Diet Quality in Older, Overweight, and Obese Adults with Knee Osteoarthritis

By

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DEDICATION

To my friend Kelton Miller, who taught me to view each day
as a new chance to learn and play. You made me stop and look at the flowers,
notice the animals, and eat guacamole with a spoon. Your simple view of the world is
humbling and our time together put my world in perspective.
You will always hold a special place in my heart.

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ABSTRACT

The concept of diet quality reflects the dietary guidance principles of macronutrient distribution, moderation, variety, and proportionality. The primary aim of this study was to assess the effect of the exercise and dietary weight-loss interventions employed in ADAPT on diet quality. The Arthritis, Diet, and Activity Promotion Trial (ADAPT) was a single-blinded, 18-month randomized controlled trial with a primary aim to determine the relative efficacy of weight loss, exercise, and their combination in reducing disability and pain in older, obese, sedentary adults with knee osteoarthritis. There were four arms to the study: Healthy Lifestyle Controls (HL), Dietary Weight Loss (Diet), Exercise (Exercise), or combined Exercise and Dietary Weight Loss (Exercise-Diet). Only one-third of the eligible participants were randomized and scheduled to have dietary assessment performed. Descriptive statistics, frequencies, and an ANCOVA were used to determine characteristics of the population and any changes in diet quality at the end of the intervention. At 18 months, the mean diet quality score of all participants was 65.77. There was no effect of the interventions on the diet quality index. In addition, there was no interactive effect of the interventions. Although there were no differences in diet and exercise effects in body weight at eighteen months, there was a difference in percent weight loss. As expected, a greater loss was observed for groups receiving the dietary treatment.

LITERATURE REVIEW

Diets of Older Adults

Americans over the age of 65 years constitute one of the fastest growing segments of the United States' population. This shift in the population places significant demands on the health care delivery system. As a result, emphasis is being placed on all aspects of geriatric health care, including nutrition (35). Food intake data from national surveys indicates that the elderly consume less food than required to meet energy and nutrient recommendations. National surveys such as NHANES I and NHANES II demonstrate that a substantial percentage of the elderly population had vitamin and mineral intakes below two-thirds of the Recommended Dietary Allowances (RDA)(1).

Various factors can affect dietary intake in older adults. Environment, society, and physical function are just three of the things that can compromise the intake of older adults. Still, diet assessment is important for optimal health care for older adults. Various dietary standards have evolved over the years in an effort to assess one's diet accurately. These include the Recommended Dietary Allowances (RDA), the Food Guide Pyramid, and the United States Department of Agriculture (USDA) Dietary Guidelines. More recently the concept of diet quality evolved leading to the creation of various diet quality indices that strive to evaluate a culmination of the aforementioned dietary standards.

Ryan and colleagues (35) analyzed several indicators of dietary quality in older adults: energy and nutrient intake, food frequency, food group intake, and number of meals that were skipped. Comparisons to the Recommended Dietary Allowances for recommended energy intake revealed that 37% to 40% of men and women reported energy intakes less than two-thirds the Recommended Dietary Allowances. Across each age group, a higher proportion of elderly women and men had the lower energy intakes compared to younger adults. Substantial percentages of those surveyed also reported vitamin and mineral intakes less than two-thirds the Recommended Dietary Allowances. The aforementioned data and other data presented in the study clearly document that a high proportion of the surveyed older adults consume an inadequate diet. The marginal and/or low dietary intakes of vitamins and minerals in this population are of concern because the elderly are at risk for mineral deficiencies from other factors besides inadequate food intake, including drug-nutrient interactions and effects of chronic disease. The risk for inadequate dietary intake in elderly persons is well established. The dietary problems are related to a multitude of physiologic, environmental, and social factors; some of which are inevitable, but others may be ameliorated through intervention. Specific research has looked at some of these factors.

Factors Affecting Nutrient Assessment

Environment

In 1996, of the 31.7 million persons aged ≥ 65 years in the United States, 24% of those aged 65-74 years lived alone and 41% of those ≥ 75 years lived alone (36). Changes in living arrangements with advancing age are more prevalent for older women than older men because older women are more likely to be widowed. Older adults living alone may be particularly vulnerable to poverty, inadequate dietary intake, and adverse health outcomes. The third National Health and Nutrition Examination Survey (NHANES III, 1988-1994) (7) constitutes the most current national data available to address issues of living arrangements and dietary quality among older Americans. Davis and colleagues (8) examined the association of four living arrangements (living with a spouse only, with a spouse plus someone else, with someone other than a spouse, or living alone) with diet quality (the number of low nutrients out of a possible 15, with low defined as <67% of the recommended dietary allowance) among 6525 U.S. adults aged 50-64 years and those ≥65 years in the third NHANES survey. Those who lived with a spouse only had better diet quality, among non-Hispanic, Caucasian adults. They had 0.8 to 1.5 fewer low nutrients compared with those with other low nutrients. Middle aged and older adults with living arrangements other than living with a spouse only (including those living alone) tended to have poorer diet quality.

Social Factors and Physical Function

Walker and colleagues (45) also investigated factors that may contribute to dietary inadequacy in older adults. Specifically they determined if loneliness, social isolation, and physical health were related to nutrient intake. Sixty-one independently living individuals aged 60 to 94 years completed 3-day food records that were compared to the 1989 Recommended Dietary Allowances. They measured frequency of interaction with others using 3-day social contact diaries. The Physical Health Questionnaire (33) was used to evaluate subjectively the number and severity of disease states, and the loneliness index was computed using the revised UCLA Loneliness Scale (34). A functional status score was based on a Guttman scale analysis of six items related to the ability to perform physical tasks of increasing difficulty (33). Energy and calcium were most likely to be underconsumed, and poor physical health was related to decreased intakes of vitamin A and ascorbic acid. Loneliness was related to dietary inadequacies. Thus, perceived loneliness may be related to dietary adequacy in the elderly and decreased physical function of elderly persons results in poorer dietary intake, which may be related to their decreased mobility.

Diet Assessment

Importance of Diet Assessment

A nutritional assessment is necessary to determine how “nutritionally fit” one is. First, a nutritional assessment is essential for evaluating the population or individual being studied to obtain pertinent background information that includes medical history (including current diseases and past surgeries), medications history, social history, family history, and economic status (46). This is also the time to determine the parameters necessary for assessing nutritional health, which comprise the following: (1) anthropometric assessment: ex. height, weight, skinfold thickness, and arm muscle circumference; (2) biochemical assessment of blood and urine: ex. enzyme activities, concentrations of nutrients or their by-products; (3) clinical assessment: ex. general appearance of skin, eyes, and tongue, rapid hair loss, sense of touch, ability to walk; and (4) diet history: ex. usual intake or record of recent meals (days to months).

Pros and Cons of Diet Assessment

The above information is vital when developing a care plan for a patient or an intervention in a research study. Furthermore, through evaluation, assessment can provide the necessary information to determine what care plan should be implemented and if the strategy or intervention is successful. Unfortunately, nutritional assessment has limitations. Substantial time may elapse between the initial development of poor nutritional health and the first clinical evidence of a problem (46). For example, a diet high in animal fat often increases the serum cholesterol concentration without producing any clinical signs or symptoms for years. Chest pain during physical activity may be the first sign that the blood vessels are sufficiently blocked by cholesterol or other materials. Thus, one may be on the road to developing a serious disease but, because it progresses slowly, the effects won't be obvious until it is possibly too late. It is thus difficult to make the connection between recent intake and current health status.

It is also important to note that clinical signs and symptoms of nutritional deficiencies are often non-specific. Typical signs may have many different underlying causes. It is often difficult to determine whether the problem is caused by faulty nutrition or by some other medical disorder. Long lag times and vague signs and symptoms often make it difficult to establish a link between an individual's current diet and nutritional state (46). Often it is not possible to separate the best nutritional state from one that is slightly jeopardized. The gradual slide from a "good" to a malnourished state caused by earlier significant undernutrition or overnutrition is difficult to detect.

To assess an individual's health, measurements must be compared to a standard. The Food Guide Pyramid, the Recommended Dietary Allowances, and the USDA Dietary Guidelines are all dietary standards that can be used in such a scenario. On the surface they appear similar, but each one has characteristics that make it distinct from the others.

