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Nutrition knowledge of young adults

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INTRODUCTION

One of the paramount goals of education at any level is to develop an informed population. Provision of nutrition education was a major recommendation of the White House Conference on Food, Nutrition and Health (1970). Recommendation No. 6 set the stage for a curriculum in nutrition education.

> Throughout his life every person should be able to make decisions on his choices of food based on an understanding of his needs as determined by: (1) his physiological state and physical activities, (2) his knowledge of the nutrient composition of plant, animal and formulated foods in his environment, (3) his ability to distinguish between truth and distortion in relation to foods, nutrition and health, (4) his personal likes and cultural background, and (5) his ability to use his available resources whatever they may be (White House Conference on Food, Nutrition and Health, 1970, p. 150).

If the goal for nutrition education is to enable individuals to gain understanding and skills which are necessary to provide and protect their nutritional well-being through the choices of food they make, objectives for nutrition education must include stimulation of public understanding and access to current information about nutritional well-being, and evaluations made of the public's knowledge of nutrition must include a determination of the ability to apply nutrition concepts (Ullrich, 1979). Application of nutrition knowledge was considered by Pye (1976) to be an underlying responsibility of nutrition education.

A review of the nutrition information in the form of concepts, generalizations, behavioral objectives, and competencies considered essential for various audiences showed diversity of expectations for different groups. An effort was made in the current study to identify the common information needed by different adult groups, i.e., students, teachers, Expanded Food and Nutrition Education Program (EFNEP) aides, and parents. One of the objectives of this study was to identify a framework of nutrition generalizations and supporting facts essential for adults.

A second objective was to develop a nutrition knowledge questionnaire based on behavioral objectives derived from the generalizations appropriate for young adults. An assessment instrument directly applicable to the several audiences addressed by the present study was not available. However, information about the processes by which various instruments were developed provided guidance for the development of the nutrition knowledge questionnaire. University students who had completed an introductory nutrition course served as the standardization group.

A third objective was to test the knowledge of nutrition of other groups of adults (college students, student nurses, EFNEP aides, teacher educators, parents, participants in weight control groups). In the current study, subjects in Iowa were tested. In later studies, knowledge of adults from other areas of the country could be assessed.

REVIEW OF LITERATURE

The purpose of this research was to identify generalizations and supporting facts in nutrition, to construct a nutrition knowledge instrument, and to assess nutrition knowledge of selected groups of adults in Iowa. Included were college students, student nurses, Expanded Food and Nutrition Program (EFNEP) aides, parents of young children, teachers, and participants in weight control groups. The review of literature will focus on nutrition content which has been identified as important for various groups, preparation of tests assessing knowledge of nutrition and results of nutrition knowledge testing of groups of people who have or have not received nutrition instruction.

Reported test information (content, number and type of items, reliability coefficients) and results of testing (information regarding subjects' mean score, standard deviation, range of scores) will be made for groups including parents, students of different ages with career interests related to health or nutrition, health practitioners and teacher educators. A chart of the compiled information to aid in comparison of tests and of nutrition knowledge of the various groups of subjects is given in Appendix A.

Nutrition Generalizations and Facts

The content identified in the area of nutrition by various investigators and stated in the form of concepts, generalizations, behavioral objectives or competencies has formed the basis for nutrition instruction and for knowledge testing of various groups. Each reported compilation differs somewhat from others. An attempt will be made to relate important aspects of the various compilations reviewed.

A subcommittee of the Interagency Committee on Nutrition Education formulated basic concepts of nutrition expressed in nontechnical language (Hill, 1966). From 23 statements, the following 4 main concepts evolved (Leverton, 1968, p. 29).

1. Nutrition is the food you eat and how the body uses it.

    **We eat food to live, to grow, to keep healthy and well, and to get energy for work and play.

This concept gave a dynamic definition of nutrition and outlined the scope of the subject. It generalized the knowledge of the relation of food to health.

2. Food is made up of different nutrients needed for growth and health.

    **All nutrients needed by the body are available through food.

    **Many kinds and combinations of food can lead to a well-balanced diet.

    **No food, by itself, has all the nutrients needed for full growth and health.

    **Each nutrient has specific uses in the body.

    **Most nutrients do their best work in the body when teamed with other nutrients.

The composition of food, its nutritive value, the flexibility in choice of diet and the nutrient needs of the body were represented. There have been translations of nutrient needs into flexible patterns of food selection.

3. All persons, throughout life, have need for the same nutrients, but in varying amounts.

   **The amounts of nutrients needed are influenced by age, sex, size, activity, and state of health.

   **Suggestions for the kinds and amounts of food needed are made by trained scientists.

This concept focused on the Recommended Dietary Allowances (RDA) of the Food and Nutrition Board of the National Academy of Sciences--National Research Council which are research-based, quantitative estimations of recommendations for daily nutrient intakes for healthy people of different age, sex, size, and activity.

