these findings because the reference point for the Recommended Dietary Allowances (RDA) combines all elderly into a single category of 51+ years.

Ten-State Nutrition Survey

The Ten-State Nutrition Survey was conducted by the Department of Health, Education and Welfare, from 1968 to 1970, to correlate nutrient intake with clinical signs of deficiency and to identify the malnourished. A random selection of households was made from states where the

largest percentage of families were living in poverty. The dietary evaluation for this study was done using 24-hour recalls and food frequency charts. In the Ten-State survey, data were collected mostly from people at near poverty level. However some data on middle and upper-income groups were also obtained. According to this study, among the older individuals, over half of the men had intakes below 2000 kcal, and half of the women had less than 1500 kcal. These caloric consumption values were below the recommended levels for people aged 65 and above. Iron intake levels were below the RDA in black females, of both low income (78%) and high income (86%) as well as high income Spanish-American families (87%). Calcium intake level was below the RDA in women. Ascorbic acid was also below the RDA for one third of the population studied (Ten-State Nutrition Survey, 1968- 1970).

National Health and Nutrition Examination Survey

The National Health and Nutrition Examination Survey (HANES) I, conducted from 1971 to 1974, used dietary recall, anthropometric, and biochemical analyses to evaluate the health and nutritional status of the U.S. population. A sample of 28,043 persons aged 1-74 years were selected for this study. These were a representative probability sample of the total U. S. population. In this study, the

nutritional status of 1515 individuals, over age 60 were determined. Results from the survey, identified that approximately one-half of the subjects over 60 years of age obtained less than two-thirds of the RDA for calories, calcium and vitamin A. Twenty percent of the elderly population consumed less than two-thirds of the RDA for iron and vitamin C. Dietary fiber intake was not assessed in this nutrition survey.

National Food Consumption Survey

The U. S. Department of Agriculture surveyed the national food consumption during 1977-'78. In that survey, it was noted that the intake of vitamin B-6 and vitamin A was at two-thirds of the RDA and the calcium intake was 85% of the RDA in elderly men over 75 years of age. For elderly women over 75 years of age, the intake of vitamin B-6 was 60% of the RDA and the intake of vitamin A was 75% of the RDA, while calcium intake was two-thirds of the RDA.

Other Studies

Several other studies have also evaluated the dietary intake of the elderly. O'Hanlon and Kohrs (1978) compiled data obtained from dietary surveys, assessing the nutrient intake of older Americans. Food energy and calcium intake were most frequently found to be below the standards. Although the standards or the dietary methodology used

differed in different surveys, the mean intake of protein was adequate in all reviewed studies, with the exception of the Ten-State Survey.

Yearick and co-workers (1980) evaluated the nutritional status of 100 elderly non-institutionalized persons in terms of their dietary nutrient intakes and selected biochemical measurements. Three-day dietary records were used for the dietary evaluation. According to this study, the energy value of the average diet was very close to the recommended allowance of kilocalories. Seventeen percent of the dietary energy was derived from protein, 47% from carbohydrate, and 36% from fat. Dietary intakes of protein and ascorbic acid were adequate for 90% of the population studied. Only 60% of the population reached the RDA for vitamin A. Diets of one-third of the women and one-sixth of the men were low in calcium. There was no significant correlation between age and the intake of any of the nutrients.

In another study, dietary intake was assessed from 3-day food records. Subjects were free-living, middle income, healthy men and women, over 60 years of age residing in the Albuquerque, New Mexico vicinity. Energy intake as percentage of the RDA was 90 $\pm$ 23 (mean + SD) for men (n = 125), and 87 $\pm$ 22 for women (n = 145). Protein intake was found to be adequate in this population. In this study, dietary intakes in the population appear to be adequate (Garry et al., 1982).

Barr et al. (1984), studied the food intake pattern of

30 women over the age of 80, who were living in a long-term care facility of a University hospital in Vancouver, B.C., Canada. This survey was conducted over a five day period using the weighed intake method. All foods served and returned by the residents were weighed individually and recorded. The dietary intake data was obtained from the difference in the weight of the food items. A computer program was used for nutrient analyses. One hundred percent of the Recommended Nutrient Intakes for Canadians was considered as the standard. Average intake of riboflavin, niacin, vitamin C, and iron met or exceeded the standard. But the average intakes of energy (91.4%), calcium (64.8%), vitamin A (79.4%), thiamin (74.0%), and zinc (75.0%) fell below the recommended levels. Analyses of dietary intake by food groups revealed that the grain group was the primary source of energy and many nutrients for elderly people.

Posner and co-workers (1987) studied the food and nutrient intake of 53 homebound older persons (mean age = 82 years) in the metropolitan area of Boston. Dietary intake of nutrients were determined using a food frequency questionnaire and the 24-hour recall. Mean intake of energy was 78.9%, and calcium was 61.7% of the RDAs for both men and women. No significant relationships between nutrient intake and characteristics such as age, income, education, and medical status was discovered in this study.

McGundy et al. (1986) did a nutritional staus survey of apparently healthy, non-institutionalized elderly, aged

60-98 living in the Boston area. This survey was done between August, 1981 and December, 1983. They used the 3-day food record method to do the dietary evaluation. Results of their study showed that the mean energy intake (24.8 kcal/kg) was substantially lower than the RDA. Protein intake was adequate; but intake of calcium was below two-thirds of the RDA for 21% of the population, whereas the intake of zinc was below two-thirds of the RDA for 35% of the population.

Factors Affecting Nutritional Status of the Elderly

Physiological changes

After about age 30, normal physiologic decline occurs at a near linear rate. Structural and functional changes take place at all levels from cells to organ systems. The rate at which these changes occur differs from individual to individual (Watkin, 1982).

As humans age, the body composition changes. The most significant change is in the loss of protein tissue, the lean body mass. Both muscular and visceral protein are reduced. This leads to both functional and metabolic changes (Shock et. al, 1970; Chernoff, 1987; Bidlack and Smith, 1988). Reduction in muscle mass affects vital organ function, particularly cardiac function (Shock, 1970; Chernoff, 1987). Similar changes also occur in other organs

such as lungs, kidneys and liver. But it is important to recognize that in the absence of disease, organ function will be adequate. But the reserve capacity of the organs or the ability to respond to stress will reduce over time (Shock, 1970; Chernoff, 1987).

Changes also occur in the immune system with age. This has an impact on the physiologic response to invading microorganisms. Thus, the elderly are at potential risk for infectious diseases. Another result is the decrease in basal energy metabolism.

Economic and Social Factors

In addition to limitations imposed by normal physiologic decline and chronic diseases, other factors that influence food selection, dietary habits and nutritional status in the elderly are psychological, social and economic factors. An individual whose whole adult life was focused on work-related interactions and associations may suffer loss of self esteem, bitterness and depression upon retirement (Bluementhal, 1980). This can lead to lack of interest in food and subsequent change in nutrient intake.

Food selection, preparation and eating can be a medium for socialization and can lead to a sense of security and love (Weinberg, 1972). The type of food an older person consumes may also depend upon the companions with whom the person eats. Loss of a spouse, siblings, friends or eating

companions can lead to loneliness, isolation and depression. Such a situation can also lead to loss of interest in food and if the problem persists, can cause malnutrition in the elderly.

Financial burdens imposed by a limited income can have a major impact on the health and well-being of the elderly (Brun and Clancy, 1980). The level of education and knowledge of good food sources of nutrients is another factor that is related to the ability of the elderly to plan a nutritionally adequate diet. The elderly are not well informed about the function of essential nutrients, their interactions or appropriate food sources of dietary fiber and minerals.