Dietary Standards

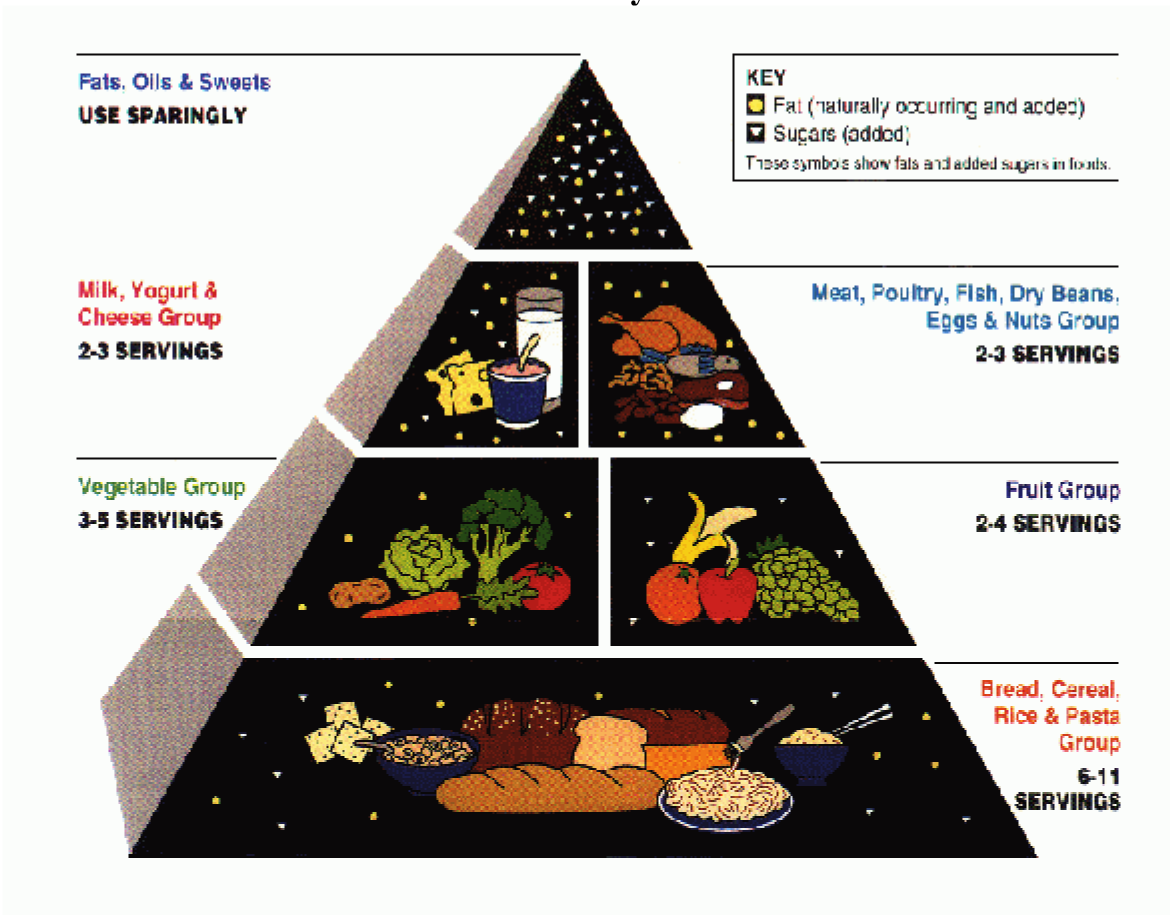
Food Guide Pyramid

The Food Guide Pyramid is a visual outline of what to eat each day. Unlike the Recommended Dietary Allowances, it is a general guide that allows the user to choose a diet consistent with good health. The Pyramid focuses on eating a variety of foods to get the necessary nutrients and nonnutrients in food and in attaining the right amount of calories to maintain or attain a healthy weight. In that there is no single food or food group that provides all the necessary nutrients for promoting health, eating a variety of foods from each of the food groups in the pyramid is the basis for optimal health. Foods from the five major food groups are shown in the three lower sections of the Pyramid and each of these groups provides some but not all of the nutrients one needs (see Figure 1). Breads, cereals, rice and pasta are at the base of the Pyramid and one needs the most number of servings (6-11) of these foods each day. The next level includes foods that come from plants-vegetables and fruits. The Pyramid recommends three to five servings from the vegetable group and two to four servings from the fruit group. These foods are low in fat and are a primary source of vitamins, minerals, and fiber. The third level is comprised of two groups of foods that come mostly from animals: milk, yogurt, and cheese; and meat poultry, fish, dry beans, eggs, and nuts. The Pyramid recommends two to three servings from both groups, which are important for protein, calcium, iron, zinc, and other trace minerals. Finally, the small tip of the Pyramid shows fats, oils, and sweets. These foods include salad dressings and oils, cream, butter, margarine, sugars, soft drinks, candies, and sweet desserts. There is not a specific recommended number of servings for this group, for these foods are to be used sparingly. Besides calories, these foods provide little nutritional value.

The recommended number of servings from each food group is based on total energy intake. This is dependent upon an individual's age, sex, body size, and physical activity level. Almost all adults should strive to achieve at least the lowest value on the number of servings suggested. The number of servings should increase as energy needs increase. For example, nearly everyone should consume at least 6 servings from the breads and cereals group. As physical activity and energy needs increase, the individual should increase the servings from this group (44).

Serving sizes are specific for each group in the Food Guide Pyramid. For example in the Bread, Cereal, Rice, and Pasta Group a serving is 1 slice of bread, 1 ounce of ready-to-eat cereal, ½ cup cooked cereal, rice, or pasta. For the Vegetable group, a serving is 1 cup of raw, leafy vegetables, ½ cup of other vegetables, cooked or chopped raw, or ¾ cup of vegetable juice. A serving of fruit is 1 medium apple, banana, or orange, ½ cup of chopped, cooked, or canned fruit, or ¾ cup fruit juice. One cup of milk or yogurt, 1-½ ounces of natural cheese, or 2 ounces of processed cheese make up serving sizes in the Milk, Yogurt, and Cheese Group. Finally, 2-3 ounces of cooked lean meat, poultry, or fish count as a serving in the Meat, Poultry, Fish, Dry Beans, Eggs, and Nuts Group. Additionally, ½ cup of cooked dry beans or 1 egg counts as 1 ounce of lean meat as well as 2 tablespoons of peanut butter or 1/3 cup of nuts (44).

Figure 1
Food Guide Pyramid



Recommended Dietary Allowances

The recommended dietary allowances (RDA) are defined as the levels of intake of essential nutrients that the Food and Nutrition Board, on the basis of scientific knowledge, judges to be adequate to meet the known needs of virtually all healthy persons (25). They provide a safety factor specific to each nutrient, and thus, with the exception of energy, exceed the actual requirements of most individuals. Essentially, the Recommended Dietary Allowances are time-averaged goals and are intended to be consumed as part of a normal varied diet (25).

The origin of the Recommended Dietary Allowances dates all the way back to the 19th century. More specifically, the Merchant Seamen's Act of 1835 made provisions of "lime" or lemon juice compulsory in the rations of the mercantile service (22). This act was probably the first formal action to establish a dietary standard and was taken in hopes of preventing scurvy (22). Mulder took the next step when he introduced the term "protein" for the complex nitrogenous substances isolated from many biological materials (27). He proposed the first dietary standard in terms of nutrients after studying the rations of the Dutch army. In 1847, on the basis of his studies, he recommended 100 grams of protein daily for a laborer and 60 grams for a sedentary person (27). During the early 1860's in Britain, the British Privy Council requested dietary surveys and the establishment of standards (27). They hoped to prevent starvation and diseases associated with starvation during this period of industrial dislocation and unemployment (27). Thus, the duty fell upon the shoulders of Dr. Edward Smith, a medical graduate of Birmingham University, to determine what kind of diet would maintain health at lowest cost (27).

Other standards evolved in a similar manner with the incentive generally being to combat starvation and associated diseases. In fact, throughout the 19th century, dietary recommendations were limited to concern with energy sources and protein.

At the turn of the century, dietary standards began to take a new direction. After various proposals and additional standards, in 1933, Hazel Stiebling of the U.S. Department of Agriculture proposed the first set of dietary standards to take account of requirements for several vitamins and minerals, calcium, phosphorous, iron, and vitamins A and C (40). Unlike previous recommendations that focused on maintenance of work capacity, these were the first recommendations designed for maintenance of health(40). The next milestone occurred in 1939, when the USDA Yearbook, Food and Life, was published (15). This Yearbook was a great representation of the then current knowledge of nutrition. Using such information, the federal government called for the permanent establishment of the Food and Nutrition Board in 1941(15). Such a move went beyond the previous committees designated to create standards.

This newest committee was chaired by Russell Wilder, but the brunt of the work fell upon the shoulders of a subcommittee of three women: Helen S. Mitchell, Hazel Stiebling, and Lydia Roberts (15). One evening, they were given the task of preparing a set of dietary standards for the committee to review the following morning. In that short amount of time, they reviewed the research that had been published up to that time and developed a tentative set of standards and a table (31),(30). After revisions, the recommendations were adopted by the Board and presented to the American Institute of Nutrition at their spring meeting in 1941(15). Finally, in May 1941, the recommendations were accepted at a National Nutrition Conference called by Franklin Delano Roosevelt in Washington (15).

The Committee on Food and Nutrition and subsequently the Food and Nutrition Board stated that the allowances "are intended to serve as a guide for planning adequate nutrition for the civilian population of the United States (2). Since that time they have been adopted and adapted by various organizations for many purposes, but still they were devised for the planning and procurement of food supplies that would be nutritionally adequate for population groups (16). Ten major uses of the Recommended Dietary Allowances have been documented, and those uses have been further combined into four categories (39). The four categories include: nutrition standards for policy purposes; education and dietary guidance; descriptive research; and food standards. In public policy, the Recommended Dietary Allowances have been used as the nutritional standard for food assistance programs and in food labeling. One will see the Recommended Dietary Allowances in nutrition education, food selection guides, food planning and procurement, and clinical dietetics in the category of education and dietary guidance. In descriptive research, Recommended Dietary Allowances are used as a standard to evaluate data collected from different surveys that vary in the type of data they collect such as with the dietary intakes of individuals or population groups. Finally, as food standards, the Recommended Dietary Allowances have been used as guides for food fortification, developing new or modified food products, and as a basis for formulating nutrient supplements and special dietary foods. For most of the above uses, the Recommended Dietary Allowances provide only a portion of the information needed. The information must be combined with other information such as food costs, food availability, food preferences/acceptability, nutrient interactions, and bioavailibility to make true conclusions about dietary adequacy.

The 10^{th} edition of the Recommended Dietary Allowances was published in 1989, and from that point on the Food and Nutrition Board stayed very busy determining the direction of future revisions (26). In 1995, in partnership with Health Canada (the Canadian equivalent of the US Department of Health and Human Services), the Board laid the framework for the Dietary Reference Intakes (DRIs)(26). The new name was used to differentiate between the Recommended Dietary Allowances and the Dietary Reference Intakes because the Dietary Reference Intakes proposed a broader application from the current Recommended Dietary Allowances and from the Recommended Nutrient Intakes in Canada. The Dietary Reference Intakes focus on how the risk of chronic disease can be related quantitatively to nutrient intakes and dietary patterns, where as the Recommended Dietary Allowances just demonstrated how to avoid deficiency. The development of the Dietary Reference Intakes replaced the periodic revisions of the Recommended Dietary Allowances and include the four following nutrient-based reference values: Estimated Average Requirement (EAR), the Recommended Daily Allowance (RDA), the Adequate Intake (AI), and the Tolerable Upper Intake Level (UL) (3).

The Estimated Average Requirement (EAR) is the daily intake value that is estimated to meet the requirement, as defined by the specified indicator of adequacy, in 50 percent of a life-stage and gender group (3). The other 50 percent of the specified group would not have its nutritional needs met at this level of intake. Once estimated, the

Estimated Average Requirement is then used to set the Recommended Dietary Allowances.

The Recommended Dietary Allowances, as previously mentioned, is the dietary intake level that is sufficient to meet the daily nutrient requirements of most individuals in a specific life-stage and gender group (3). It is set at a level that meets the needs for at least 95% of the target population, and is thus intended primarily for use as a goal for daily intake by individuals. The Recommended Dietary Allowances are generally set at two standard deviations (SD) above the EAR: $RDA = EAR + 2SD_{EAR}$

If credible evidence is not available to calculate the Estimated Average Requirement, Adequate Intake, the third category, is used instead. It is based on observed or experimentally determined approximations of the average nutrient intake, by a defined population or subgroup, that appears to sustain a defined nutritional state (3). A "defined nutritional state" includes things such as normal circulating nutrient values or growth. Reference values are not based solely on the prevention of nutrient deficiencies, but rather on contemporary concepts of reduction of disease risk. The Adequate Intake generally exceeds the Estimated Average Requirement and possibly the Recommended Dietary Allowances for the same specified endpoint of nutritional adequacy.

The final category, the Tolerable Upper Intake Level (UL), is the maximum level of daily nutrient that is unlikely to pose risks of adverse health effects to almost all individuals in the specified life-stage and gender group (3). Tolerable Upper Intake Levels became a necessity with the increase in the practice of fortifying foods with nutrients, and in the use of dietary supplements by more people and in larger doses. The title is intended to denote a level of intake that can, with high probability, be tolerated biologically, but it is not intended to be a recommended level of intake. Thus, there is no established benefit for healthy individuals associated with nutrient intakes above the Recommended Dietary Allowances or the Adequate Intake.