4. The way food is handled influences the amount of nutrients in food, its safety, appearance, and taste.

   **Handling means everything that happens to food while it is being grown, processed, stored, and prepared for eating.

This concept focused on eating quality and nutrient retention at every stage of food handling.

The basic concepts for nutrition education developed by the Interagency Committee on Nutrition Education were used and expanded in the proposed conceptual framework for nutrition teaching in elementary and high schools recommended by the White House Conference on Food, Nutrition and Health (1970, p. 151).

1. Nutrition is the process by which food and other substances become you. The food we eat enables us to live, to grow, to keep healthy and well, and to get energy for work and play.

2. Food is made of certain chemical substances that work together and interact with body chemicals to serve the needs of the body.

   a. Each nutrient has specific uses in the body.
   b. For the healthful individual the nutrients needed by the body are usually available through food.
   c. Many kinds and combinations of food can lead to a well-balanced diet.
   d. No natural food, by itself, has all the nutrients needed for full growth and health.

3. The way a food is handled influences the amount of nutrients in the food, its safety, appearance, taste, and cost; handling means everything that happens to food while it is being grown, processed, stored, and prepared for eating.

4. All persons, throughout life, have need for about the same nutrients, but in varying amounts.

   a. The amounts needed are influenced by age, sex, size, activity, specific conditions of growth, and state of health, altered somewhat by environmental stress.
   b. Suggestions for kinds and needed amounts of nutrients are made by scientists who continuously revise the suggestions in the light of the findings of new research.
   c. A daily food guide is helpful in translating the technical information into terms of everyday foods suitable for individuals and families.

5. Food use relates to the cultural, social, economic, and psychological aspects of living as well as to the physiological.

   a. Food is culturally defined.
   b. Food selection is an individual act but it is usually influenced by social and cultural sanctions.
   c. Food can be chosen so as to fulfill physiological needs and at the same time satisfy social, cultural and psychological wants.
   d. Attitudes toward food are a culmination of many experiences, past and present.

6. The nutrients, singly and in combinations of chemical substances simulating natural foods, are available in the market; these may vary widely in usefulness, safety of use and economy.

7. Foods play an important role in the physical and psychological health of a society or a nation just as it does for the individual and the family.

   a. The maintenance of good nutrition for the larger units of society involves many matters of public concern.
   b. Nutrition knowledge and social consciousness enable citizens to participate intelligently in the adoption of public policy affecting the nutrition of people around the world.

Concepts reported by the Interagency Committee (Leverton, 1968) focused primarily on physiological aspects of nutrition, i.e., the body utilizes a combination of nutrients from foods for functioning; needs for each nutrient vary; and energy is needed for work and play. The influence of food handling on eating quality and nutrient content of food was emphasized also. The conceptual framework recommended by the White House Conference on Food, Nutrition and Health (1970) went beyond concepts formulated by the Interagency Committee into the areas of social, cultural, economic, and psychological influences on food selection. Nutrient supplements also were considered.

The Nutrition Education and Training (NET) Program of the California State Department of Education published minimum proficiency levels for nutrition education (preschool through grade 12) in California schools (Nutrition Education and Training Program, 1979). Standards of performance were noted for five age groups. Topic coverage included food choices, factors influencing food choices, food-related careers, consumer competencies, and food handling. Nutrient sources, functions and varying needs for individuals, use of food by the body, and energy sources and needs were included. Food handling, sociopsychological influences on food selection, and consumer use of information on nutrition, cost and food quality in food choices were included also. The Basic Four Food Group classification was used as a guide for food selection for younger children and foods in school lunches were related to nutrients supplied for students in upper elementary grades.

Pattison, Barbour and Eppright (1957) formulated 18 generalizations to use in teaching nutrition. The first four generalizations related to the ways in which nutrition may affect health characteristics and performance of an individual. Eleven generalizations dealt with ways of assuring good nutrition. Included were nutrient functions, food selection to meet nutrient needs, food handling, budgeting, distribution of foods in meals and snacks, supplementing food if needed, good attitudes toward nutrition, assuming responsibility for nutrition, and the capability to discriminate between nutrition fact and fallacy. The final three generalizations indicated ways of evaluating nutritional status of the individual.

Ombwara (1972) identified concepts and generalizations appropriate for youth ages 8-11 in EFNEP. Generalizations were prepared in the content areas of nutrition and health, nutrient functions and sources, nutrient needs of various persons, influences on nutrient needs, food selection based on a food classification system, supplements, energy needs, influences on food habits, and food handling.