Nutrition Recommendation

Changes in body composition and activity levels in elderly are to be considered in evaluating their nutritional requirements (Shock, 1982). Apart from the need for energy which is known to decrease with increasing age in the elderly, the recommendations for other essential nutrients for active, healthy elderly persons are the same as those for younger adults (RDA, 1980; Shock, 1982).

The Recommended Dietary Allowances (RDA) established by the Food and Nutrition Board of the National Academy of Sciences, are the most commonly used guidelines for estimating the nutritional adequacy of diets. The

Recommended Dietary Allowances (RDA) published in 1980 include two age groups for older adults, 51-75 years and 76+ years for energy allowances; but only one age grouping of 51+ for all other nutrients. The RDA are considered sufficient to meet the nutrient needs of practically all healthy persons. Thus the RDA focus on health maintenance and are not designed to meet the additional requirements that may occur because of acute and chronic diseases and infections, physical trauma or other stressful events often experienced by the elderly. Medications, frequently taken by the elderly can also increase nutrient requirements by decreasing nutrient absorption or by altering the utilization of nutrients by tissues (Smith and Bidlack, 1982). As the RDA do not cover unusual nutrient needs associated with special conditions such as chronic diseases or drug regimens, their use in evaluating the nutritional status of elderly individuals may be limited (Butler, 1982). Recommended Dietary Allowances for food energy and minerals for the elderly are shown in Table I.

Minerals

Recommended intake for calcium phosphorus, magnesium, iron, and zinc, according to the 1980 RDA are given in Table I. Estimated safe and adequate daily intake for copper, potassium, selenium, and sodium, according to the 1980 RDA is shown in Table II. The bio-availability of a mineral

TABLE I

RECOMMENDED DIETARY ALLOWANCES, 1980

	Males[a] (years)		Females[b] (years)	
	51-75	76+	51-75	76+
Energy (kcal)	2400	2050	1800	1600
Minerals (mg)	51+ years		51+ years	
Calcium	800		800	
Phosphorus	800		800	
Magnesium	350		300	
Iron	10		10	
Zinc	15		15	

[a]Males for both age groups are based on weight of 70 kg and height of178 cm.

[b]Females for both age groups are based on a weight of 55 kg, and height of 163 cm.

Ref. FNB/NRC, RDA, 1980.

TABLE II

ESTIMATED SAFE AND ADEQUATE DIETARY INTAKES OF MINERALS (1980) FOR ADULTS

Minerals	Amount (mg)
Copper	2.0 - 3.0
Potassium	1875 - 5625
Selenium	0.5 - 0.2
Sodium	1100 - 3300

depends on various factors such as the food source and interaction with other nutrients (James, et al., 1978; Ismail-Beigi, et al., 1977). From the NHANES studies, iron intake in elderly males met the RDA while in elderly females, the intake was 92% of the RDA. However, the bio-availability of iron depends on the type of food and the form of iron in the food (Monsen, 1978). The myoglobin found in animal tissues are a good source of iron; but the recent trend to avoid meat because of concern over fat and cholesterol may decrease dietary iron intake in the elderly. The elderly may also refrain from eating meat because of difficulty in chewing.

The RDA for calcium is 800 mg/day for both men and women over 50 years of age. The amount of calcium required is related to phosphorus intake and vitamin D status. The calcium to phosphorus ratio should be from 1:2 to 1:1 (Alford and Bogle, 1982). The major portion of the calcium is in the bones. The bone can serve as a reservoir for calcium which will be depleted to meet the cellular requirement when dietary calcium is not adequate (Alford and Bogle, 1982). Negative balance of calcium can result from inadequate intake, malabsorption, or excessive excretion. NHANES studies found that the mean consumption of calcium by the elderly was less than one-third of the RDA. Pao and Mickle (1981) reported that 40-50% of the elderly had calcium intake which met only 70% of the RDA.

Dietary deficiency of phosphorus is very rare.

However, hypophosphatemia can cause osteomalacia, cardiomyopathy and pseudomyopathy. A decrease in intracellular phosphorus can affect all energetic reactions including muscle contractions, neurologic functions and electrolyte balance, as adenosine triphosphate (ATP) stores are diminished (Tolstoi and Fosmire, 1987).

The RDA for magnesium is 300 mg for women and 350 mg for men. No evidence exists for an increased need with aging (Alford, 1982). Based on a 24-hour recall and a 2-day diet record, 40-50% of the elderly consumed less than 70% of the RDA of magnesium (Pao and Micke, 1981).

Zinc plays an important role in taste acuity for the elderly and is also required for wound healing and tissue repair. The RDA for zinc is 15 mg. Absorption of this mineral decreases with aging (Gregor, 1977). Turnland and co-workers (1986) reported that zinc absorption averaged 17% in six elderly men compared to 31% in six young men.

Copper is another essential mineral and is only slightly affected by the age of the population. Turnland et al. (1986) determined that the balance of zinc and copper was maintained in an elderly population receiving 15 mg zinc and 2-3 mg of copper per day.

Methods for Assessing Dietary Intakes

Recommendations for the dietary management of the elderly individuals arise from the knowledge of the food

habits and nutritional status of the population. Dietary history, 24-hour recall, and food record are the three main methods used to assess dietary intakes. Each of these methods has its advantages and disadvantages.

Dietary History

Dietary history is a method designed to give an overview of dietatry habits for a lengthy span of time. Histories may be self administered or can be recorded by the help of a trained professional. The latter method of collection provides the most accurate data. However, a self administered history may be reviewed by a nutritionist with the subject (Beal, 1969). Advantage of this method is that it takes into account seasonal variations in food intake.

Food Record

Food records consist of recording present intake either in household measures or more accurately by weighing. The subject maintains a written record of all food and beverages consumed for the designated time period, usually three to seven days. If the subject is aware of the importance of estimation of accurate portion size and recording of all consumables, this can be an accurate method of dietary survey. Problems may arise if the subject modifies intake levels.

24-hour Recall

Twenty four-hour recall is a simple and rapid method of obtaining information about the dietary intake (O'Hanlon, 1978). In this method, the subject is interviewed by a trained person who asks the subject to describe the kinds and amounts of food consumed in the previous 24 hours. The subject is often given food models and measuring cups. A comparative study of various methods of dietary survey found that a one day food record or 24-hour recall was adequate for obtaining the mean intake of a group when large numbers of subjects are used (Young, 1952).

The elderly are apt to suffer from short attention spans, poor reading skills, and impaired vision (Shock, 1970). For these reasons, a 24-hour recall is a suitable method to obtain dietary information from elderly subjects. According to Guthrie (1983):

> The 24-hour recall is considered a feasible method of obtaining data that can be used to compare the nutritive intake of groups of individuals..... Since it is a retrospective account taken at an unannounced time, it reduces the possibility of the subject modifying his food habits during a time when he knows they are being assessed. The use of the immediately past 24 hours does not involve an appreciable memory span, thus increasing the likelihood of obtaining a complete record (pp 404-405).

Congregate Meal Program

The congregate meal program was designed to provide meals as well as opportunities for social interaction and

companionship to older Americans, especially the low income and minority, with a view to support independent living. Such nutrition services were originally authorized by Title VII of the Older Americans Act of 1965 (Wells, 1973). In 1978, the authorization was changed to Title III-C by an amendment to the Act by the U. S. Congress. Two services offered by Title III-C are congregate dining and home delivery of food to the elderly.

In the congregate meal program, one nutritionally balanced meal is served in a congregate setting usually for 5 days a week. This program may include nutrition education and other services such as transportation and shopping assistance that are needed for the participants. According to United States Department of Health, Education, and Welfare: Older Americans Act of 1965, the food served at the congregate meal site should provide one-third of the RDA for this age group. Careful selection of food in this program increases the potential for providing the desired levels of all nutrients.