The Dietary Reference Intakes have many uses, but most fall into two broad categories: assessing existing nutrient intakes and planning for future nutrient intakes. Certainly, each category could be subdivided into uses for individual diets and uses for diets of groups. The Recommended Dietary Allowances, Estimated Average Requirements, and Tolerable Upper Intake Levels may be used as one aspect in the assessment of an individual's diet, whereas the Estimated Average Requirements and the Tolerable Upper Intake Levels would be used to assess the nutrient intakes of a group of individuals. An example would be people participating in a dietary survey. The Recommended Dietary Allowances and the Adequate Intake could then be used as a basis for planning an improved diet for an individual. The Dietary Reference Intakes provide a more complete set of reference values than the Recommended Dietary Allowances or the RNIs (Recommended Nutrient Intakes-Canadian Equivalent to the Recommended Dietary Allowances) (4).

USDA Dietary Guidelines

Unlike the early releases of the Recommended Dietary Allowances, the USDA Dietary Guidelines were not published until 1980. The USDA and the Department of Health and Human Services (DHHS) have jointly published the Dietary Guidelines for Americans every 5 years. Their purpose is to provide the basis for Federal nutrition policy and nutrition education activities. In addition, they provide advice for healthy

Americans ages 2 years and over about food choices that promote health and prevent disease (44).

The evolution of the Dietary Guidelines began in 1979 when the Department of Heath, Education, and Welfare (now the Department of Health and Human Services) released a study by the American Society for Clinical Nutrition on the relationship between dietary practices and health outcomes. Obviously the public needed guidance on diet and health, so the USDA and DHHS issued seven principles for a healthful diet in response. They were published in 1980 as the first edition of *Nutrition and Your Health: Dietary Guidelines for Americans* (USDA and DHHS, 1980). These new guidelines called for a variety of foods to provide essential nutrients while maintaining recommended body weight and moderating dietary fat, saturated fat, cholesterol, and sodium-any of which could be a risk factor in certain chronic diseases. Their release prompted some concern among consumer, commodity, and food industry groups-as well as nutrition scientists-who questioned the causal relationship between certain guidelines and health (44).

Since 1980, the Dietary Guidelines for Americans have been revised and issued every 5 years, and the second edition, issued in 1985, was very similar to the first. A few changes provided guidance about nutrition topics that were more prevalent after 1980, such as following unsafe weight-loss diets, using large dose supplements, and drinking of alcoholic beverages by pregnant women. Unlike the first edition, this edition received wide acceptance and was used as the framework for consumer nutrition education programs. Many groups also used it as a guide for healthy diets (44).

According to the USDA, consumers wanted more specific food-related guidance, definitions of technical terms, and practical tips for behavior change strategies. The third edition of the Dietary Guidelines (USDA and DHHS, 1990) reaffirmed these ideas by promoting enjoyable and healthful eating through variety and moderation, instead of dietary restriction. Unlike other editions, this edition suggested numerical goals for total fat-30 percent or less of calories- and for saturated fat-less than 10 percent of calories. The goals were for diets over several days, not just for one meal or one food. The goals aimed to and achieved compliance with recommendations in the Diet and Health report and those suggested for the National Cholesterol Education Program of the National Heart, Lung, and Blood Institute in DHHS. This was also the first time the food guide-A Pattern of Daily Food Choices- was included with the Guidelines even though it had been developed by the USDA in the early 1980's (44).

The 1995 edition was the first report mandated by statute-the 1990 National Nutrition Monitoring and Related Research Act. This legislation required the Secretaries of Agriculture and Health and Human Services to jointly publish a report entitled Dietary Guidelines for Americans at least every 5 years. The 1995 guidelines contained an abundance of information not seen in previous editions. Key inclusions were: use of Nutrition Facts Label and a Food Guide Pyramid graphic; a statement recognizing that vegetarian diets can meet Recommended Dietary Allowances and conform with the dietary guidelines; changes in the weight guideline to emphasize the benefits of physical activity, to encourage weight maintenance as a first step to achieving a healthy weight, and to discourage weight gain with age for adults; movement of the grain products, vegetables, and fruits guideline from fourth to third position to give it more prominence, and a slight change in the title to be consistent with the placement of food groups in the Food Guide Pyramid; and addition of specific guidance regarding dietary fat intake among children. Also for the first time, the Dietary Guidelines brochure was made available electronically through the World Wide Web (44).

The 2000 Guidelines saw several additions and changes not seen in previous editions. For the first time, the Guidelines were clustered into three groups: Aim for fitness; Build a healthy base; and Choose sensibly (5). In these groups there were also some completely new additions that included "Keep food safe to eat", "Let the pyramid guide your food choices", and "Be physically active each day". These guidelines were also the first to include a specific guideline for grain foods separate from fruits and vegetables (20), emphasizing the importance of this food group in itself and not related just to its fiber intake.

Another change in these Guidelines is the transition of "Eat a variety of foods" to "Let the pyramid guide your choices"(10). Unlike previous versions, the 2000 edition considers multiple aspects of the diet simultaneously with this change. This change came about for several reasons. First, variety among (as opposed to within) the food groups was most likely to promote nutrient adequacy. Second, variety within some food groups might lead to excessive intakes of energy; and lastly, the original statement simply was not clear to consumers. The committee wanted to use the pyramid because of its familiarity to consumers and its success as a nutrition education tool. This edition of the Guidelines gave them ample opportunity.

The Guideline "Aim for a healthy weight" emphasized weight loss more than in previous editions (13). Unlike other guidelines, this one has a health outcome rather than a behavioral outcome and is more medically oriented. The committee wanted to emphasize that in order to maintain a healthy weight, body composition, fat distribution, and weight related health conditions must be considered. Thus, this guideline is not just about weight. In fact, it is very difficult to arrive at a valid definition of a healthy weight for a given individual and the 2000 Guidelines note that both weights outside the healthy weight range may be healthy and weights inside the range may not be healthy.

The 2000 edition included a non-dietary guideline for the first time: "Be physically active each day" (43). In this edition, it was new as a separate guideline although it had held a prominent position in the body weight guideline of the 1995 edition. This guideline recognizes the importance of physical activity to health and goes beyond its effect on weight maintenance. The change with this guideline evolved because of the increasing recognition of the versatile relationship between nutrition and physical activity that goes beyond weight management. The committee felt that it was time to relay this message to consumers.

Diet Quality

The Food Guide Pyramid, Recommended Dietary Allowances, and Dietary Guidelines encompass different angles for examining a person or group's diet. Initial evaluation could lead one to believe that a combination of these could provide a complete assessment, but the ideal situation would provide one index to capture all the necessary components for a complete assessment. The concept of diet quality does just that. By using a diet quality index to examine a person's intake, one can gauge macronutrient intake, vitamin and mineral intake, Food Guide Pyramid adherence, and variety in the diet. Thus, diet assessment does not seem like such a daunting task. One is able to assess overall intake or focus on certain components that could be specifically related to certain diseases or deficiencies.

There are many published indices of overall diet quality. There are those based on examination of the intake of nutrients, food groups, or a combination of both. Three major approaches to construction of diet quality indexes have been reported in the literature: indexes derived from nutrients only (Table 1); indexes based on foods or food groups (Table 2); and indexes based on a combination of nutrients and foods (Table 3) (18).

The indices of diet quality based on nutrients use either summary measures derived from a group of nutrients or single nutrients as indicators of intake of several nutrients. The following table (Table 1) derived from Kant (18)gives several examples of such indexes.

Table 1

Nutrient Based Indexes of Overall Diet Quality		
Index	**Definition**	**Author**
***Indexes examined for relation to nutrient intake**		
Nutrient Adequacy Ration (NAR)	Ratio of intake of a nutrient relative to its RDA	Madden & Yoder, 1972
Mean Adequacy Ration (MAR)	Computed by averaging sum of the NARs	Madden & Yoder, 1972
Nutritional Score	Sum of selected nutrients consumed at a level equal to at least 2/3 of RDAs	Clarke & Wakefield, 1975
Diet Quality	Meeting 2/3 of RDA for intakes of 5 or more of nine selected nutrients	Davis et al, 1990
DINE Score	Evaluation of meeting the RDA of selected micronutrients	Dennison et al, 1994
***Indexes examined for relation to health outcome**		
Dietary Rating	Compared nutrient intake levels to “optimal” intake level	Burke et al, 1943
Vegetable & Animal Foods Score	% of energy from vegetable or animal protein, starch, animal fat, fiber, and cholesterol	Kushi et al, 1985

The Nutrient Adequacy Ratio (NAR) and the Mean Adequacy Ratio (MAR) were first used for evaluating the efficacy of food stamp and commodity distribution (23). As mentioned in the table, the NAR is the ratio of intake of a nutrient relative to its RDA and the MAR is computed by averaging the sum of the NARs (18). The MAR permits an evaluation of overall adequacy of selected nutrients in a given population group, but very high or very low NARs of some nutrients may still make interpretation of the final MAR difficult (18).

Indexes of overall diet quality based on foods or food groups examine intake patterns of food or food groups to identify patterns associated with nutrient adequacy. The indexes did this through one of two approaches: (1) developing scores derived from consumption of all foods or of foods grouped into major/minor groups; or (2) deriving patterns by means of factor analysis on food groups. Table 2, derived from information from Kant(18)gives several examples of such indexes.

Table 2

Food and Food-Group-Based Indexes of Overall Diet Quality		
Index	**Definition**	**Author**
Indexes examined for relation to nutrient intake and parameters of nutritional status		
Food Diversity	Overall diet quality derived from total number of unique foods consumed	Black & Sanjur, 1980
Campbell Diet Indexes	Examined qualitative indexes derived from food frequency data	Campbell et al, 1982
Overall Variety Measure	Found score assessing variety among major food groups to be better predictor of variation in the MAR	Krebs-Smith et al, 1987
Variety Among Food Groups	Same as Overall Variety Measure	Krebs-Smith et al, 1987
Variety Within Food Groups	Same as Overall Variety Measure	Krebs-Smith et al, 1987
Composite Dietary Index	Dietary index based on frequency of consumption of 14 food categories	Davenport et al, 1995
Indexes examined for relation to risk reduction and health outcome		
Prudent Diet Score	Score from 0 to 10 was calculated from frequency of consumption of 10 food items	Nube et al, 1987
Eating Patterns	Identified eating patterns associated with cardiovascular risk factors	Nicklas et al, 1989
Dietary Patterns	Identified eating patterns associated with cancer risk behavior	Randall et al, 1991
Diet Diversity	Measure from an assessment of whether food groups were reported in a FFQ	Miller et al, 1992

The measure of dietary diversity developed by Miller et al (24) assessed whether food groups-grains and tubers, vegetables, fruits, legumes, and animal products-were reported in a semi-quantitative food frequency questionnaire among Saba Islanders. The researchers found that dietary diversity and hypertension were strongly related in both unadjusted and multiple-covariate adjusted models. This index demonstrated that foods and food groups are related to certain health outcomes.

The indexes of overall diet quality based on nutrients and foods are complex and require quantitative estimation of nutrients and food groups (18). Recommendations related to fat intake (total fat, saturated fat, and cholesterol), which tend to be highly intercorrelated, contribute a large proportion to the total index scores. Table 3, derived from information from Kant (18) gives several examples of such indexes.