Knudtson (1972) formulated general statements in nutrition considered important for fifth and sixth grade teachers. Twenty-seven statements were judged by experts as important. Content of the 10 most important statements included food as a source of nutrients, nutrient functions, effects of inadequate consumption of nutrients, factors influencing the amount of nutrients needed by the body, classification of foods for food selection, and the use of food by the body. Included in the second most important set of statements were effects of food handling on nutrient retention, the relationship between nutrition and appearance, energy balance, "health foods," malnutrition, and economic, psychological and sociological influences on food choices.

Hardinger (1974) stated objectives for seventh graders in home economics classes. Content areas included nutrition and health, food selection, serving sizes, nutrient composition of foods, nutrient functions, energy, careers, cultural and sociological influences on food choices, snacks, increase in nutrient needs during growth, and food preparation, safety and sanitation.

Nutrition objectives for high school boys were identified by Dillon (1972). The objectives included recognition of responsibility for nutritional status, acceptance of rights and responsibilities as a consumer of foods, awareness of problems related to world use of food resources and possible solutions, comprehension of basic concepts of nutrition as they pertain to health, development of skill in meeting nutrient needs and in purchase and preparation of foods, examination of potential careers for men related to food industry and nutrition, and evaluation of mass media information concerning food, nutrition and food-related equipment.

The Iowa Guide for Teaching Food Use and Nutrition Education (Iowa Department of Public Instruction, 1978) in high school identified seven competencies in the areas of physical, social, cultural, and psychological aspects of food, twenty in the area of consumer aspects, and nineteen in the area of food preparation and management. Included in the first category were recognition of nutrient functions and food properties which influence acceptance. Food patterns were emphasized as well as nutritional needs of persons of different ages and factors which determine how an individual makes food choices. Social and emotional aspects of food as a form of nonverbal communication and the influence of level of calorie intake on health were also included.

Those competencies listed in the category of consumer aspects included analysis of information on product labels, purchasing techniques, advertising, economic factors, legislation dealing with customer protection, food-related markets, use and care of equipment, and conservation of resources. The ability to use food guides to select food products for different income levels, and to use knowledge of food additives in food selection and evaluation also were listed.

The third area, that of food preparation and management, included identification of methods of food selection and preparation which maintained nutritive quality of food and use of work practices in management, resource use, sanitation, safety, meal planning, food preparation, and storage.

The prime objective of a study directed by Strong (U.S. Department of Health, Education and Welfare, Office of Education, 1968) was to elucidate concepts and generalizations upon which college and university teaching of foods and nutrition is structured. The definitions used in this dissertation for concept and generalization were taken from that study:

> concept--a key idea central to mastery of a field, usually expressed by words or phrases.
> generalization--a complex thought that expresses an underlying truth, has an element of universality, and usually indicates relationships between or among concepts.

Three sections included food materials, biological aspects of human nutrition, and human behavior in relation to food, respectively. In the section related to food materials, one of the eight topic areas was changes in the nutritive value of foods during storage, processing and preparation. The main concepts related to biological aspects of human nutrition were organized under five topics. Included were biological needs for nutrients, significance of nutrients in meeting biological needs, nutrient requirements and standards, and foods as sources of nutrients. Included in the last topic area were factors affecting nutritive value of foods.

The third section, human behavior in relation to food, included human foodways, i.e., the uniformities and diversities of man's activities in the getting, selecting, manipulating and eating of food;

the origin and development of human foodways, individuality in food behavior, and food behavior and human well-being.

The concepts and generalizations prepared by the American Home Economics Association (1967) showed the significance of food as related to cultural and socioeconomic influences, to nutrition, and to physiological and psychological satisfactions. Included in the first category (cultural and socioeconomic influences) were eight generalizations related to food habits and customs, adequacy of the food supply, distribution of food, and the role of food as a socializer.

Thirteen generalizations were included under the heading of the significance of food as related to nutrition. Function and sources of nutrients were noted as well as the indication that there is an optimum range of nutrient intakes for health. A specific generalization related inadequate, excessive or imbalanced intakes of nutrients to health. Use of food by the body was included as well as a generalization dealing with energy needs and provision. Other generalizations were that adequate nutrient intake could be achieved with many combinations of foods and that food selection to meet nutrient needs must be learned.

The 10 generalizations in the area of the significance of foods as related to physiological and psychological satisfactions included relationships between food selection and prior experiences with food, hunger, stress, and factors influencing food habits and preferences.

Competencies needed by home economics teachers were identified at a national workshop jointly sponsored by the American Home Economics Association, American Vocational Association, Home Economics Education

Association, and U.S. Office of Education. The 71 participants met at Kansas City in 1977. The workshop findings, published in Competencies for Home Economics Teachers (Home Economics Teacher Educators, 1978), included competencies which related to the need for individuals to make decisions about food choices based on their physiological state and activities, knowledge of food composition, cultural influences, food preferences, ability to distinguish between truth and distortion in food, nutrition and health, and the ability to use available resources.