Dietary Fiber

Although dietary fiber is not a nutrient, it does benefit gastrointestinal function. The physiologic effect of fiber results from the chemical properties of the fiber components present. The elderly are often bothered by two gastrointestinal problems: constipation and diverticulosis.

These could be relieved by increased dietary fiber. Studies have shown that a dietary intake of 20 to 25 g of fiber from a variety of food sources can be expected to provide health benefit and improve the nutritional quality of the diet.

Dietary fiber has emerged as an important factor in nutrition and medicine that appears to have complex and far reaching effects on the physiology and health of man. Previously, it was regarded as being unimportant since fiber provided little nutritive value. Epidemiological studies conducted by Burkitt (1973) demonstrated an association between low fiber intake and occurence of diseases such as colon cancer, gastrointestinal disorders, heart disease, diabetes, and obesity (Trowel, 1976). These findings triggered more research in these areas.

Concern about the effects of dietary fiber is not a recent development. Hippocrates, the Father of Medicine, recommended eating whole wheat "for its salutory effects upon the bowels" (McCance, 1955). Even Roman athletes ate whole wheat bread in the belief that it would preserve their strength (Dreher, 1987). Graham of Graham cracker fame, condemned the harmful effects of refined carbohydrate foods during the 19th century. In the 1920s, J. H. Kellogg published extensively on the benefits of bran. Possible advantages claimed were increasing stool weight, promoting laxation, and preventing disease. Dietary fiber was researched throughout the 1930s and then forgotten (Slavin, 1987).

The modern fiber era was born in America with a paper by Burkitt, Walker and Painter (1974). According to these researchers, the lack of dietary fiber in the diet is the cause of diseases such as constipation, diverticulosis, atherosclerosis and obesity that are common in the United States and are missing or rare in Africa.

Hipsley, a British doctor in 1953 was the first to use the term 'dietary fiber'. He used it to describe the unavailable carbohydrate content of plant foods. Prior to that the term 'crude fiber' had been used. Crude fiber is mainly cellulose and lignin. Dietary fiber is defined as the portion of the plant cells that are resistant to human digestive enzymes (Trowel, 1976; Slavin, 1987).

Dietary fiber includes compounds of different chemical and physical characteristics which are not digested in human beings. Components of dietary fiber include structural polysaccharides such as cellulose, hemicellulose, and pectic substances derived from plant cell walls and non-structural polysaccharides such as gums, mucilages and lignin, a non-carbohydrate structural material (Trowel, 1978).

Dietary fiber is widely distributed in our foods. Some of the good food sources of dietary fiber include cereal bran, vegetables and fruits. In human food, non-cellulose polysaccharides are present in a greater proportion than cellulose or lignin (Schneeman, 1986). Fiber composition of a plant depends on the plant species and maturity.

Based on its solubility in water, dietary fiber can be

classified into two groups: soluble and insoluble fibers. Cellulose, some hemicellulose, and lignin are regarded as insoluble fiber whereas pectins, gums, mucilages and other type of hemicellulose are classified as soluble fiber (Schneeman, 1987). Physical and chemical properties of fibers influence their physiological effects. It is the soluble fiber that has been demonstrated to have effects on carbohydrate and lipid metabolism. The insoluble fiber on the other hand is largely responsible for the bulk of the feces; but has little metabolic effect.

Analysis of Dietary Fiber

Early methods for estimating fiber content were developed to assess ruminant feed. In the early 1800's Einhof obtained fiber values extracting milled feeds with hot water. A few years later, a crude fiber method based on the sequential extraction of feeds by ether, acid, and alkali was developed. This method was adapted by the Association of Official Analytical Chemists (AOAC) in the late 1800s and had been used until the 1960s. But this method gave incomplete accounting of hemicellulose, lignin, and celluloses, which may be extracted with the acid and alkali solution (Dreher, 1987).

As the relationship between the dietary fiber and the management of certain diseases was established, the accurate determination of fiber and its components became more

critical. Van Soest (1963) developed the acid detergent fiber method (ADF) which was approved as an effective method by the AOAC in 1975. This method involved the refluxing of a sample for 1 hour in a solution of 1 N sulfuric acid and 2% cetyltrimethylammonium bromide. The residue consists mainly of cellulose and lignin. In this procedure, the hemicellulose is completely extrated, but lignin and cellulose can be separated by hydrolyzing the ADF residue with 72% sulfuric acid. Further refinement of this method led to the development of neutral detergent fiber (NDF) method in which the sample is boiled with sodium lauryl sulfate and ethylene diamine tetraacetic acid (EDTA). In 1982, the American Association of Cereal Chemists approved an enzyme modified neutral detergent method.

Another approach for the analysis of fiber components was pioneered by Southgate (1969). The Southgate procedure involves removing the individual fractions through a series of extraction steps. After hydrolyzing the fractions, the sugar components are determined by gas liqid or liquid chromatography (Schneeman, 1986). Although this procedure gives a good accounting of TDF, it is a complex time consuming process which is not very useful for routine use.

Most recently, Prosky and co-workers (1984) have developed a technique to gelatinize starch in defatted material by heating in boiling water bath with termamyl (heat-stable amylase) and then enzymatically digest it with protease and amyloglucosidase to remove protein and starch.

Ethanol (95%) is added to precipitate the soluble dietary fiber. The total residue is filtered and washed first with ethanol (71% and 95%) and then with acetone, and the residual protein content is measured on the dried material. The protein value is subtracted from the dried weight to give the dietary fiber. This technique has the advantage of being relatively quick. But some losses of the soluble fiber components are still experienced. This is a relatively quick and reliable method for fiber analysis.

Physiochemical Properties and Physiological Effect

The physiochemical properties of fiber that have attracted the most interest are its viscosity, water holding capacity, digestibility, and cation exchange properties. These properties and related physiological effects are summarized by Eastwood and Key. See Table III.

Viscosity. Certain fibers such as the gums and pectin increase the viscosity of the intraluminal content within the gastointestinal tract. This increases the mouth-to-cecum transit time. Small intestinal absorption will also be reduced due to the thickness of the unstirred layer (Jenkins, et al., 1976; Holt, et al., 1979; Jenkins, et al., 1980; Leeds, et al., 1981)

On the other hand, particulate fiber such as wheat bran

TABLE III

PHYSIOCHEMICAL, PHYSIOLOGIC AND CLINICAL ASPECTS OF FIBER

Physiochemical Property	Type of fiber	Physiologic Effect	Clinical Implication
Viscosity	Gums, mucilages, pectins	↓Gastric emptying. ↑Mouth to cecum transit. ↓Rate of small intestinal absorption.	Dumping syndrome Diabetes Hypercholesterol-emia
Particle formation and water-holding capacity	e.g., Wheat bran, pentosan content, poly-saccharide-lignin mixtures	↑Gastric emptying. ↓mouth to cecum transit. ↓total GI transit time. ↓colonic intra-luminal pressure. ↑fecal bulk.	Peptic ulcer Constipation Diverticular disease. Dilute potential carcinogens
Cation exchange	Acidic poly-saccharides e.g., pectins	↑Small intestinal losses of minerals	Negative mineral balance, probably compensated by colonic salvage.
Degradability (colonic bacteria)	Polysaccharides	↑Gas production ↓cecal pH	Flatus

Adapted from Eastwood and Kay, 1979

leaves the stomach and passes through the small intestine more rapidly. In the colon, this viscous property is of little significance as the fibers are degraded by colonic bacteria. But lignin and cellulose are not degraded in the colon and thus help to increase fecal bulk and continue to reduce the transit time.