Table 3

Indexes of Overall Diet Quality Based on Nutrients and Foods

Index	Definition	Author
***Indexes examined for relation to nutrient intake**		
Diet Quality Index	Weighting of selected nutrient and food intake recommendations of Food & Nutrition Board	Patterson et al, 1994
Healthy Eating Index	Consists of scores for consumption of suggested # of servings of 5 food groups	Kennedy et al, 1995
***Indexes examined for relation to health outcomes**		
Risk Score	Calculated from consumption levels of foods and nutrients using a dietary history	Kune et al, 1987

The Healthy Eating Index (HEI) is one of the first indexes to try to incorporate nutrient needs and dietary guidelines for the U.S. consumer into one measure (21). The HEI is a single summary measure of diet quality that can be used to monitor changes in consumption patterns as well as serve as a useful tool for nutrition education and health promotion. It was developed based on a 10-component system of five food groups, four nutrients, and a measure of variety in food intake. Components 1 through 5 measure the degree to which a person's diet conforms to the recommendations of the Food Guide Pyramid for five major food groups: grains, vegetables, fruits, milk, and meat. Component 6 is based on overall fat consumption as a percentage of total food energy intake. Component 7 is based on saturated fat consumption as a percentage of total food energy intake. Component 8 is based on cholesterol intake and component 9 is based on sodium intake. Component 10 is based on the amount of variety in person's diet. Each of the 10 components has a score ranging from 0 to 10, so the total possible index score is 100.

In testing this index, researchers used data from the 1989 and 1990 Continuing Survey of Food Intake by Individuals (CSFII). In their study, the mean HEI was 63.9. No one component of the index dominated the HEI score. People were most likely to do poorly in the fruit, saturated fat, grains, vegetable, and total fat categories. As hoped, the HEI correlated positively and significantly with most nutrients; as the total HEI increased, intake for a range of nutrients also increased (21). The HEI does seem to be a useful index of overall diet quality of the consumer.

A few years later the Dietary Variety Score was developed. The Dietary Variety Score was based on the cumulative number of different foods consumed over a 15-day period (11). A single 24-hour recall and 14 consecutive days of food records were collected. The full score was awarded for diets deriving 30% or less of energy from fat, 10% or less of energy from saturated fat, more than 50% of energy from carbohydrate, and containing less than 300 mg cholesterol and 2400 mg sodium per day (11). This index was tested using 24 healthy young (ages 20 to 30 years) and 24 healthy older (ages 60 to 75 years) adults, consisting of 24 men and 24 women. Older subjects consumed more varied diets than did young subjects and higher DVS values were linked positively to vitamin C intakes and negatively to the consumption of salt, sugar, and saturated fat. Unlike previous studies, this study addressed the issue of the number of different foods that constitute a varied diet. The described classification offers a way of assessing dietary variety at the individual or group level and demonstrates an additional aspect of diet quality.

Once the concept for diet quality was established, research focused on populations with similar demographic characteristics. The association between living arrangements and dietary quality of older U.S. adults was investigated in 4,402 adults aged 55 years or older who participated in the Nationwide Food Consumption Survey 1977 to 1978 (9). In this study, dietary quality was based on percent of Recommended Dietary Allowances for 3-day intakes of nine nutrients. These nutrients included thiamin, riboflavin, vitamin B-6, vitamin B-12, vitamin C, vitamin A, calcium, iron, and magnesium. These nine nutrients were selected because they were not highly correlated with each other and because many older adults consume amounts below the Recommended Dietary Allowances for them. They also investigated whether certain factors-economic, employment, health status, body mass index, energy intake, and nutrient supplement useaccounted for the association of living arrangement with dietary quality. If an individual reported low intakes of five or more of the nine selected nutrients, the diet was considered to be of poor quality and diets not classified as poor quality were defined as higher quality. Still, it was recognized that some of the higher quality diets were likely to be inadequate for some nutrients. The researchers found that approximately 13% of individuals 55 years of age and older reported diets that were categorized as inadequate (defined as less than two thirds of the Recommended Dietary Allowances for five of nine nutrients). More men living alone consumed a poor-quality diet than did men living with a spouse, but in general more women than men were found to have poor quality diets. In terms of the factors examined, energy intake was the most important variable accounting for the association of living arrangement with dietary quality. Older adults living alone did not make poorer food choices than those living with a spouse, but rather they consumed fewer calories.

Ten years later researchers took a similar approach investigating the association of demographic and economic factors with dietary quality (28). They examined the quality of the diets of U.S. adults by studying nutrient intakes as percents of the Recommended Dietary Allowances (as a measure of underconsumption) and energy from fat as a percent of total energy intake (as a measure of overconsumption) in 5,884 adults (19 years of age and older) who participated in the 1987-88 Nationwide Food Consumption Survey. When examining 15 nutrients, they found that few adults reported mean intakes that met suggested guidelines: only 22% of diets were above two thirds of the Recommended Dietary Allowances for all 15 nutrients and 14% were below 30% of calories from fat, but only 2% met both criteria. Energy intake was found to be a strong negative predictor of number of low-intake nutrients and weak positive predictor of percent of energy from fat, yet there were few demographic or economic predictors of either the number of low-intake nutrients or percent of energy from fat. Thus, according to the analyses, energy intake is the best single predictor of the nutritional adequacy of the U.S. adult diet.

The natural progression of research merited the study of U.S children, for diet quality is a concept that can also be extended to children. Wolfe and colleagues(48) examined the food patterns and diet quality of elementary schoolchildren in New York State and tried to determine sociodemographic characteristics that correlated with diet quality. Nearly 1,800 second and fifth graders completed a 24-hour recall and parents completed a brief questionnaire to assess diet quality. Components of the diet quality index included food-group pattern score; consumption of breakfast; consumption of vegetables other than potatoes or tomato sauce; food diversity score (a measure of dietary variety correlated with nutrient intake); and number of snack foods eaten. Children were considered low SES if they participated in free or reduced-price school lunch, had no parent working, or received social or food assistance. Children were classified as medium/high SES if they met none of these criteria. On the day of the survey, 40% of students did not eat vegetables, 20% did not eat fruit; 36% ate at least four different types of snack foods, and 16% of fifth graders did not eat breakfast. Children who ate a school lunch had more dairy foods and fruits and vegetables and fewer snack foods than those who brought lunch from home. Boys had lower food-group pattern scores than girls and children of lower SES status had less diverse diets but ate less snack foods than children of a higher SES. As demonstrated in this article, diet quality is not just a concept for adults.

As evaluative criteria for diet developed in the United States, the question arose of whether or not the criteria was adequate to assess diet in other countries. Drewnowski and colleagues(12) used the criteria developed in the U.S. to evaluate the diet quality and diet diversity of French adults. The researchers used a modified diet quality index (DQI), a dietary diversity (DD) score, and a dietary variety score (DVS) to evaluate habitual dietary intakes of a representative sample of 837 adults. The 5-point DQI assessed compliance with the key guidelines of the USDA for healthy people with a higher score indicating a higher quality diet. The DD score counted the number of major food groups consumed whereas the DVS counted the total number of foods consumed on a regular basis. Not surprisingly, few French adults consumed diets consistent with the USDA dietary recommendations. A meager 14% of respondents derived less than 30% of energy from fat and only 4% derived less than 10% of energy from saturated fat. Thus, 63% of the sample had a DQI score of either 0 or 1, again with the maximum points possible being 5. Conversely, close to 90% of the participants scored a maximum of 5 in DD, yet these scores were less sensitive to the macronutrient composition of the diet than were the DQI scores. Finally, persons whose diets met the U.S. dietary recommendations also had the lowest DVS possible indicating that the most “healthful” diets often come at the expense of dietary variety.

Would this trend transcend to other European countries? Could differences between two countries be due to socioeconomic differences rather than cultural differences? One particular study strove to answer these questions. The relationship of nutrient intake and food consumption to education and household income in men and women was studied (32). Additionally, the researchers investigated to what extent the goals of the national dietary guidelines were met in different socioeconomic groups. A total of 870 men and 991 women from four different regions in Finland completed a 3-day food record and a self-administered questionnaire. The researchers looked at food group and nutrient consumption, two saturated fat indices, educational level, and household income. They found that men with a higher educational level had a lower energy intake and women with a higher income a lower intake of carbohydrates. There was also an increased intake of vitamin C and carotenoids with increasing socioeconomic status. Otherwise, there were no socioeconomic differences in energy intake, densities of fat and saturated fat, macronutrients or fiber between the regions. However, they did find that higher socioeconomic groups consumed more cheese, vegetables, fruit and berries, and candies, and less milk, butter, and bread. Thus, the higher socioeconomic groups did not follow current dietary guidelines better than lower socioeconomic groups. However, they did appear to have different patterns of intakes.

The idea of a diet quality index was also tested in China. Stookey and colleagues(41) selected 10 DQI components based on the Dietary Guidelines for Chinese Residents. The components were weighted and assessed using the Chinese Food Guide Pagoda and international dietary reference values. Seven thousand four hundred and fifty adults from the 1991 China Health and Nutrition Survey completed a 3-day diet record and anthropometric assessments for evaluation of the Chinese DQI. A total DQI score was calculated for each individual as the sum of components and it was compared with component scores, food and nutrient intake, weight status, and sociodemographic variables. The researchers found that the total DQI score was significantly correlated with food and nutrient intakes, BMI, urban residence, and income. The China DQI proved to be very successful in China appearing sensitive to under- and overnutrition, as well as sociodemographic variables.

Kant and colleagues(19) took diet quality one-step further by examining the association of mortality with a diet quality index. A total of 42,254 women from the Breast Cancer Detection Project (a prospective cohort study of breast cancer screening) completed a food frequency questionnaire. The index in this study was entitled the Recommended Food Score (RFS) and consisted of the sum of the number of foods recommended by current dietary guidelines that were reported on the questionnaire to be consumed at least once a week for a maximum score of 23. There were 2065 deaths due to all causes in the cohort demonstrating an inverse association between the RFS and all cause mortality. Subjects in the upper quartiles of the RFS had relative risks for all cause mortality of 0.82 (95% CI, 0.73-0.92), for quartile 2, 0.71 (95% CI, 0.62-0.81) for quartile 3, and 0.69 (95% CI, 0.61-0.78) for quartile 4 when compared with those in the lowest quartile. These were apparent after adjusting for education, ethnicity, age, BMI, smoking status, alcohol use, level of physical activity, menopausal hormone use, and history of disease. Thus, based on these data, a dietary pattern characterized by consumption of foods recommended in current dietary guidelines is associated with decreased risk of mortality in women.