Four competencies for the topic of the significance of food included interpretation of the significance of food as related to cultural and socioeconomic influences, interpretation of nutrition and its relationship to the well-being of an individual, identification of the composition of food and its function through the life cycle, and interpretation of the significance of food practices as related to psychological and physiological satisfactions. Other topics related to nutrition and food management were the nature of food, provision of food and occupations related to nutrition and food.

Ninety-seven of the competency statements that were prepared by Ofei (1978) in 14 content areas were judged important for satisfactory personal and family living for older adolescents. Content areas included in the category nutrition and health were the significance of food, nutrient sources, nutrient requirements, and food safety. In the category of food management, competencies were listed under topic headings of meal planning, meal preparation, food service, home food preservation, food storage, and safety and sanitation in the kitchen.

Food habits, consumer behavior, including food selection and marketing, and careers were the other categories noted.

Ikeda (1975) investigated nutrition information needs of 128 homemakers in the California EFNEP. The greatest need was found to be in the area of food shopping and prices, food preparation, and meal planning to meet nutritional needs within food budgets. The second general area considered important consisted of an understanding of the best foods for health of family members and of how nutrients from food affect the body. The third area of importance was weight control; safety and wholesomeness of foods ranked as the fourth area of importance.

Gillespie (1978) stated behavioral objectives for a nutrition program that was conducted for parents of young children. Included were recognition that Recommended Dietary Allowances are recommendations that may change as new information becomes available, that the amounts of nutrients needed by family members vary, that increasing activity increases energy needs, that knowledge of food composition helps in food selection, that good nutrition does not necessarily mean spending more money for food, and that many different eating patterns can still result in a nutritionally adequate diet. Other objectives included recognition that there can be substitutions or exchanges of one food for another, that there is a need for variety of foods in the diet, that excess fat and energy intakes should be of concern, and that proper snacks can make a positive contribution to intake.

Responsibility for their own food intake and recognition of nutrition authorities were also considered important for parents. There should be recognition that nutritional deficiencies may not be apparent immediately; that there is a relationship between nutrition and health, and between nutrition and heart disease; that all nutrients are needed by the body; and that excesses of nutrients may be harmful or wasteful. The concept of risk/benefit also was included.

Linn (1972) prepared 17 objectives and 70 generalizations that related to nutrition for extension family food aides. Content areas included were nutrition and health, nutrient functions, nutrient and energy needs for different individuals and at different stages of the life cycle, food composition, food classifications, food handling, and snacks. Attention was focused on physiological aspects of nutrition and foods as nutrient sources. The Basic Four Food Group plan was used as the basis for evaluation of food selection. Very little emphasis was placed on sociopsychological and economic influences on nutrition.

A joint committee of the American Dietetic Association and the National League for Nursing was activated in 1957 to identify major concepts to be developed in the basic nursing curriculum. The understandings and abilities that they considered essential were reported by Newton (1960).

Johnson (1971), project director for a study of nutrition knowledge needs of nurses and integration of nutrition content into the nursing program at Northwest Texas Hospital School of Nursing, developed a questionnaire to obtain information about nutrition knowledge needs of nurses to meet their job responsibilities. From the responses of nurses and from information available in nutrition textbooks, cognitive objectives for normal nutrition were formulated. These objectives included application of principles of normal nutrition in diet selection, identification of essential nutrients and a description of their function throughout life, knowledge of nutrition and the nutritive value of foods, identification of socioeconomic factors which influence food habits, utilization of reliable sources of information in the area of food and nutrition, discussion of reports of current nutrition research, and evaluation of food misinformation and fad diets. For normal nutrition objectives were similar to those reported by Newton (1960).

Investigators at Pennsylvania State University initiated a School Nutrition Education Curriculum Study (SNECS) to design and implement a nutrition education program (Sherman, Lewis and Guthrie, 1978). One goal was to develop a nutrition curriculum to be taught in grades preschool through 12/adult. The SNECS team was established with members representing the fields of nutrition science, curriculum supervision and development, early childhood education, home economics education, health education, educational psychology, and testing and evaluation.

The first step in development of the curriculum was formulation of educational objectives. These Project Learner Objectives (PLOs) provided a base from which nutrition content was identified. Subsets of skills, knowledge and attitude areas considered crucial to good nutrition decision-making for the high school graduate were considered. This attempt resulted in identification of 15 skills, knowledge and attitude subsets. The expansion of the subsets resulted in 87 PLOs. These PLOs related to five general categories: 1) why nutrients are needed; 2) amounts of nutrients needed; 3) ways of obtaining nutrients; 4) changes in nutritional needs; and 5) ways of studying nutrition.