Water-holding Capacity. The water-holding capacity of dietary fibers are of great interest and importance to nutritionists. The chemical composition of dietary fiber plays a major role in determining this property. Particulate fiber with low digestibility such as coarse wheat bran is capable of absorbing more water (Eastwood, et al., 1973; Cummings, et al., 1976). This property of fiber enables it to soften the stool and increase the fecal bulk and thus reduce the intraluminal pressure.

Digestibility. The digestibility of fiber is a major factor in determining fecal bulk. Non-cellulosic polysaccharides are readily degraded by the colonic bacteria. These fibers are degraded to volatile fatty acids. These are then absorbed by the colonic mucosa (Cummings, et al., 1979). Thus some fibers such as pectins are almost completely metabolized and have no laxative effect.

Cation Exchange Potential. The cation binding and exchange capacity of fiber for calcium (James, et al., 1978) and iron and zinc (Ismail-Beigi, et al., 1977) have been demonstrated. Wheat bran does not appear to affect calcium, iron or zinc status significantly in rats (Bagheri and Guefuem, 1982; Caprez and Fairweather-Tait, 1982; Fairweather-Tait, 1982).

Wheat bran added to a high protein diet affected calcium (Cummings, et al., 1979) but pectin did not (Cummings, Southgate, et. al, 1979). Kelsay et al. reported that fruit and vegetable fiber led to negative balance for calcium, zinc, copper, magnesium and silicon (Kelsay, Behall, and Prather, 1979; Kelsay, Jacob, and Prather, 1979). But the diet contained spinach whose oxalic acid content affected mineral availability. Repetition of the study with the substitution of cauliflower for spinach resulted in no calcium or magnesium imbalance. It has been suggested that phytate may be responsible for the mineral imbalances caused by the consumption of high-fiber bread. However, phytate is not the sole cause. Sanstead, et al. (1978) showed that addition of modest (26 g) amounts of wheat or corn bran does not affect copper or zinc.

Fiber also has the property of adsorbing materials of biological importance such as proteins, bile salts, certain toxic substances and bacterial cells (Kritchevsky and Story, 1974). Generally, moderate levels of dietary fiber do not

appear to exert a significant influence on mineral imbalance of adults consuming an adequate diet. However, people in their marginal level of mineral status are at potential risk of imbalance. Soluble fibers such as pectin or guar gum exert hypolipidemic effects due to their ability to bind bile.

Dietary Fiber and Disease Relatioship

Epidemiological studies conducted in developing countries of Africa demostrated a possible relationship between dietary fiber and certain diseases (Trowel, 1972, 1976; Burkitt, 1973). The prevalence of diseases such as constipation, hemorrhoids, diverticular disease, hiatus hernia, ischemic heart disease and colon cancer appears to be due to lack of adequate fiber in the diet (Burkitt, 1973).

A definite value of fiber is in relieving constipation, while the probable value is in the treatment of diverticular disease of the colon. The possible value relates to the reduction of serum cholesterol levels and prevention of certain diseases such as cardiovascular diseases, hemerrhoids, varicose veins, colon cancer, diabetes, appendicitis, obesity, gallstones and dental caries.

One of the most consistent effects of dietary fiber is to increase fecal weight and water content, thereby making the stools softer and bulkier. Thus the ability of dietary

fiber to promote regularity cannot be overlooked. Wheat bran supplements have been shown to be effective in preventing constipation in elderly (Smith, et al., 1980). Coarse bran is more effective in reducing transit time and intraluminal pressure and increasing stool weight than fine bran (Brodribb and Groves, 1978; Smith et al., 1981). Processing, such as cooking the bran appears to reduce its effefctiveness only slightly (Wyman, et al., 1976; Yu and Miller, 1981).

Both epidemiological data and clinical studies add support to the fiber deficiency theory as to the cause of diverticular disease (Trowel, 1976). This disorder develops because of the relatively small, hard and dry digesta residue in the intestine, that requires high pressure to pass through the colon. When the fiber is added to the diet, it binds some of the available water, increasing the stool weight and creating a softer stool. This lessens the pressure within the colon and decreases transit time (Smith, et al., 1981; Klurfield, 1987).

Diverticular disease is often related to the following disorders: varicose veins, hiatus hernia and appendicitis. Straining, which is characteristic of diverticular patients, causes pressure in the venous system of the large intestine and legs. This increases the development of hemorrhoids and varicose veins.

Cancer of the colon is the second leading cause of cancer death in the United States (Greenwald, et al., 1987).

The cause of colon cancer is not known. But epidemiological studies suggests a clear relationship between colon cancer and diet low in fiber. Burkitt (1973) postulated that diets depleted of fiber prolong the time the stool remains in contact with intestinal mucosa and might favor carcinogenesis. Huang et al. (1978) suggested the following mechanisms as means to reduce the colon cancer by dietary fiber.

1. Fiber decreases intestinal transit time, hence exposure to fecal carcinogens is reduced.
2. Fiber influences bile acid metabolism, hence less potential carcinogens are produced from bile acids.
3. Fiber, because of its availability to bind water, sterols, bile acids and fat may act to dilute potential carcinogens.
4. Fiber may alter the flora in the intestine thereby decreasing bacterial degradation of bile acids.

There is an increased risk of atherosclerotic heart disease among the elderly. Soluble fibers such as pectin, oat bran and guar gum seem to have a controlling effect on triacyl glycerol and serum cholesterol (Story, Kritchevsky, 1976; Anderson, 1984). These fibers have also been shown to lower LDL cholesterol (Anderson, 1984; Hagander, et al., 1988).

Diabetes is a common problem among the elderly. Several investigators have demonstrated that the addition of fiber to the diet reduced the post prandial glycemia in both

normal and diabetic subjects, often with a reduced need for insulin (Anderson, Ward, 1979; Hagander, et. al, 1988). Fibers with the highest viscocity were the most effective (Holt, et. al, 1979). This may be related to slowing of gastric emptying or limited diffusion of digestive products. Water soluble fibers slow down the release of glucose from the stomach by delaying gastric emptying time (Holt, et. al, 1979; Ray, et. al, 1983). It was found that the effect of dietary fiber on carbohydrate absorption is a function of the viscosity of the fiber in solution (Topping, et. al, 1988). High viscous fiber slows the digestion and absorption of nutrients in the small intestine.

Water soluble fibers such as guar gum and pectin increase intestinal transit time (Holt, et. al, 1979), whereas the insoluble fibers such as wheat bran and whole grain decrease the intestinal transit time and increase intestinal bulk.

The possible effects of fiber within the small intestine include changes in mixing, motility, and thickness of the unstirred layer. (Munoz, 1984). There is also speculation that fiber may package carbohydrate molecules and insulate them from digestive enzymes in the intestine and decrease access to the intestinal wall (Dunaif and Schneeman, 1981). Fiber has been shown to reduce pancreatic enzyme activity and decrease enzyme secretion (Dunaif and Schneeman, 1981).

Adverse Effects of High Fiber Diets

Vitamin and mineral status of people who change from a habitually low fiber diet to one rich in fiber is of great concern. Jenkins et al. (1980) administered 14-26 g of guar daily for six months to eight diabetic patients. Biochemical tests of blood showed that guar produced no evidence of changes in serum zinc, copper or calcium. Aro et al. (1984) and James et al. (1978) have found no effects on serum calcium, magnesium, phosphate and iron.