In addition to the association of diet quality with overall mortality, studies have shown that diet quality is also related to lifestyle and environmental factors. Using data from the cross-sectional SENECA baseline study and Framingham Heart Study, dietary quality of European and American elderly subjects was evaluated (17). Food intake data were summarized into dietary clusters and into two dietary scores: the Healthy Diet Indicator and the Mediterranean Diet Score. These measures were then tested for associations with lifestyle factors and measures of nutritional status. The participants included 828 subjects, aged 70-77 years, from the two previously mentioned studies. Southern European Centers and Framingham had higher mean diet scores, indicating a higher diet quality, than Northern European Centers. Five dietary patterns evolved characterized by: (1) sugar and sugar products; (2) fish and grain; (3) meat, eggs, and fat; (4) milk and fruit; and (5) alcohol intake. The meat, eggs, and fat pattern had significantly lower average dietary quality, as measured with the aforementioned diet scores, than all other groups, except the alcohol group. The fish and grain group had significantly better Mediterranean diet scores than all other groups. Thus, dietary scores and dietary clusters are complementary measures to classify dietary quality, and the associations with nutritional and lifestyle factors indicate the adequate categorization into dietary quality groups (17).

In an attempt to examine the effect of dental disorders and oral hygiene on the quality of dietary intake, Shinkai and co-workers(38) performed cross-sectional analysis on 731 community dwelling individuals. The researchers collected data from clinical examinations, bite force recordings, masticatory performance measurements, and two, 24-hour dietary recalls. The Healthy Eating Index was used to assess diet quality. Females, European-Americans, and older subjects had better HEI scores than males, Mexican-Americans, and younger subjects, respectively. However, income, education, and the masticatory variables were not related to diet quality. Thus, chewing related factors evaluated in this sample were not predictors of overall diet quality across the sociodemographic groups.

As evident from the review, there is a scarcity of published research that has focused on measures of diet quality and its relationship to chronic diseases. This idea fueled the creation of the Diet Quality Index (DQI), an index that reflects a risk gradient for major, diet-related, chronic diseases (29). Data from 5484 adults (aged 21 years and older) who participated in the 1987-88 Nationwide Food Consumption Survey (NFCS) were used to develop the index. For scoring in this index, dietary recommendations from the 1989 National Academy of Sciences publication *Diet and Health* were stratified into three levels of intake for scoring. Those who did not meet a goal, but had a fair diet, were given one point, and those who had a poor diet were given two points. The points were then summed across eight diet variables to score the index from zero (excellent diet) to 16 (poor diet). The eight variables included: (1) reduce total fat intake to 30% or less of energy; (2) reduce saturated fatty acid intake to less than 10% of energy; (3) reduce cholesterol to less than 300 mg daily; (4) eat five or more servings daily of a combination of vegetables and fruits; (5) increase intake of starches and other complex carbohydrates by eating six or more servings daily of breads, cereals, and legumes; (6) maintain protein intake at moderate levels; (7) limit total daily intake of sodium to 6 g (2400 mg) or less; and (8) maintain adequate calcium intake. Lower index scores were positively associated with high intakes of other important measures of diet quality (eg, fiber, vitamin C). Also, single nutrients (such as dietary fat) were not necessarily associated with other measures of diet quality. This index ranking of overall dietary patterns was reflective of total diet quality, but misclassification can result from using single nutrients or foods as indicators of diet quality. Thus, there was room for improvement with this index.

Recognizing the weaknesses of the DQI, the Diet Quality Index Revised (DQI-R) was developed several years later. The revision was a result of improved methods of estimating food servings, and to develop and incorporate measures of dietary variety and moderation (14). The revision had two main objectives: (1) to adopt a method of measuring fruit, vegetable, and grain servings; and (2) to evaluate the nutrition criteria on which the index is based. Two new scores were added to measure the constructs of variety (diversity) and moderation. The dietary diversity score was developed to reflect differences in consumption across 23 broad food group categories. The moderation score reflects measurement of four other dietary elements not directly measured as part of the DQI-R. The four elements were: added sugars, discretionary fat, sodium intake, and alcohol intake. All four components reflect "discretionary" behavior on the part of consumers, thus the consumers can regulate the amount of alcohol they consume, just as they can control their intake of sugar or sodium from processed foods. In the revision, the scoring of the original scale was reversed in direction and expanded to a 100-point scale to improve interpretability. A sample of 3202 adults aged 18 and older from the 1994 CSFII was used. Each contributed 2 days of dietary intake data based on 24-hour recalls for the development and revision of the components of the DQI-R.

The mean DQI-R score for the 1994 sample was 63.4 out of a possible 100-point score. The respondents were more likely to have met dietary guidance in the areas of dietary cholesterol (66.9 %) and iron intakes (59.6%) relative to the Recommended Dietary Allowances, but less likely to have met goals related to fruit servings (19.6%), grain servings (23.1%), and calcium intakes (16.6%) relative to the Recommended Dietary Allowances (14). On a positive note, there was a statistically significant quantitative and qualitative improvement in all components of the DQI-R as one moves from the lowest grouping of scores to the highest. For example, persons with DQI-R scores less than 40 consumed 43.9% of energy from fat, 72% of the Adequate Intake for calcium, and 6.7% of the recommended servings of fruit per day. On the other hand, persons with DQI-R scores greater than 80 consumed 24.2% of energy from fat, 101% of the Adequate Intake for calcium, and 137% of the recommended servings of fruit per day (14). The DQI-R achieved the goals it set out to attain. The index is suitable for the population as well as for an individual. DQI-R scores for an individual provide an estimate of diet quality relative to national guidelines, and differences in scores over time should suggest improvement or decline in overall diet quality.

The DQI-R provides an emphasis for many aspects of dietary assessment that should be considered for older, obese, adults. Macronutrient intake can be measured to look for a relationship to weight gain or weight loss. Intake of dietary fat and its components, such as saturated fat and cholesterol would be of importance as they relate to increased risk for cardiovascular disease. Selected vitamin and mineral intakes that are commonly found in low amounts in this population can be assessed. Food groups can be assessed to determine dietary variety. Diet quality seemed to provide a rational approach to examine several critical areas of nutrition and assess a person's overall intake.

Specific Aims and Hypotheses

The primary aim of this study was to assess the effect of the exercise and dietary weight-loss interventions employed in ADAPT on diet quality. In this trial utilizing older, obese adults, it is hypothesized that groups receiving the dietary intervention would show improvements in an index of diet quality over the 18-month intervention. Thus, at the 18-month time point, groups receiving the dietary intervention would have an improvement in diet quality score whereas those in the exercise intervention or control groups would not see an improvement. To date, no studies have been published that examine the effect of a nutrition related intervention on changes in a diet quality index.

METHODS

The Arthritis, Diet, and Activity Promotion Trial (ADAPT) was a single-blind, 18-month randomized controlled trial with a primary aim to determine the relative efficacy of weight loss, exercise, and their combination in reducing disability and pain in older, obese, sedentary adults with knee OA. There were four arms to the study: Healthy Lifestyle Controls (HL), Dietary Weight Loss (Diet), Exercise (Exercise), or combined Exercise and Dietary Weight Loss (Exercise-Diet).

Study Population

Participant recruitment for the study was performed in 6 waves over an 18-month period. A total of 316 community dwelling sedentary women and men were randomized into the four arms of the study with each group having approximately 78 participants. Only one-third of the eligible participants were randomized and scheduled to have dietary assessment performed. The inclusion and exclusion criteria were developed to give the highest level of assurance that physical disability was due to knee OA, and that the trial included persons who were likely to benefit from a weight loss and physical activity intervention. In addition, current conditions that prevented individuals from beginning or completing the interventions were a rationale for exclusion from the trial.

Interventions

The delivery of the intervention for each arm of the study was conducted independent of the other groups to eliminate cross-contamination of the treatments. The Diet group had a weight loss goal of a mean loss of $\geq$ 5% of initial body weight. Both group and individual diet sessions were utilized throughout the duration of the investigation in a 3:1 ratio with one of every four sessions being an individual appointment. The first session was an introductory, individual meeting with the interventionist to establish weight loss goals and to orient the participant to the study and facilities. The first four months were termed the intensive phase with weekly meetings conducted by a registered dietitian trained in the intervention strategy. The topics in the intensive phase focused on healthful food selection with portion and dietary fat control to decrease energy intake, emphasizing an increased awareness in the consequence of and the need to change dietary habits. Examples of group program topics included *Healthy Eating, Reading Labels, Shopping, Food Preparation, Meal Ideas, Restaurants, Ethnic Eating, Special Occasions, and Old and New Routines.* Self-regulatory skills were taught by the interventionists, including self-monitoring, goal setting, environmental management, stimulus control, and cognitive restructuring. Group sessions included problem solving, education on specific topics, and tasting of nutritious foods consistent with the overall goals of the intervention, i.e. weight loss. Individual sessions included a review of participant progress, problem solving, goal setting, and answering specific questions.

Biweekly meetings were held during months 5 and 6 of the transition period. The emphasis of this phase was to maintain and prevent relapse in participants that reached their weight loss goals and to re-establish new goals for those that did not reach their goals. During the maintenance period of months 7-18, diet meetings were held monthly. In addition to these meetings, phone contacts were alternated every two weeks to provide interventionist-participant contact on a biweekly basis. Further contact was conducted through regularly distributed newsletters that provided pertinent nutrition information and a schedule of events for the intervention groups. The goals of the maintenance phase included assisting in weight maintenance for those that had achieved their weight loss goals, and providing counsel for participants who had a difficult time in losing weight and adhering to the intervention. Intervention groups were approximately 12-14 participants in size. Compliance to the dietary intervention was monitored based on attendance to sessions and completion of routine dietary logs. Additional measurements were obtained at follow-up visits scheduled for months 6 and 18 of the intervention.

Details of the exercise intervention can be found in Appendix A. Briefly, the goal for participants randomized to this arm of the study was to engage in the facility-based exercise program 3 times per week, 60 minutes per day for 4 months. After this time, they could transition to home-based exercise if they desired, or they could opt to remain in the facility-based exercise for the remainder of the study. The exercise session consisted of 30 minutes of aerobic exercise, 15 minutes of strength training, and 15 minutes of warm-up and cool-down exercises.

The healthy lifestyle controls met monthly for one hour over the first 3 months of the trial. Topics for these sessions included osteoarthritis, obesity, and exercise. Phone contacts were performed on a monthly (for months 4-6) and bimonthly (months 7-18) basis. Information on pain, medications, illnesses, and hospitalizations was obtained during the phone contacts. Details of the healthy lifestyle control intervention can be found in Appendix A.

Measurements

A complete list and description of measures obtained in ADAPT can be found in Appendix B. The variables of interest and of direct relevance to this substudy from ADAPT are described below.

Demographics. At baseline, general demographic information was obtained from each participant. These included education level, income, ethnicity, and age.

Body Weight and Height. Body weight and height were measured at baseline and 18 months. Both were obtained in comfortable clothes, with shoes and outer garments removed. The scale was calibrated prior to baseline and at each follow-up testing assessment. Weight and height were used to calculate BMI, which was also determined at baseline and 18 months.

Dietary Intake. A registered dietitian from the General Clinical Research Center at Wake Forest University Baptist Medical Center, who was not involved with the delivery of the intervention, obtained a 24-hour recall at baseline and 18 months. Nutrient and food group analysis for this substudy was performed from these food lists using Food Processor, version 7.6 (ESHA, Salem, Oregon). Dietary quality was calculated from these analyses.