An instrument was prepared to use in validating and ranking the PLOs (Sherman, Lewis and Guthrie, 1978). Sixty nutrition and education professionals assigned a priority for each PLO on a seven-point scale. From this the number of PLOs was reduced to 54. A second pretest with 52 members of the state dietetic and school food service association resulted in a reduction of PLO items to 40. The refined instrument was distributed to 1,000 members of the Society for Nutrition Education (SNE) for review and priority ranking of the PLOs. Approximately 60% (599) were returned. The respondents were considered representative of the SNE membership since the jobs they held were in the same ratio as those of all members of SNE.

Top-ranked PLOs included analysis of one's own nutrition and food patterns, and knowledge of how to improve dietary intake; a description of the relationship between nutrition and health; an explanation for including a variety of foods in the diet; a critical evaluation of food and nutrition claims; and the selection of an adequate diet for one week considering limited food resources. Next in order were identification of health risks associated with different food patterns, the role of food and nutrients in body functions at different stages in the life cycle, planning a weight control program, and planning a diet when given nutrient composition and cost information.

Barnette and Branca (1978) completed a principal component factor analysis of the results. Four PLOs fell into the category of the relationship between nutrition and health, three in application of scientific and practical information in food selection, six in planning nutritionally adequate meals, three in solution of family and community nutrition problems, three in food, nutrients and body functions, four in social and cultural aspects of food selection, three in identification and solution of global nutrition problems, and three in nutrition as a career. Eleven PLOs with factor loadings of less than 0.50 were listed in a miscellaneous category.

Nutrition and Health Knowledge

An analysis of content coverage for tests of nutrition knowledge that have been reported in the literature is included along with other information reported about nutrition knowledge in Appendix A. Information about the number and type of subjects, number and type of questions, and test results are stated if reported. Each time a mean score was included, the standard deviation is reported if known. Available information will provide some means of comparison for tests that have been prepared and for the nutrition knowledge of various groups of subjects.

Nutrition knowledge of homemakers and parents

In many early studies investigators used open-ended questions to assess nutrition knowledge. Young, Waldner and Berresford (1956) studied nutrition knowledge of homemakers in two upstate New York communities, Rochester and Syracuse. A total of 646 homemakers were interviewed using a 96-item open-ended questionnaire. Questions asked related to basic food groups, food substitutions based on nutrient content and balanced diets.

Replies to the question of what foods should be included in family meals each day were tabulated according to the mention of each of the basic food groups. Meats or meat substitutes and potatoes and other fruits and vegetables were mentioned by nearly all homemakers; milk and milk products by about two-thirds; breads and cereals by slightly over half. Leafy, green or yellow vegetables or vitamin C-rich foods were mentioned by only 15% and 10%, respectively. Only one-third to one-half of the homemakers could give an adequate nutritional reason (a function or a major nutrient for which the food group is known) for including foods from any of the food groups. Forty-three percent of the respondents could give a reason for including meat; one-third a reason for including milk; less than 20% a reason for including bread and cereal; fewer than 10% for including leafy, green or yellow vegetables; and fewer than 5% for vitamin C-rich fruit and vegetables.

Approximately one-fourth of the homemakers could define "balanced diet" in a nutritionally meaningful way. Two-thirds to three-fourths of the homemakers said they had never heard of the basic food group plan of the USDA. Only 10-20% could name any of the food groups in the Basic Seven food plan.

When asked to name foods with some of the same food values to substitute for basic foods in the daily food plan, about one-third knew possible substitutes for milk; and about two-thirds knew meat, fish and poultry substitutes.

Homemakers were asked many other questions including how often basic foods should be served. From responses to all of the questions asked, approximately 25% of the homemakers studied appeared to have a fair understanding of nutrition as it related to feeding their families. They were least able to discriminate between the value of different types of fruits and vegetables. They needed additional knowledge of the nutritional value of bread and cereals and the adult need for milk.

Nutrition knowledge scores were higher for younger, better educated, higher income homemakers than for older, less educated, lower income homemakers. When income and educational influences were segregated by two-way tabulation for any given measure of nutrition knowledge, formal educational attainment was shown to be the important factor. Those homemakers who reported having "studied about what to eat" also had better knowledge by any of the criteria used than those who reported they had not.

In several other studies, open-ended questions were used also. Emmons and Hayes (1973) studied nutrition knowledge of 486 mothers and their 783 children in grades 1-4. Mothers were interviewed by phone to obtain information such as family income, age and educational level of the mother. Data on nutrition knowledge were obtained by asking what foods mothers tried to include in their child's diet each day and why. In the method used to score the answers, credit was given for listing each of the basic food groups and for correctly providing the name of a nutrient or the function of a nutrient in each group. This method was also used to score answers to the questions where children were asked which foods they would choose to make them strong and healthy and why.