However, the absorption of calcium, iron and zinc could be impaired with diets rich in phytate and insoluble fiber (James, et al., 1978). This could result in deficiencies of minerals if used for a long time in susceptible individuals. There is no evidence that soluble fiber supplements or moderate increases in fiber intake from mixed sources causes malabsorption of macro or micro nutrients. But long term use of fiber in individuals at risk, such as the elderly should be monitored. Increase in dietary fiber can cause some abdominal discomfort and flatulance. But this can be avoided by a slow increase in dietary fiber over time.

Dietary Intake of Fiber and Minerals

Several studies have been carried out to assess the dietary fiber and mineral intake in adult populations. However, data on the dietary intake of fiber among the

elderly are rare. Intake of dietary fiber range from 20 g/day in Britain, the USA, New Zealand, and Europe to 75 g/day in rural African populations (Bingham, 1987).

Mean dietary fiber intake in the U. S. adult population is estimated from the NHANES II data as 13.3 g/day (Lanza et al., 1987). In the NHANES II survey, trained personnel used the 24-hour recall method to collect the data. Another finding of this study was that the foods in the cereal group were the major contributors (20%) of food energy in the age group of 65+.

Dietary fiber intake of individuals, 5-71 years of age, with different eating patterns were studied by Davies, et al. in 1985. They have found that the omnivores consumed the least fiber (23 g/day), vegetarians significantly more (37 g/day) and vegans the most (47 g/day). In this case also cereal group contributed more to the dietary fiber intake than the other food groups. All the subjects in this study were free-living. Food intakes were measured for seven consecutive days by means of the weighed inventory method.

Intakes of dietary fiber were measured in a random sample of 63 men and women, 20-80 years of age in Cambridgeshire, England. Total dietary fiber intake was 19.9 $\pm$ 5.3 g/day. Vegetables supplied the major portion of the fiber (41.3%). Cereals contributed 30.5% of total dietary fiber intake whereas fruits and mixed sources supplied 28.2%. This study also didnot find any significant

influence of age or gender on total dietary fiber intake (Bingham et al., 1979).

Mbofung et al. (1984) determined dietary fiber, energy, and mineral intake of a group of 250 urban and 50 rural Nigerian women, 18-35 years old. The contribution of different food groups to the total dietary fiber intake as well as the relation between dietary fiber and zinc, copper, iron and calcium content of the diets was also determined. They used the 7-day food weighing method to assess the daily food intake of the village subjects. For the urban population, they used 24-hour recall method to collect the food intake data. Samples of all diets were analyzed for dietary fiber, calcium, iron, copper, and zinc. Results of this study showed that the mean dietary fiber intake of the urban subjects was 62.0 g/day while that of the rural subjects was 69.3 g/day. It was also found that in the urban population, major portion (36%) of the daily dietary fiber intake was derived from grain and cereal based food. But in the rural population, major portion of the dietary fiber was derived from roots and tuber food group. A significant posistive correlation was found between dietary fiber and the minerals, zinc, copper, iron, and calcium present in the diet.

In a study of a relatively healthy aged residents in an extended care facility, Gregor (1987) found that the dietary intakes of all nutrients were generally adequate compared to the RDA, except in regard to zinc and magnesium. The zinc

and magnesium intakes of the subjects were computed using the values obtained by analyzing the food stuff served at the facility during a 10-day period. Dietary intake of zinc was 55.3% and that of magnesium was 74.2% of the RDA.

Summary

The fastest growing segment of the U. S. population is the elderly. Susceptibility to diseases multiplies with advancing age. Diseases such as diabetes, colon cancer, diverticulosis, constipation and heart disease are very common among the elderly. Studies have shown that increased intake of dietary fiber can help to alleviate some of these problems. But the specific type or the amount of fiber needed, has not been established. Review of related research shows that there is a need for further studies to identify the food groups of dietary fiber and minerals in elderly nutrition.

CHAPTER III

METHODS AND PROCEDURES

This chapter includes the information about the population, sample size, data collection, and methods of statistical analyses used for the study. These were done to meet the objectives of the study.

Data Collection

The data used here was obtained from another study conducted in Summer, 1987 to evaluate the impact of Cooperative Extension Nutrition and Fitness Program on older adults at Stillwater, Oklahoma. The population included the participants attending the Payne County Elderly Nutrition Program located in Stillwater, Oklahoma. These people were aged 60 or older. Regardless of age, their spouses were also eligible to participate in this program. Plans for this research were presented and discussed with the Site Manager of the Payne County Elderly Nutrition Center and permission was obtained to conduct the study. Volunteers were accepted and data were collected from 24 elderly individuals: 16 females and 8 males. Human conscent forms were signed by the participants of the study.

A 24-hour recall and personal interview were used to

obtain the dietary intake data. Interview forms were developed by Dr. Janice Hermann and Dr. Bernice Kopel, which were pilot tested for their reliability among similar population of age groups and peer professionals. Samples of interview forms used are given in Appendixes A and B. The interviews were conducted by four graduate students, who were trained by Dr. Janice Hermann and Dr. Bernice Kopel on how to obtain dietary intake data without asking leading questions. Data were collected in August 1987, prior to 12 weeks of nutrition and exercise education program provided at the site. Responses were kept in strict confidence and names of participants were deleted while analyzing the data for the study.

Analyses of Data

The 24-hour dietary intake data were coded by the researcher and were analyzed using the computer program Food Processor II, available in the Department of Food, Nutrition and Institution Adnministration of Oklahoma State University. The Food Processor II nutrition system is a software package with an encyclopedia of nutrition information on foods. The nutritional information contained in this system was compiled from over 350 sources, including the most recent United States Department of Agriculture (USDA) data, scientific journal articles, food composition tables from Canada and England, unpublished scientific data

from USDA, information from other nutrient data banks and publications and manufacturer's data (The Food Processor II, User's Manual 1988).

Dietary fiber intakes and the percentage of the 1980 RDA of the minerals, calcium, copper, iron, magnesium, phosphorus, potassium, selenium, sodium, and zinc were obtained from the results of the analyses done by Food Processor II. Dietary fiber intakes were categorized according to intake from various food groups. Food groups identified by the researcher were: (1) bread, cereals, and pasta, (2) vegetables, (3) fruits, (4) legumes, and (5) other groups. The bread, cereal, and pasta group included foods made from grains, such as bread, ready to eat cereal, pasta, rice, noodles, etc. The vegetable group included raw and cooked vegetables. The fruit group consisted of all fresh, dried, and canned fruits, and fruit juices. The legumes included dried, cooked beans and green peas. Other foods consisted of jam, jelly, gravy, condiments, beverages, and butter.

Dietary fiber contributions of specific food groups were determined by classifying all food items consumed into these food groups. Dietary fiber intake from the various categories of food groups were determined as grams of dietary fiber per day. Fiber standard used was 2 g/100 kcal as was given in Food Processor II. Intakes of minerals, calcium, iron, magnesium, phosphorus, and zinc were determined in terms of their percentages of 1980 RDA, while

that of copper, potassium, selenium, and sodium were determined as the percentage of the median level of estimated safe and adequate level. Adequacy of intakes of nutrients was considered as two-thirds of the RDA.

Statistical Analyses

Statistical analyses on the results were done in cooperation with the Statistics department of Oklahoma State University. The correlation between total fiber intake and fiber intake from various food groups were determined using Pearson correlation analysis. Pearson correlation coefficients were also calculated to determine the association between the dietary intake of fiber and minerals. Analysis of variance in combination with Duncan's Multiple Range testing, was used to examine the effects of age and gender on dietary fiber and mineral intake. The level of significance was set at $p = < 0.05$.