Diet Quality Index

Our index of diet quality reflects 10 dietary characteristics, with a total maximum score of 100 points, 10 points for each component. Low scores reflect poorer achievement of dietary recommendations and higher scores reflect better diet quality. This index was patterned after the Dietary Quality Index-Revised (14). When appropriate, gender specific values were used as standards.

The 10 nutritional quality indicators in our diet quality index are listed in Table 4. This table shows each component, the number of points available for each, and the scoring criteria required to receive the highest and lowest scores.

Table 4

Components of Diet Quality Index		
Component	**Score**	**Scoring Criteria**
Total fat ≤ 30% energy intake	0-10 points	≤ 30%=10 >30, ≤ 40=5 >40=0
Saturated fat ≤ 10% energy intake	0-10 points	≤ 10%=10 >10, ≤ 13=5 >13%=0
Dietary cholesterol < 300 mg/day	0-10 points	≤ 300 mg=10 >300, ≤ 400 mg=5 >400 mg=0
2-4 servings fruit/day, % recommended servings	0-10 points	≥100% 99%-50% <50%
3-5 servings vegetables/day, % recommended servings	0-10 points	≥100% 99%-50% <50%
6-11 servings grains/day, % recommended servings	0-10 points	≥100% 99%-50% <50%
Calcium intake as % AI for age	0-10 points	≥100% 99%-50% <50%
Iron intake as % 1989 RDA for age	0-10 points	≥100% 99%-50% <50%
Dietary diversity score • Vitamin C intake as % 1989 RDA for age • Vitamin A intake as % 1989 RDA for age • Protein intake, % 0.8 g/kg per day • Fiber intake, % recommended servings (25g/day)	 0-2.5 points 0-2.5 points 0-2.5 points 0-2.5 points	≥100%=2.5 99%-50%=1.25 <50%=0
Dietary moderation score • Sodium intake as % 1989 RDA for age • Alcohol intake	 0-5 points 0-5 points	≤ 2400 mg=5 2400-3400 mg=2.5 >3400 mg=0 ≤ 100%=5 100-150%=2.5 ≥ 200%=0

The first three components of the diet quality index reflect lipid distribution recommendations. In other words, to restrict relative dietary fat to less than or equal to 30% of energy, to restrict saturated fat to less than or equal to 10% of energy, and to consume less than 300 mg cholesterol daily. Following these recommendations is rewarded with 10 points, and with 5 and 0 points awarded for higher intakes of the lipid components (reflecting poorer intakes). The next 3 indicators, which reflect the proportionality construct illustrated in the Food Guide Pyramid, measure relative differences in consumption of servings of fruit, vegetables, and grains-the base and the middle of the Food Guide Pyramid. The recommended number of servings from the Food Guide Pyramid depends on recommended energy intakes, so diet quality measures of grain, vegetable, and fruit intake adequacy are adjusted to reflect intake as a proportion of the number of servings recommended for the appropriate energy intake level. If a participant had greater than or equal to 100% of the recommended number of servings from a particular group he/she received 10 points. An intake of 50-99% of recommended number of servings received 5 points, while an intake of less than 50% of recommended number of servings received 0 points.

The next two diet quality indicators reflect relative intakes of calcium and iron. Because of the transition from the Recommended Dietary Allowances to the Dietary Reference Intakes, the criterion for calcium intake adequacy is based on the value designated as the Adequate Intake value. The scoring was the same as that for the vegetable, fruit, and grains intake, but the recommendations are based on the Adequate Intake value for calcium and the Recommended Dietary Allowances for iron.

The dietary diversity score reflects variety in one's diet. Vitamin C and Vitamin A, presented as a percentage of gender specific Recommended Dietary Allowances values, reflect consumption of citrus fruits and a variety of vegetables (specifically green vegetables), respectively. The protein component is present to convey consumption of foods from the meat and dairy groups. The score for this component is based on the recommendation of 0.8 grams of protein per kilogram of body weight. The fiber component is present to demonstrate the consumption of whole grains. Scoring for this component was based on the recommendation that adults should consume at least 25 grams of fiber per day. Measures of dietary diversity, such as those presented here, contain broader food aggregates, and have a greater probability of capturing true variability than do other measures. Each component of this section can receive a maximum of 2.5 points for a total of 10 points. Thus, if a participant has 100% or greater of the recommended amount of the above components, he receives 2.5 points. If he consumes between 99-50% of the recommended amount he receives a score of 1.25 points, and if he receives less than 50% of the recommended amount he receives 0 points.

Two other elements were measured for the dietary moderation score: sodium intake and alcohol intake. These two components reflect discretionary behavior on the part of consumers, that is, consumers can regulate the amount of alcohol they consume, just as they can control their intake of sodium from processed foods. Alcohol intakes were converted to drinks per day, reflecting grams of ethanol intake. For females, the recommended amount per day was 15 grams of alcohol and for males the recommended amount per day was 30 grams. Dietary sodium intake is measured as milligrams of dietary sodium consumed as a natural part of food, sodium added to processed foods, and salt added to prepared foods. Sodium intake is presented as a percentage of established dietary guidelines (2400 mg). The two components of the dietary moderation score provided 5 points each of the possible 10 total points for the moderation score. Persons consuming less than or equal to 100% of the recommendation for added sodium or alcohol received a score of 5. Scores decline progressively so that persons consuming more than 200% of the recommendation received 0 points in the dietary moderation score.

Statistics

Analysis of Covariance (ANCOVA) was used to assess the effect of the main effects (diet and exercise) and their interaction (diet*exercise) on diet quality from baseline to the 18 month time point. Analysis was done on completer's only for all statistical measures. Diet quality at baseline served as the covariate to allow for differences in baseline values between groups. Diet quality scores are presented as means (standard deviation). An ANCOVA was also used to assess weight loss among the four treatment groups. Baseline weight served as the covariate and 18-month weights are presented as mean (standard deviation). Frequencies were calculated for each time period and each treatment to determine the proportion of participants that received certain scores in each of the components of the diet quality score. Descriptive statistics provided information on demographic variables at baseline.

RESULTS

Baseline demographics for participants randomized into the study are presented in Table 5. The mean age of the participants randomized for dietary assessment at baseline was 68.25 years, ranging from 60 to 85. Nearly two-thirds of the participants were women (65.1%) with another 77% classified as white/Caucasian. Approximately, 44% had an annual household income between $25,000-50,000, with an additional 26% earning more than $50,000 per year. The majority of the participants had some post high school education, with 22% having at least a college degree.

Selected outcome variables at baseline for the participants are presented in Table 5. Prior to the initiation of the interventions, BMI was 33.9 (4.74) $kg{\bullet}m^2$ with a range from 27.2 to 47.7 $kg{\bullet}m^2$. The participants had a mean weight of 91.9 (16.6) kg. with a range from 62.1 to 136.1 kg.

Table 5

Baseline Demographics	
Variable	
Age, mean (SD), years	68.25 (5.37)
Sex, % (n)	
Females	65.1 (56)
Males	34.9 (30)
Weight, mean (SD), kg.	93.22 (16.64)
Height, mean (std. deviation), in.	65.27 (4.06)
BMI, mean (SD), kg•m^2	33.90 (4.74)
Ethnic Background, % (n)	
Black	23.5 (19)
White	76.5 (62)
Education, % (n)	
< High School	7.4 (6)
High School Degree	16.1 (13)
Post High School	34.5 (28)
College Degree	22.2 (18)
Post Undergraduate Degree	19.8 (16)
Income, % (n)	
< $10,000	6.2 (5)
$10,000-$24,999	23.4 (19)
$25,000-34,999	18.5 (15)
$35,000-49,999	26 (21)
$50,000-$74,999	11.1 (9)
>$75,000	14.8 (12)

At baseline, measurements of diet quality scores ranged from 32.5 to 93.75 with a mean across all groups of 63.97 (14.14). Individual group values for diet quality and body weight at baseline and 18 months are shown in Table 6. At eighteen months, there was no effect of the interventions on the diet quality index as determined by ANCOVA with the index at baseline serving as the covariate. The p value for the main effects of diet and exercise were 0.566 and 0.182, respectively. In addition, there was no interactive effect of the interventions ($p = 0.101$). All 18 month values are for completer's only.

Although there were no differences in diet and exercise effects in body weight at 18 months (p = 0.070 for diet and p = 0.643 for exercise), there was a difference in percent weight loss. As expected, a greater loss was observed for groups receiving the dietary treatment (p = 0.041). However, there was no exercise effect on relative weight loss. Percent weight loss was -1.15 (7.31)% for the healthy lifestyle controls, -4.6 (9.43)% for the diet group, -1.02 (6.25)% for the exercise group, and -6.16 (6.81)% for the combined diet and exercise group. Percent weight loss is for completer's only.

Table 6

Diet quality at baseline and 18 months		
Intervention Groups	**Baseline**	**18 months***
Healthy Lifestyle Controls		
Diet Quality	65.27 (12.37)	67.41 (13.13)
Diet		
Diet Quality	62.88 (13.26)	59.37 (13.17)
Exercise		
Diet Quality	62.17 (15.34)	66.18 (13.22)
Diet-Exercise		
Diet Quality	70.71 (12.84)	70.14 (13.41)

*Estimated Marginal Means for ANCOVA
n = 14 for Healthy Lifestyle Controls; n = 13 for Diet; n = 15 for Exercise; and n = 14 for Diet-Exercise

Examination of the components of the diet quality index is worth noting. Table 7 presents the frequencies of scores for each of the ten components of the index. Since there were no differences across the interventions, the data were pooled to provide an overall view of these areas at each time period. Frequencies expressed by time and treatment can be found in Appendix C. The majority of our participants met dietary guidance in the areas of dietary cholesterol (64.1% of participants received a score of 10 for this component), saturated fat (53.3%), and iron consumption (87.0%) relative to the Recommended Dietary Allowances, but were less likely to have met goals relative to fruit servings (33.7%) and calcium intake (21.7%). Within the Moderation Score and Diversity Score the majority of participants met recommendations for alcohol intake (95.7%), vitamin A intake (58.7%), vitamin C intake (65.2%), and protein intake (57.6%), but did poorly meeting the recommendations for fiber intake (27.2%). At 18 months, our participants continued to meet the recommendations for saturated fat intake (56.5%), dietary cholesterol (77.4%), and iron consumption (87.1%). Additionally, the majority of the participants now met the recommendations for number of vegetable servings (53.2%). Participants were still less likely to have met goals in calcium intake (9.7%) and fruit servings (33.9%). Participants continued to meet the recommendations for alcohol intake (91.9%), and saw improvements in meeting recommendations for sodium intake (46.8%) in the Moderation Score. They continued to do poorly meeting the recommendations for fiber intake (17.7%), but continued to do well with Vitamin A intake (71.0%) and Vitamin C intake (61.3%) in the Diversity Score. Frequencies at 18 months are for completer’s only.