Both mothers and their children were asked to provide 24-hour recalls of the child's diet for the same day. In order to determine whether knowledge and practices were related, the nutrition knowledge scores of the mothers and their children were compared to the reports of the child's diet.

Approximately 50% of the mothers worked away from home and about 50% had completed high school; 14% had schooling beyond high school. An attempt was made to determine how the mother viewed the importance of various foods and how often she served them to the child. The child's recall was compared to that of the mother for a day when the child was not in school. The child's recall was also compared to foods considered important as reported by that child. More mothers served foods from the different groups than reported the food groups as being important in their child's diet. Nutrition practices seemed better than nutrition knowledge might indicate for all food groups except vegetables. While 77% to 87% of the mothers said vegetables were important, only 55% to 69% reported vegetables in their child's diet the day of the recall. Thirty-six to 54% of the children reported vegetables in their diets the same day. Fourth graders appeared to agree most with mothers on recall of food intake.

Mothers of 264 children from seventh, eighth and ninth grades in Vermont were tested for nutrition knowledge with a 33-item multiple choice test (Morse, Clayton and Cosgrove, 1967). The test had been developed by Kilander in 1942 and revised in 1957. The test covered a wide range of practical information on nutrition and diet. Mothers (n = 238) completed the knowledge test during a home visit. Fourteen mothers answered from 30 to 32 questions correctly. The lowest number of correct answers was two. The average score was between 20 and 23 correct out of 33 questions. The three most difficult questions related to calculated values of foods, i.e., protein in grams for a person of a given weight, a food with the most calories selected from a choice of four, and the daily range of calories needed by an active high school boy. Other questions often missed dealt with nutrient stability in food processing and nutrient functions in the body. The higher the level of education, the better was the knowledge of nutrition. A course in nutrition was beneficial to scores without being related to the level of higher education.

In work reported by Eppright, Fox, Fryer, Lamkin, and Vivian (1970), 2,000 mothers of preschool children in 12 North Central states were interviewed regarding the eating behavior of their children, their knowledge of nutrition and attitudes toward meal planning, food preparation, nutrition, and permissiveness in feeding children.

True-false statements were developed that related to general knowledge of nutrition, food composition, misconceptions about food, and the application of principles of nutrition. Eight highly qualified nutritionists reviewed and scored the questions with the 35 most highly intercorrelated items being selected for the final test. Answers included "true," "false," or "don't know" with provision for one of five degrees of certainty. Mean scores, with a possible range of scores of -280 to +280, were 100 for mothers from open country (n = 420); 93 for those from rural places (n = 160); 94 for mothers from small towns (n = 320); 108 for those mothers from small cities (n = 460); and 77 for those from large cities (n = 640).

Education of the mother was positively correlated with nutrition knowledge. Favorable attitudes toward nutrition on the part of the mothers did not seem to influence the nutritional quality of their children's diets. Increased efforts in nutrition education were needed for all segments of the population, but especially for those living in large cities and those who were poorly educated. Those mothers whose children's diets were classified in the lowest 10% with respect to nutritional quality had low levels of nutrition knowledge and unfavorable attitudes toward meal planning and food preparation.

Numerous other investigators used the questionnaire developed by Eppright and co-workers (1970). Lohse (1968) tested nutrition knowledge of 171 homemakers between the ages of 18 and 25 in Ohio. The tests were scored by assigning numerical values for each answer as follows (Table 1).

Table 1. Score assignments for nutrition knowledge test[a]

Correct Answer	Response	Degree of Certainty 1	2	3	4	5
True (Agree)	T(A)	+8	+5	+3	+2	+1
	F(D)	-8	-5	-3	-2	-1
False (Disagreed)	T(A)	-8	-5	-3	-2	-1
	F(D)	+8	+5	+3	+2	+1

[a]SOURCE: Lohse (1968).

The possible range of scores was from -280 to +280. The mean score on the nutrition knowledge test was 90.5 and the range was -42 to 213. Since the homemakers were able to answer only half (52%) of the nutrition questions correctly, a low level of nutrition knowledge among the young homemakers was assumed. A gradual increase in the level of nutrition knowledge with an increase in both education and income was apparent. In this study community size (same categories as study by Eppright et al. (1970)) had no significant effect on knowledge scores. Most homemakers lived in rural areas. Those homemakers who reportedly had obtained nutrition information from college courses had a mean score more than twice that of all of the homemakers taking the test.