CHAPTER IV

RESULTS AND DISCUSSION

This study was undertaken to assess the dietary fiber intake and to identify the food sources of dietary fiber in the diet of a group of elderly in Stillwater, Oklahoma. Correlations between the dietary intake of fiber and selected minerals were also determined. The relationship between the variables, age and gender, to dietary fiber intake was also studied. Mean intake of dietary fiber and mineral intake of the subjects were determined from the analyses of a 24-hour recall. The adequacy of nutrients in their diet were analysed using the computer program, Food Processor II.

Description of Subjects

The sample consisted of 24 volunteers from the participants in the Stillwater site of the Payne County Elderly Nutrition Program. The participants in the study, 16 females and eight males were aged 60 or older. Percentages of the sample population in each age and sex group are presented in Table IV. Majority of the respondents, 13 (54.2%) were aged 70-79. Only two participants were 80 years or older.

TABLE IV

NUMBER AND PERCENTAGES OF SUBJECTS ACCORDING TO AGE AND GENDER
N = 24

	Number	Percentage
Age (Years)		
60-69	9	37.5
70-79	13	54.2
80 +	2	8.3
Gender		
Male	8	33.3
Female	16	66.7

Analyses of Data

Analyses of the data were based on the objectives of the research. These objectives were: (1) to determine the total dietary fiber intake of the elderly according to food groups, (2) to assess the adequacy of total dietary fiber and selected mineral intakes in a group of elderly (3) to determine the correlation between the dietary intake of fiber and trace mineral status of a group of elderly, (4) to identify the relationship between the total dietary intake

of fiber and the variables, gender and age. The statistical techniques used were Analysis of Variance test, Duncan Multiple Range testing and Pearson Correlation.

Dietary Fiber Intake

The daily mean intake of dietary fiber was 20.59 g. Average food energy intake was 1601.5 kcal. Thus the average intake of fiber per 100 kcal was 1.29 g. This was 64.8% of the reference value of dietary fiber intake, 2 g/100 kcal, used in the computer program Food Processor II. However, the mean intake of dietary fiber for the subjects studied, is more than the estimated intake of 13.3 g/day for the U. S. adult population determied by Lanza et al. (1987), based on NHANES II data. It is also more than the level of intake of dietary fiber (15.5 g/day) determined by Hanson et al. (1986) for a group of American college freshmen.

Dietary fiber intakes of the subjects were analyzed according to intake from major food groups. These food groups were: (1) Bread, Cereal and Pasta, (2) Vegetables, (3) Fruits, (4) Legumes, and (5) Other foods such as condiments, beverages, butter, jam, jelly, and gravy. Mean intake of dietary fiber from various groups were expressed in g/day and as a percentage of the total daily intake of fiber. See Table V. It was found that the major sources of fiber in the diets of the elderly, were foods from the bread, cereal, and pasta group, 44.42%. This finding is

TABLE V

MEAN AND STANDARD DEVIATION OF DIETARY FIBER INTAKE ACCORDING TO FOOD GROUPS
N = 24

Food Group	Dietary Fiber Intake (g/day)	
	Mean	SD
Bread, cereals, pasta	9.14 (44.42%)[a]	± 11.31
Vegetable	4.40 (21.34%)	± 1.66
Fruits	2.45 (11.90%)	± 2.07
Legumes	2.39 (11.64%)	± 6.24
Other Foods	1.82 (8.84%)	± 2.36
Total diet	20.59 (100%)	± 14.18

[a]Figures in parentheses indicate dietary fiber intake from various sources expressed as a percentage of total daily intake of fiber.

consistent with other studies reviewed. For example, Barr et al. (1984), in their study of women over the age of 80 found that the grain group was the primary source of energy and nutrients. In another study based on NHANES II survey, Lanza et al. (1987) found that the foods in the cereal group were the major contributors of food energy in the age group of 65 +. Davies et al. (1985) also found that the cereal group contributed more to the dietary fiber intake than all other food groups.

However, vegetables contributed 21.3% (4.4g) of the total dietary fiber intake while 11.9% (2.5g), 11.6% (2.4g), and 8.8% (1.8g) of the total dietary fiber intake were obtained from fruits, legumes and other foods respectively. Dietary fiber intake from fruits and vegetables together was 33.2% (6.9 g).

Dietary Fiber and Food Groups

Pearson Correlation was used to determine the relationship between the contributions of the food groups to total daily fiber intake. The results (Table VI) show a positive correlation between the dietary fiber intake from bread cereal and pasta group and the total dietary fiber intake at a significance level of $p = 0.0001$. A positive correlation was also found between the dietary fiber from legumes and total dietary fiber consumption at a significance level $p = < 0.05$. No such significant relation

TABLE VI

CORRELATION COEFFICIENT AND LEVEL OF SIGNIFICANCE OF DIETARY FIBER INTAKE FROM DIFFERENT FOOD GROUPS
N = 24

	Correlation Coefficient and Level of Significance					
Food Groups	Total diet	Bread, Cereal, Pasta	Vegetable	Fruits	Legumes	Other Foods
Bread, cereal, pasta	0.7916 0.0001*	1.0000 0.0000	0.2391 0.2605	-0.3242 0.1222	-0.0442 0.8378	0.7082 0.7423
Vegetables	0.3744 0.0714	0.2391 0.2605	1.0000 0.0000	-0.0736 0.7326	0.2299 0.2797	0.1827 0.3929
Fruits	-0.2075 0.3306	-0.3242 0.1222	-0.0736 0.7326	1.0000 0.0000	-0.0971 0.6517	-0.2066 0.3328
Legumes	0.4571 0.0247*	-0.0441 0.8378	0.2299 0.2797	-0.0971 0.6517	1.0000 0.0000	0.1692 0.4293
Other Foods	0.1335 0.5341	0.0708 0.7423	0.1827 0.3929	-0.2066 0.3328	0.1692 0.4293	1.0000 0.0000
Total diet	1.0000 0.0000	0.7916 0.0001*	0.3744 0.0714	-0.2075 0.3306	0.4571 0.0247*	0.1335 0.5341

*p = $<$ 0.05 level

was found between total dietary fiber intake and dietary fiber from vegetables or fruits.

Dietary Intake of Minerals

Dietary intake of minerals studied, are expressed as the percentage of the 1980 RDA and Estimated Safe and Adequate Intake, (See Table VII). For this study, adequacy of nutrient intake was defined as two-thirds of the 1980 RDA. The dietary intake of calcium, iron, magnesium, phosphorous, and zinc were 66 percent or more of the 1980 RDA, and the intake of potassium, selenium, and sodium were also 66 percent or more of the 1980 Estimated Safe and Adequate Level of the FNB/NRC. Dietary intake of iron and phosphorus were 100% and above the 1980 RDA. Thus the intake of calcium, iron, magnesium, phosphorous, potassium, selenium, sodium, and zinc were adequate among the elderly participants. The mean intake of copper was 49.6% of the 1980 Estimated Safe and Adequate Level of the FNB/NRC. This could be due to the partial data available about the copper contents of foods.

When this information was compared with similar studies of the elderly (O' Hanlon, 1978; Ten-State Nutrition Survey, 1968-70), dietary intake of minerals was higher in this study. This may be due to a variety of reasons. The subjects in this study were participants in a congregate meal program. One criterion for the congregate meal program

TABLE VII

MEAN INTAKE AND PERCENTAGE OF RDA* AND ESA** OF SELECTED MINERALS CONSUMED BY ELDERLY SUBJECTS
N = 24

Minerals	Mean Intake (mg/day)	% RDA/ % ESA	SD
Calcium	741.60	92.7	± 59.08
Copper	0.75	49.7	± 18.69
Iron	16.20	162.0	± 80.29
Magnesium	316.23	97.3	± 48.57
Phosphorus	1271.20	158.9	± 75.62
Potassium	2523.75	67.3	± 22.87
Selenium	0.09	68.7	± 29.46
Sodium	2569.60	116.8	± 62.01
Zinc	11.76	78.4	± 38.23

*1980 RDA

**Mean of FNB/NRC Estimated Safe and Adequate Level, 1980

is that one-third of the RDA of nutrients for the elderly must be provided in the noon time meal. If the rest of the meals provided at least one-third of the RDA of nutrients, it could be assumed that the elderly consumed adequate amount of nutrients. Another reason may be that these individuals, who were willing to participate in this study might have been interested in their nutritional well being. If this assumption was correct, they might have better eating habits.