Table 7

Frequencies of Diet Quality Components' Scores						
	Baseline			**18 Months**		
	0 points	**5 points**	**10 points**	**0 points**	**5 points**	**10 points**
Fat Score	23.9 %	32.6 %	43.5 %	17.7 %	35.5 %	46.8 %
Sat Fat Score	22.8 %	23.9 %	53.3 %	21.0 %	22.6 %	56.5 %
Fruit Score	46.7 %	19.6 %	33.7 %	38.7 %	27.4 %	33.9 %
Vegetable Score	27.2 %	31.5 %	41.3 %	21.0 %	25.8 %	53.2 %
Grains Score	18.5 %	39.1 %	42.4 %	22.6 %	53.2 %	24.2 %
Cholesterol Score	21.7 %	14.2 %	64.1 %	14.5 %	8.1 %	77.4 %
Calcium Score	37.0 %	41.3 %	21.7 %	48.4 %	41.9 %	9.7 %
Iron Score	1.1 %	11.9 %	87.0 %	0.0 %	12.9 %	87.1 %
Moderation Score	**0**	**2.5**	**5**	**0**	**2.5**	**5**
Sodium	31.5 %	33.7 %	34.8 %	25.8 %	27.4 %	46.8 %
Alcohol	1.1 %	3.3 %	95.7 %	3.2 %	4.8 %	91.9 %
Moderation Total*	**0** 0.0 %	**2.5-5** 33.7 %	**7.5-10** 66.3 5	**0** 1.6 %	**2.5-5** 27.4 %	**7.5-10** 71.0 %
Diversity Score	**0**	**1.25**	**2.5**	**0**	**1.25**	**2.5**
Fiber	25.0 %	47.8 %	27.2 %	27.4 %	54.8 %	17.7 %
Vitamin A	21.7 %	19.6 %	58.7 %	11.3 %	17.7 %	71.0 %
Vitamin C	20.7 %	14.1 %	65.2 %	12.9 %	25.8 %	61.3 %
Protein	4.3 %	38.0 %	57.6 %	9.7 %	48.4 %	41.9 %
Diversity Total*	**0-2.5** 12.0 %	**3.75-6.25** 34.7 %	**7.5-10** 53.3 %	**0-2.5** 14.5 %	**3.75-6.25** 29.0 %	**7.5-10** 56.5 %

* Due to the assignment of points in the subsections of the moderation and diversity score, possible values in 2.5 increments and 1.25 increments from 0 to 10, respectively. Ranges were then established for the data summary in this table.

DISCUSSION

The diet quality index calculated in this study utilized 10 dietary components derived from three different nutritional standards: Recommended Dietary Allowances, Dietary Guidelines, and the Food Guide Pyramid. Numerous studies have examined different variations of diet quality or other indices with similar objectives. The Nutrient Adequacy Ratio (NAR) (23)and the Mean Adequacy Ratio (MAR) (23) are both indexes that are nutrient based. The Diet Diversity score (24)is an index based on foods and food groups, similar to the Diet Quality Index that looked for a relationship with a certain health outcome. The Healthy Eating Index (21), is most similar to the Diet Quality Index in that it looks at both nutrients and food groups. The use of the diet quality index in the current study is unique in that no other studies previously published had examined the effect of a dietary/lifestyle intervention on the scores. Previous studies had used the concept of diet quality solely to describe dietary intake in a cross-sectional design.

The current study found no effect of either the diet or exercise interventions on changing dietary quality. These findings were surprising since it was hypothesized that diet quality would improve following the diet intervention. This may be explained in part by the fact that the dietary intervention utilized in ADAPT focused on weight loss and not specifically on diet quality. The success of the intervention is observed in the significant decrease in body weight for the dietary arms of the study. It is important to note that all statistics presented are completers only analysis. Thus, it is uncertain how the non-completers would have responded to the intervention, and subsequently would have biased these results.

Previous research examining diet quality may provide insight on why there was no change in diet quality. Diet quality may not be sensitive to change over time, for it's primary purpose previously has been to describe a population rather than improve it. The index itself encompasses so many aspects of a person's diet. One can obtain information about macronutrients, micronutrients, food groups and vitamins and minerals. Small changes could take place in each of these areas, but they may too small or too specific to cause a significant change in the overall diet quality score. Furthermore, as one strives to improve one aspect of diet quality he may hurt another. If someone needs to decrease his percent fat from calories, he may sacrifice certain good sources of protein (red meat) to reduce the fat in his diet and thus decrease his protein score. Perhaps, if diet quality is be to evaluate a post-intervention diet, the focus should be on each component rather than the overall score.

Our diet quality index scores are comparable to those found for the 1994 sample evaluated by the DQI-R (14). The mean score for the 1994 sample was 63.4 points out of a possible 100 points. The mean score for the present sample was 65.77. The present population has similar values to those presented by Haines et al, indicating that they had similar diets. Although the present population is composed of obese, older adults, it is not that different from the population in Haines et al.

The question arises of whether or not the present population is really a true representation of the population at large. The present population is mostly white, well-educated, and female (See Table 5), not to mention older and obese. Still, as mentioned previously, the diet quality of the present population matched the national average found by Haines et al (14). Thus, although the present population does not seem average, their diet quality matches the specifications of just that.

The amount of weight loss experienced by our participants who received the diet intervention is comparable to the percent weight loss achieved by participants of similar age in a separate study. Obese (BMI > 30.0 kg/m^2), hypertensive, older adults (60-80 years) were able to maintain a 5.4% decrease in body weight over a 30 month period with monthly contacts during a 22 month maintenance phase during an intervention entitled TONE by Whelton and colleagues (47). The participants in the present study who received the diet intervention lost 4.6% of their body weight, and those that received the diet intervention and exercised lost 6.2% of their body weight. The weight loss goal established was a 5% loss in weight from baseline. Toda et al. (42) showed that a 5.6% decrease in body weight over a 6-week period produced a significant decrease in symptoms of knee OA in women over the age of 45 years. The percent weight loss achieved by the present participants is comparable to that presented in these two similar studies.

The present diet quality index permits the examination of selected nutrients that are generally areas of concern with older adults. For example, many older adults have a low iron intake (9); however, this was not observed in the present population. On the other hand, older adults often have a diet deficient in calcium and the present population exhibited this problem at both baseline and 18 months. In comparison to the results of Drewnowski and colleagues (11) with the Dietary Variety Score, the present indices appear similar. The older subjects in their study consumed a mean of 33% of energy from fat, whereas the majority (46.8%) of the participants in the present study consumed

≤ 30% of energy from fat (See Table 7). Results are also comparable with percent of calories from saturated fat. Drewnowski's population consumed 11% of calories from saturated fat and the majority (56.5%) of the participants in the current study consumed ≤ 10% of energy from saturated fat.

The Healthy Eating Index scores found by Kennedy et al (21) are also comparable to the diet quality scores found in the present study. Their participants, like those in the present study, were less likely to meet the recommendation for number of fruit servings per day. Furthermore, few people scored very high or very low overall. Their mean HEI score was 63.9 points out of a possible 100 points, and the mean diet quality score in the present study at 18 months was 65.77.

There are several limitations with the current research. First, a 24-hour recall was used to obtain dietary information. Although, this method of diet assessment is associated with recall bias, it is a relatively simple, valid, and reliable method that provides minimal burden to the participant (37). However, it may not represent normal dietary habits for certain participants. Depending on the day the recall was performed, a participant may not have consumed his normal diet for the day recalled. A 3-day food record provides a more optimal approach as it can include week and weekend days. Also, with a 3-day food record, participants could write down foods and beverages immediately post-consumption, rather than having to wait and recall them the next day. However, food records have the disadvantage in that they are more burdensome to the participant and the respondent must be highly motivated. Respondents may change their usual eating patterns to simplify the measuring process, or alternatively, to impress the investigator (6).

Another potential limitation of the present study is the sample size and the lost data at follow-up. The original protocol called for 1/3rd of the participants in ADAPT be randomized for dietary assessment. This would provide approximately 100 participants from among the 4 intervention arms. However, due to dropouts and lost appointments with the nutritionists performing the dietary assessments, data are available on only 60% of the original sample for both baseline and 18 month follow-up visits.

Finally, as mentioned earlier, the present analysis is on completer's only. One cannot speculate how the present results may have differed if the non-completer's had finished the intervention.

Findings from this study are valuable for several reasons. First, this study was able to characterize overall dietary quality. This can be used in the developing future dietary and healthy lifestyle interventions targeting a similar group. That is, by examining the distribution of the different components of the index, emphasis could be placed on areas that had the lowest scores. Finally, in order to see changes in diet quality, diet quality needs to be emphasized, rather than weight loss.

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APPENDIX A

Interventions			
Intervention	**Days per Week/ Month**	**Time**	**Details**
Exercise	3 per week	60 minutes	• Warm-up Phase (5 minutes) • Aerobic Phase (15 minutes) • Strength Phase (20 minutes) • 2nd Aerobic Phase (15 minutes) • Cool Down Phase (5 minutes)
Diet	• Intensive Phase (months 1-4)-1 per week • Transition Period (months 5 and 6)-2 per week • Maintenance Period (months 7-18)-diet meetings monthly; phone contacts every 2 weeks; regular newsletters		• 3:1 ratio; 1 in every four sessions an individual appointment • Intensive topics focused on healthful food selection with portion and dietary fat control • Maintain and prevent relapse in those that reached goals; re-establish new goals for those that did not reach their goals • Assist in weight maintenance, and provide counsel for participants who had difficulty
Healthy Lifestyle Controls	1 time per month for first 3 months	60 minutes	• Topics included osteoarthritis, obesity, and exercise • Monthly phone contacts (months 4-6) • Bimonthly phone contacts (months 7-18)

APPENDIX B

List and Timing of Outcome Measures		
Measures	**Baseline at Screening and Randomization**	**18 Month Follow-Up**
Eligibility Screen	X	
Informed Consent	X	
Background	X	X
Blood Screening	X	X
Questionnaires		
Medical History	X	X
MMSE	X	X
Medications	X	X
SSSI	X	X
Rand 36	X	X
Sleep	X	X
WOMAC	X	X
Self/Body Image	X	X
Knee Pain Scale	X	X
Physical Function	X	X
Physical Exam	X	X
X-Ray	X	X
Height/Weight	X	X
Stair Climb	X	X
6-Minute Walk	X	X
Graded Exercise Test	X	X
Biomechanics/Strength	X	X
Dietary Intakes	X	X
Cost Effectiveness	X	X