Sims (1976) assessed the nutrition knowledge of mothers of preschool children by means of a true-false test and their knowledge of the Basic Four Food Groups. Mothers of 163 preschool children attending a nursery school program or public health clinic in Indiana were interviewed. Nutrition knowledge was measured using 23 true-false questions designed by Eppright and co-workers (1970). Each mother was also asked to name the foods thought to be necessary for her child each day. Specific responses were evaluated to determine whether the foods named and number of servings corresponded to those in the Four Food Groups guide. In general, the subjects performed well; over 80% named at least three of the Four Food Groups and 75% of the sample answered 15 out of the 23 items correctly on the test. Variables in this study that were highly positively correlated with nutrition knowledge were socioeconomic status, occupation-education, family income, a "Nutrition is Important" attitude, and less authoritarian attitudes toward child-rearing.

In a study by Sims (1978), the nutrition knowledge of 61 lactating women was assessed with an instrument containing 36 true-false and multiple-choice items on general nutrition information, originally used by Sims (1976) and by Grotkowski and Sims (1978). The reliability was maximized by reducing the number of items used for data analysis to 20. The Cronbach alpha internal reliability for the instrument was 0.77.

The attitudes measured were: 1) "Nutrition is important" (six items); 2) "Vitamin supplements are necessary" (four items); 3) "Meal planning is important" (six items); and 4) "Meal preparation is enjoyable" (seven items) (Sims, 1978, p. 148). Scales used were developed by Eppright and co-workers (1970) and by Grotowski and Sims (1978). The Cronbach alpha reliability coefficients for scales used ranged from 0.71 to 0.83. Nutrient data (10 nutrients and energy) from foods was obtained from three 24-hour food records.

Path analysis was used for two competing models to evaluate which model received better empirical support. The technique served as an aid in interpreting causal relationships but was not intended to prove them. The two models were that "knowledge causes attitudes which cause behavior" and "attitudes cause knowledge which causes behavior" (Sims, 1978).

The mothers were fairly knowledgeable about nutrition. The mean score on the 20-item instrument was 74.5%, ranging from 25% to 100% correct. Approximately one-third had scores of at least 90%. The items most frequently missed were related to calcium pills as a milk substitute; whether ascorbic acid was synthesized by the body on exposure to sunlight; whether oranges increase body acidity; and the definition for an amino acid.

The attitude that "nutrition is important" was positively related to the knowledge test score. This agreed with results found by Eppright et al. (1970). The attitude that "meal preparation is enjoyable" correlated with self-evaluation of knowledge about nutrition. The knowledge test scores were significantly correlated with self-evaluation of knowledge. The number of years of education was the variable most closely related to performance on the knowledge test.

The score for nutrition knowledge correlated positively with dietary factors. Those with the highest knowledge scores had iron intakes approximately equal to the Recommended Dietary Allowances. Those with lower knowledge scores had iron intakes that were either very low or very high. Attitudes were not related to dietary behavior except in the case of the attitude that "nutrition is important" and the protein group index. The strength of the relationship was through nutrition knowledge, an intervening variable, rather than being directly related to dietary intake. The path analysis supported the second model, "attitudes cause knowledge which causes behavior."

Eppright and her co-workers (1970), Sims and Morris (1974) and Grotkowski and Sims (1978) found that favorable attitudes toward nutrition ("nutrition is important") are correlated with higher nutrient intakes. Schwartz (1975) accepted the knowledge--attitude--practice model. Carruth, Mangel and Anderson (1977) observed that increased knowledge on the part of Nutrition Education Assistants (NEAs) was not associated with a tendency to seek information. Knowledge in that case was not sufficient to convince people that nutrition is important. Yetley and Roderuck (1980), in analyzing the relative importance of factors influencing nutrition knowledge and health goals, reported that if the symbolic adoption based on evaluation of information was combined with use adoption based on trial acceptance, the importance placed on health and dietary goals would become an intervening variable between nutrition knowledge and food behavior. In their study, the importance placed on health goals was negatively correlated with nutrition knowledge for wives. From their data it was not possible to determine the "correct" ordering of the two variables, although they stated that indirect evidence supported the ordering used in the adoption model where the importance placed on health and dietary goals was an intervening variable between nutrition knowledge and food behavior.

In Yetley's study (1974), nutrition knowledge was assessed using information obtained from correct responses to 11 test items for a survey population of 116 husbands and wives. There was no significant difference between the mean and standard deviation of 5.4 $\pm$2.5 for husbands and 5.9 $\pm$ 2.4 for wives. (Throughout the dissertation the standard deviation, when known, will be included and shown following the mean scores.)

Scores for husbands ranged from zero to 11 and for wives from one to 11. In test preparation, 66 items were evaluated for content validity by faculty members in nutrition and home economic education and pretested with 105 junior college and university students. Content coverage included general nutrition, food composition, application of basic nutrition principles, misconceptions about nutrition, and consumer aspects of nutrition. Table 2 gives the specifications that were used. Cognitive levels were based on the taxonomy by Bloom and his co-workers (1956). The 11 items with discrimination indices of 0.20 to 0.40 were selected for inclusion in the final instrument. Reliability coefficients, calculated by the coefficient alpha formula for the survey population on the 11-item questionnaire, were 0.64 and 0.61 for husbands and wives, respectively.