Correlation Between Dietary Fiber Intake and Mineral Intake

Data in Table VIII identified the correlation between dietary fiber intake and the intake of calcium, copper, iron, magnesium, phosphorous, potassium, selenium and zinc. The results showed significant positive correlation between the amounts of dietary fiber and all minerals consumed. The intake of copper, iron, magnesium, phosphorous, and potassium increased in relation to an increase in the consumption of dietary fiber ($p = 0.0001$). There was also a positive correlation at a significance level of $p < 0.05$ between the intake of calcium and zinc and total dietary fiber intake. This finding of significant positive correlation between dietary fiber intake and intake of minerals copper, iron, magnesium, and potassium is consistent with the results of a study of 61 college

TABLE VIII

CORRELATION COEFFICIENTS AND LEVEL OF SIGNIFICANCE BETWEEN DIETARY FIBER INTAKE FROM VARIOUS FOOD GROUPS AND INTAKE OF SELECTED MINERALS

Food Groups	Correlation Coefficient and Level of Significance								
	Calcium	Copper	Iron	Magnesium	Phosphorus	Potassium	Selenium	Sodium	Zinc
Bread, cereal, pasta	0.4266 0.0376*	0.8550 0.0001*	0.7443 0.0001*	0.8976 0.0001*	0.7525 0.0091*	0.6078 0.0017*	0.1793 0.4012	0.5158 0.0099*	0.7832 0.0001*
Vegetables	0.2549 0.2293	0.1290 0.5480	0.0919 0.6492	0.1393 0.5163	-0.0733 0.7337	0.1398 0.5146	-0.1067 0.6199	-0.3761 0.0701	0.0239 0.9118
Fruits	0.0463 0.8299	-0.1546 0.4707	-0.4612 0.0233*	-0.2735 0.1960	-0.2167 0.3092	-0.0047 0.9828	-0.0590 0.7843	-0.1742 0.4156	-0.2764 0.1910
Legumes	0.1377 0.5212	0.1347 0.5304	0.2767 0.1905	0.2156 0.3117	0.1989 0.3515	0.4444 0.0296*	0.1316 0.5400	0.1644 0.4427	0.0813 0.7056
Other foods	-0.0479 0.8242	0.2095 0.3259	0.1093 0.6110	0.0534 0.8043	0.0490 0.0010*	-0.0068 0.9750	0.3844 0.0636	0.0817 0.7044	0.0767 0.7218
Total diet	0.4276 0.0371*	0.8317 0.0001*	0.6990 0.0001*	0.8422 0.0001*	0.7206 0.0001*	0.7674 0.0001*	0.3057 0.1464	0.4682 0.0210*	0.5954 0.0022*

*$p = < 0.05$

freshmen conducted by Hanson et al. (1986). This is also in agreement with the results of a study of Nigerian women conducted by Mbofung et al. (1984).

Intake of copper, iron, magnesium, and zinc also were correlated positively to the dietary intake of fiber from foods belonging to the bread, cereal, and pasta group at a significance level of $p = 0.0001$. No such significant correlation was found between the mineral intake and dietary fiber intake, from other food groups. These findings of a significant correlation between dietary intake of fiber and minerals can have wide health and nutrition implications, since decrease in the dietary intake of fiber can result in mineral deficiency.

Age and Gender in Relation to Dietary Fiber Intake

Gender

Information concerning mean intake of dietary fiber in relation to gender and age is presented in Table IX. Mean intake of total dietary fiber for male was 18.16 g/day, whereas that of female was 21.81 g/day. Dietary fiber intake from the bread, cereal, pasta group was 12.03 g/day for the male participants while for the female participents it was 7.71 g/day. On the other hand, fiber intake from vegetables was 3.96 g/day for males and 4.61 g/day for females. In the sample population studied, the dietary

TABLE IX

DIETARY FIBER INTAKE FROM VARIOUS FOOD GROUPS ACCORDING TO GENDER
N = 24

Food Groups	Mean Intake of Dietary Fiber (g/day)		t value	Probability
	Male (n = 8)	Female (n = 16)		
Total diet	18.16	21.81	-0.5853	0.5646
Bread, cereal, pasta	12.03	7.71	0.8781	0.3896
Vegetables	3.96	4.61	-0.9082	0.3738
Fruits	1.92	2.71	-0.8799	0.3884
Legumes	0.00	3.58	-1.3495	0.1909
Other Foods	1.50	1.98	-0.4574	0.6519

$p = \leq 0.05$

fiber intake from legumes was 0 g in men whereas it was 3.58 g/day for women. Dietary fiber intake from fruits and vegetables was 7.32 g in females and 5.88 g in males. Thus the females consumed more vegetables and fruits than the males and females consumed approximately the same amount of fiber from the bread, cereal, and pasta group (7.71 g/day) as from fruits and vegetables (7.32 g/day).

Age

Mean intake of dietary fiber in relation to age is given in Table X. In the first category of subjects aged 60-69 years, the mean dietary fiber intake was 17.12 g/day. On the other hand, those subjects aged 70-79 years consumed 23.68 g of total dietary fiber daily. There were only two subjects aged over 80 years. The mean dietary fiber intake for this age group was 16.15 g/day. Thus subjects of 70-79 years of age consumed more dietary fiber than the other two groups. According to the Analysis of Variance test, dietary fiber consumption was not significantly affected by age or gender in the subjects. However, this finding may be some what biased due to the disproportionate number of subjects in the different categories. Yearick and co-workers (1980) in a study of 100 elderly non-institutionalized persons, also found that dietary intake of nutrients were not affected by the age and gender of the subjects. Posner et al. (1987) made the same observation in their study of 53

TABLE X

MEAN INTAKE OF DIETARY FIBER BY ELDERLY ACCORDING TO AGE
N = 24

Age of Subjects	Number of Subjects	Mean DF* Intake (g/day)
60-69	9	17.12
70-79	13	23.68
80+	2	16.15

*DF: Dietary fiber

home-bound older persons.

Summary

Mean dietary fiber intake was 20.59 ± 11.31 g daily. Average intake of fiber per 100 kcal was 1.29 g. Foods belonging to the bread, cereal, and pasta group were identified as the major source of dietary fiber in the diet of the elderly. A positive correlation was found between the intake of dietary fiber and the minerals, calcium, copper, iron, magnesium, phosphorus, potassium, sodium, and zinc. No such correlation was found between dietary intake of fiber and selenium. Thus food sources of dietary fiber are also good sources of minerals. It was also found that the dietary fiber consumption of the elderly was not significantly affected by their age or gender.

CHAPTER V

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Summary

The objectives of this study were to: (1) determine the total daily dietary fiber intake of the elderly according to food groups, (2)assess the adequacy of total dietary fiber and selected mineral intake in a group of elderly, (3) determine the correlation between the dietary intake of fiber and selected mineral status of the elderly, (4) identify the relationship between the total dietary intake of fiber according to gender and age of the subjects. The hypotheses developed to meet the objectives of this research were: (1) There will be no difference in the dietary fiber intake from different catagories of food. (2) There will be no significant correlation between the dietary fiber intake and adequacy of calcium, copper, iron, magnesium, phosphorous, potassium, selenium, sodium, and zinc. (3) There will be no significant correlation between the dietary fiber intake and the age and gender of the subjects.