APPENDIX C

Time and Treatment Frequencies (%)							
		Baseline			18 Months		
		0 points	5 points	10 points	0 points	5 points	10 points
Controls	**Fat Score**	16.7	29.2	54.2	13.3	33.3	53.3
	Sat Fat Score	16.7	25.0	58.3	6.7	26.7	66.7
	Fruit Score	50.0	8.3	41.7	40.0	6.7	53.3
	Vegetable Score	29.2	25.0	45.8	40.0	26.7	33.3
	Grains Score	25.0	41.7	33.3	26.7	40.0	33.3
	Cholesterol Score	16.7	12.5	70.8	6.7	6.7	86.7
	Calcium Score	41.7	37.5	20.8	46.7	33.3	20.0
	Iron Score	4.2	12.5	83.3	0.0	20.0	80.0
	Moderation Score	**0**	**2.5**	**5**	**0**	**2.5**	**5**
	Sodium	25.0	20.8	54.2	20.0	26.7	53.3
	Alcohol	0.0	4.2	95.8	0.0	0.0	100.0
	Moderation Total*	**0** 0.0	**2.5-5** 25.0	**7.5-10** 75.0	**0** 0.0	**2.5-5** 20.0	**7.5-10** 80.0
	Diversity Score	**0**	**1.25**	**2.5**	**0**	**1.25**	**2.5**
	Fiber	37.5	29.2	33.3	53.3	33.3	13.3
	Vitamin A	25.0	20.8	54.2	20.0	13.3	66.7
	Vitamin C	16.7	8.3	75.0	13.3	26.7	60.0
	Protein	4.2	50.0	45.8	20.0	40.0	40.0
	Diversity Total*	**0-2.5** 16.7	**3.75-6.25** 25	**7.5-10** 58.3	**0-2.5** 20.0	**3.75-6.25** 40.0	**7.5-10** 40.0

Time and Treatment Frequencies (%)							
		Baseline			**18 Months**		
		0 points	**5 points**	**10 points**	**0 points**	**5 points**	**10 points**
Diet	**Fat Score**	31.8	40.9	27.3	26.7	40.0	33.3
	Sat Fat Score	31.8	31.8	36.4	33.3	26.7	40.0
	Fruit Score	40.9	27.3	31.8	53.3	13.3	33.3
	Vegetable Score	27.3	27.3	45.5	26.7	13.3	60.0
	Grains Score	31.8	36.4	31.8	13.3	66.7	20.0
	Cholesterol Score	22.7	9.1	68.2	33.3	20.0	46.7
	Calcium Score	40.9	40.9	18.2	53.3	33.3	13.3
	Iron Score	0.0	18.2	81.8	0.0	6.7	93.3
	Moderation Score	**0**	**2.5**	**5**	**0**	**2.5**	**5**
	Sodium	31.8	31.8	36.4	20.0	26.7	53.3
	Alcohol	0.0	4.5	95.5	0.0	20.0	80.0
	Moderation Total*	**0**	**2.5-5**	**7.5-10**	**0**	**2.5-5**	**7.5-10**
		0.0	31.8	68.2	0.0	26.7	73.3
	Diversity Score	**0**	**1.25**	**2.5**	**0**	**1.25**	**2.5**
	Fiber	27.3	59.1	13.6	26.7	66.7	6.7
	Vitamin A	36.4	22.7	40.9	13.3	26.7	60.0
	Vitamin C	31.8	13.6	54.5	26.7	20.0	53.3
	Protein	9.1	45.5	45.5	6.7	60.0	33.3
	Diversity Total*	**0-2.5**	**3.75-6.25**	**7.5-10**	**0-2.5**	**3.75-6.25**	**7.5-10**
		18.2	45.4	36.4	26.7	20.0	53.3

Time and Treatment Frequencies (%)							
		Baseline			**18 Months**		
		0 points	**5 points**	**10 points**	**0 points**	**5 points**	**10 points**
Exercise	**Fat Score**	28.6	23.8	47.6	25.0	25.0	50.0
	Sat Fat Score	19.0	23.8	57.1	18.8	31.3	50.0
	Fruit Score	57.1	14.3	28.6	37.5	43.8	18.8
	Vegetable Score	38.1	38.1	23.8	18.8	18.8	62.5
	Grains Score	4.8	33.3	61.9	31.3	37.5	31.3
	Cholesterol Score	33.3	23.8	42.9	12.5	6.3	81.3
	Calcium Score	38.1	38.1	23.8	37.5	56.3	6.3
	Iron Score	0.0	0.0	100.0	0.0	12.5	87.5
	Moderation Score	**0**	**2.5**	**5**	**0**	**2.5**	**5**
	Sodium	47.6	47.6	4.8	43.8	25.0	31.3
	Alcohol	4.8	0.0	95.2	12.5	0.0	87.5
	Moderation Total*	**0** 0.0	**2.5-5** 52.4	**7.5-10** 47.6	**0** 6.3	**2.5-5** 43.7	**7.5-10** 50.0
	Diversity Score	**0**	**1.25**	**2.5**	**0**	**1.25**	**2.5**
	Fiber	9.5	57.1	33.3	18.8	68.8	12.5
	Vitamin A	9.5	14.3	76.2	6.3	18.8	75.0
	Vitamin C	28.6	9.5	61.9	6.3	37.5	56.3
	Protein	0.0	23.8	76.2	0.0	50.0	50.0
	Diversity Total*	**0-2.5** 4.8	**3.75-6.25** 33.3	**7.5-10** 61.9	**0-2.5** 6.3	**3.75-6.25** 37.5	**7.5-10** 56.2

Time and Treatment Frequencies (%)							
		Baseline			**18 Months**		
		0 points	**5 points**	**10 points**	**0 points**	**5 points**	**10 points**
Diet and Exercise	**Fat Score**	25.0	30.0	45.0	6.7	46.7	46.7
	Sat Fat Score	20.0	15.0	65.0	26.7	6.7	66.7
	Fruit Score	40.0	30.0	30.0	20.0	46.7	33.3
	Vegetable Score	15.0	30.0	55.0	0.0	40.0	60.0
	Grains Score	15.0	40.0	45.0	13.3	73.3	13.3
	Cholesterol Score	15.0	10.0	75.0	6.7	0.0	93.3
	Calcium Score	35.0	40.0	25.0	53.3	46.7	0.0
	Iron Score	0.0	15.0	85.0	0.0	6.7	93.3
	Moderation Score	**0**	**2.5**	**5**	**0**	**2.5**	**5**
	Sodium	30.0	35.0	35.0	20.0	33.3	46.7
	Alcohol	0.0	5.0	95.0	0.0	0.0	100.0
	Moderation Total*	**0**	**2.5-5**	**7.5-10**	**0**	**2.5-5**	**7.5-10**
		0.0	35.0	65.0	0.0	20.0	80.0
	Diversity Score	**0**	**1.25**	**2.5**	**0**	**1.25**	**2.5**
	Fiber	30.0	40.0	30.0	6.7	53.3	40.0
	Vitamin A	20.0	20.0	60.0	6.7	6.7	86.7
	Vitamin C	10.0	20.0	70.0	6.7	20.0	73.3
	Protein	5.0	35.0	60.0	6.7	46.7	46.7
	Diversity Total*	**0-2.5**	**3.75-6.25**	**7.5-10**	**0-2.5**	**3.75-6.25**	**7.5-10**
		10.0	35.0	55.0	6.7	13.3	80.0

*Due to the assignment of points in the subsections of the moderation and diversity score, possible values in 2.5 increments and 1.25 increments from 0 to 10, respectively. Ranges were then established for the data summary in this table.

SCHOLASTIC VITA

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Education

- Master of Science, Health and Exercise Science, Wake Forest University, Winston Salem, NC, to be completed: May 2002. Thesis: Diet Quality in Older, Obese Adults. Advisor: Dr. Gary D. Miller, RD.

- Bachelor of Science in Public Health, Concentration: Nutrition. University of North Carolina, Chapel Hill, NC, May, 1999.

- UNC Summer Study Abroad, Lorenzo de Medici, Art Institute of Florence, Florence, Italy, June, 1997.

- Classes toward bachelor's, Lenoir Rhyne College, Hickory, NC, June 1996 and July 1997.

Relevant Professional Experience

- Graduate Teaching Assistant, Wake Forest University, Winston Salem, NC. Department of Health and Exercise Science, 8/00-5/02. Taught HES 101, a basic health and exercise class for freshman undergraduates. Topics taught include cardiovascular fitness, muscular strength and endurance, body composition, and muscular flexibility.

- Graduate Teaching Assistant, Wake Forest University, Winston Salem, NC. Department of Health and Exercise Science, 8/01-5/02. Assisted in teaching of HES Assessments Lab, a general lab for HES major undergraduates. Topics covered in lab include, pulmonary function testing, body composition assessment, muscular strength assessment, basic ECG interpretation, and GXT Testing.

- Wake Forest University Cardiac Rehabilitation Program Intern, Wake Forest University, Winston Salem, NC, 8/00-5/02. Program and exercise leader for maintenance phase of program.

- Wake Forest University Cardiac Rehabilitation Program Lecturer, Wake Forest University, Winston Salem, NC, 8/01-5/02 (quarterly lecture). "Risk Factors for Coronary Artery Disease."

- Research Assistant for CHAMP Research Study, Wake Forest University, Winston Salem, NC. Department of Health and Exercise Science, 1/02-5/02. Duties include reviewing participant files and analyzing diet recalls using Food Processor.

- Research Assistant for ADAPT Research Study, Wake Forest University, Winston Salem, NC. Department of Health and Exercise Science, 6/01-11/01. Duties included performing follow-up testing for participants which included reviewing informed consents, conducting the 6-minute walk, and conducting the stair climb. Also entered and analyzed diet recalls using Food Processor.

- WIC Nutritionist, Iredell County Health Department, Statesville, NC, 7/99-6/00. Duties included determining medical/nutritional risk factors for people applying for WIC and assessing the eligibility of each applicant. Developed care plans for nutrition counseling based on the need of each applicant. Performed nutritional assessments of pregnant women and determined WIC eligibility in prenatal clinic.

- Student assistant for DASH Research Study, Sarah W. Stedman Center for Nutritional Studies at Duke Center for Living, 1/99-5/99. Duties included weighing participants each day upon arrival, delivering meals to participants, preparing snacks for participants to take home, and preparing food items for meals.

Grant Awards

- Project Title: Reducing Breast Cancer Risk in African American Women. American College of Sports Medicine, August 2001, $2,250.

Conference Presentations

- G.E. Austin, G.D. Miller, K. Meyer, P.H. Brubaker (FAACVPR), W.J. Rejeski. Nutrient Intake and the Effect of a Nutrition Education Program in Older Adults with Cardiovascular Disease. Submitted for presentation at American Association of Cardiovascular and Pulmonary Rehabilitation Conference, 9/01. Conference cancelled.

- G.E. Austin, G.D. Miller, K. Meyer, P.H. Brubaker, W.J. Rejeski. Nutrient Intake and the Effect of a Nutrition Education Program in Older Adults with Cardiovascular Disease. Presented at Southeast American College of Sports Medicine Conference, Atlanta, GA, 2/02.

- G.E. Austin, G.D. Miller, W.J. Rejeski, T.P. Morgan, S.P. Messier (FACSM). Relationships Between Nutrient Intakes and Physical Function in Older Adults with Knee Osteoarthritis. To be presented at National American College of Sports Medicine conference, St. Louis, Missouri, 6/02

Affiliations and Certifications

- Member American Dietetics Association, 1999–present.

- Member North Carolina Public Health Association, 2000.

- Member American College of Sports Medicine, 2000-present.

- Member American Association of Cardiovascular and Pulmonary Rehabilitation, 2001-2002.

- Certified Basic Life Support, 1999-present.

- Certified ACLS, 2002-2004