A group of 24 elderly individuals from the Payne County Elderly Nutrition Program were interviewed in August 1987, using the 24-hour recall method of dietary survey. The 24-hour dietary intake data were analyzed using the computer

program Food Processor II to determine the dietary fiber intake and percentage of RDA of selected minerals. Dietary fiber intake for the subjects were then categorized according to intakes from major food groups: bread, cereal and pasta, vegetables, fruits, legumes, and other foods. Statistical analyses on the results were done in co-operation with the the Statistics department at OSU.

Mean intake of total dietary fiber was 20.59 g/day, for the elderly participants of the study. Average intake of food energy was 1601.5 kcal/day and the average intake of fiber per 100 kcal was 1.29 g. This was 64.8% of the reference value of dietary fiber intake of 2 g/100 kcal, used in the computer program, Food Processor II. It was also identified that the major source of the dietary fiber for the elderly subjects was foods from the bread, cereal, and pasta group. There was a positive correlation between the total dietary fiber intake and dietary intake of fiber from the bread, cereal, and pasta food group. Foods belonging to the bread, cereal, and pasta group contributed 44.4% (9.14 g) of the total daily dietary fiber intake, while 21.3% (4.40 g), 11.9% (2.45 g), 11.6% (2.39 g), and 8.8% (1.82 g) of the total dietary fiber intake were obtained from vegetables, fruits, legumes and other foods respectively.

The results of the study also found that the mean dietary intakes of the minerals, calcium, iron, magnesium, phosphorus, potassium, selenium, and zinc were adequate for

the elderly subjects according to the standard used (two-thirds of the 1980 RDA). The mean intake of copper was 49.6% of the 1980 FNB/NRC Estimated Safe and Adequate level; this was less than the adequate level.

When correlation coefficients were determined between dietary intake of fiber and minerals, a significant positive correlation was noticed between total dietary fiber intake and dietary intake of copper, iron, magnesium, phosphorous, and potassium at a significance level of $p = 0.0001$. Thus foods that are high in fiber are also good sources of these minerals.

Analysis of Variance and Duncan Multiple Range testing found no significant relation between age and gender when compared to consumption of dietary fiber intake.

The hypotheses were reviewed based upon the findings from the study. Amount of dietary fiber consumed from various food groups were different for the elderly subjects. It was found that 9.14 g of the total daily dietary fiber intake was from foods belonging to the bread, cereal, and pasta group, while 4.40 g, 2.45 g, 2.39 g, 1.82 g of total daily dietary fiber intake was from vegetables, fruits, legumes, and other food groups respectively. This results in the rejection of the first hypothesis of the study, that there will be no significant difference in the dietary fiber intake from different catogories of food.

There was a significant correlation observed between total dietary fiber intake and the adequacy of copper, iron,

magnesium, phosphorus, and potassium intake at a level of significance $p = 0.0001$. A correlation at a significance level of $p = < 0.05$ exist between dietary fiber intake and the adequacy of calcium, sodium, and zinc intake. Thus the second hypothesis of the study was rejected.

The third hypothesis was that there will not be any significant correlation between the dietary fiber intake and the age and gender of the subjects. The findings of the study has not rejected this hypothesis. Analysis of Variance and Duncan Multiple Range test showed no significant correlation between the consumption of dietary fiber and the age and gender of the elderly population studied.

Conclusions and Recommendations

According to the results of this study, the average daily intake of dietary fiber (20.59 g) was not adequate for the elderly subjects. Increasing the consumption of dietary fiber can be beneficial to the health of the elderly and may even reduce the risk of certain diseases. This study also found that the dietary fiber intake was not equally distributed among the various food groups. Major portion of the dietary fiber intake was from bread, cereal and pasta group. Because of the diversity of beneficial effects provided by various types of dietary fiber, it should be emphasized to the elderly participants to include more

vegetables, fruits and legumes in their diet. Dietary intake of of the minerals studied were adequate except that of copper. This study also showed that as the total dietary fiber intake increased, the mineral intake also increased. More emphasis should be placed on nutrition education of the elderly so that they become aware of the benefits of dietary fiber intake and minerals.

The results of this study suggest several recommendations for future research. (1) A similar study could be conducted comparing a sample of congregate meal participants and comparable non-participants. (2) A similar study could be carried out by increasiing the sample size. (3) It is also possible to study the influence of income and educational level attained on dietary fiber intake. (4) Another study could be conducted to find the influence of the season of the year on the intake of dietary fiber.

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APPENDIX A

TWENTY FOUR-HOUR RECALL

OKLAHOMA STAE UNIVERSITY

Nutrition and Fitness Education Program
For older Persons

24-Hour Recall

Name.....

Date.....

Pre.....Post.....

Time	Food Items describe	Type and Preparation	Amount	Where Eaten	Office Use Only Food Code	Amount	Code
Breakfast							
AM Snack							
Midday Lunch							
Afternoon Snack							
Evening Supper							
Evening snack							

AM breakfast	Fried, baked, boiled	Home
AM Snack	Toasted	Restaurant
Midday Lunch	Whole wheat	Carried lunch
PM Supper	Fresh, Frozen, canned	School
Evening Snack	Creamed	Senior ccenter
	Condiments	Child care center.

Additional Questions:

Was food or bevarage intake unusual in any way? Yes... No....

If yes, why (in what way)? .....

Do you take vitamine or mineral supplements? Yes.... No ....

IF yes, how many per day?.....per week? .....

If yes, what kind (give brand name if known)?

Multi vitamin .....

Iron .....

Ascorbic acid .....

Other (list) .....

APPENDIX B

HEALTH AND FITNESS CENTER

WELLNESS SCREENING

HEALTH AND FITNESS CENTER
WELLNESS SCREENING

NAME ..... DATE .....

AGE ..... SEX ..... JOB .....

SS # ..... CAMPUS ADDRESS .....

FACULTY ..... CAMPUS PHONE .....

A & P .....

CLASSIFIED ..... ARE YOU AVAILABLE IN SUMMER .....

HEIGHT .....in. ..... cm

WEIGHT .....lb. ..... kg

SITTING B/P ..... SUPINE B/P .....

SKINFOLDS:

TRICEPS ..... CHEST .....

BACK ..... ABD .....

ILLIAC ..... THIGH .....

MIDAX ..... TOTAL .....

%FAT ..... %OVERFAT ..... LBS. OVER .....

TOTAL CHOLESTEROL ..... mg/dl HDL ..... mg/dl

%HDL .....% TC/HDL RATIO .....

CARDIAC RISK PROFILE .....

COMMENTS .....

VITA

Elizabeth Zachariah

Candidate for the Degree of

Master of Science

Thesis: FOOD GROUPS OF DIETARY FIBER BY ELDERLY PARTICIPANTS IN A CONGREGATE MEAL PROGRAM

Major Field: Food, Nutrition and Institution Administration

Biographical:

Personal Data: Born in Kerala, India, October 15, 1948, daughter of Aley and Mathew Karrottukunnel.

Education: Received Bachelor of Science degree in Chemistry from University of Kerala, India, in 1970; Master of Science degree in Chemistry from University of Kerala, India, in 1973; completed the requirements for the Master of Science degree at Oklahoma State University, Stillwater, Oklahoma in May, 1990.

Professional Experience: Senior Secondary School Science Teacher, Kaduna State, Nigeria, 1974-1984.