Social goals, health goals and economic goals were measured. Variables related to nutrition knowledge for both husbands and wives were social class status, educational levels, mastery orientation (extent to which a person believes he/she is in control of own life and future), and nutrition knowledge of the spouse. For both family

Table 2. Table of specifications for nutrition knowledge test[a]

Content	Knowledge	Comprehension	Application	Total
Nutrition, function of nutrients and sources	17	13	3	33
Maintaining nutritive value of foods	13	7	7	27
Nutrient requirements of individuals	10	3	7	20
Synthetic foods	7	3		10
Consumer responsibility and protection	7	3		10
Total	54	29	17	100

[a]SOURCE: Yetley (1974).

members educational level was the most important factor affecting their knowledge of nutrition.

Schwartz (1973, 1975) tested the nutrition knowledge, attitudes and practices of 313 high school graduates in Ohio. The 30-item knowledge questionnaire was adapted from work by Eppright and co-investigators (1970) and related to general knowledge of nutrition concepts, food composition, misconceptions about food, and the application of basic nutrition principles. Responses included a designation of true or false and one of four degrees of certainty. Thirty statements were used to evaluate attitudes toward food and nutrition.

Questionnaires were mailed to young women for whom four years had elapsed since high school graduation. The investigator reported that the findings generally indicated a relatively high understanding of nutrition concepts. The mean score for the 313 respondents was 147.2 out of a possible 210.

Scores were highest on items related to general nutrition concepts and lowest on those related to the need for vitamin supplements, food composition and the relationship of dietary fat to health. Sixty percent or more of the respondents considered that concentrated sweets are required for healthy, active young children each day, that all people should use a low-fat, low-cholesterol diet to prevent heart disease and strokes, and that gelatin desserts are a good source of protein.

More than 50% of the sample thought that vitamin pills were needed by healthy adults, and more than 40% thought that children need vitamin pills for good health. More than 40% of the respondents did not know that dry beans, peas and nuts may serve as alternates for meat, and about 35% thought that chemicals as used to bleach flour are harmful. More than 60% of the subjects knew that skim milk contains similar amounts of minerals and proteins to those found in whole milk.

Scores for knowledge, attitudes, and practices were not significantly different ($p < 0.05$) for graduates who had taken home economics courses in high school than for those who had not. Scores for knowledge were 145 and 149 for those with high school home economics background and those without, respectively. Knowledge scores were higher ($p < 0.05$) for those who attended college ($\bar{x} = 153$; $n = 134$) than those who did not ($\bar{x} = 142$; $n = 179$), but attitudes and practices were not significantly different between those groups. Findings supported the relationship of knowledge with attitudes and attitudes with practices but did not support a direct relationship between nutrition knowledge and practices.

Pearson (1969) evaluated the knowledge of food and nutrition and attitude toward food preparation of 186 wives of a sample of industrial workers in Iowa. Knowledge was measured by means of a series of 17 true-false statements. A cluster of 12 statements resulted in a Spearman-Brown reliability coefficient of 0.52. Using the 12 statements as the basis for scoring, scores ranged from 3 to 23 out of a possible score of 24. The mean score was 13.65. On the average, homemakers were able to answer correctly slightly more than one-half of the statements included in the cluster.

Six statements were answered correctly by fewer than 33% of the subjects. Results from two statements were similar to those found by Schwartz (1973, 1975). Respondents thought that school-age children need vitamin pills to insure good health and that gelatin desserts were a good source of protein. Other statements often answered incorrectly related to which person in a family should have the largest serving of meat, identification of good sources of vitamin C, and evaluation of a meal containing steak, fries, lettuce, and coffee. Nutrition knowledge was positively related to educational variables.

Davis (1971) investigated the relation between nutrition knowledge and dietary intake of groups of adults in Illinois. The conceptual framework of nutrition education as adopted by the White House Conference on Food, Nutrition and Health (1970, p. 151) with the exception of concepts 5 and 7 was used as the basis for the knowledge test. The fifth concept--"food use relates to the cultural, social, economic, and psychological aspects of living as well as to the physiological"--contributed to the construction of a measure of attitudes. Concept 7 was "Foods play an important role in the physical and psychological health of a society or nation just as it does for the individual and the family."

Three groups of 34 subjects were selected who would be expected to have varying levels of nutrition knowledge. The first population was county extension advisors in home economics. A baccalaureate degree in home economics was a minimum requirement for employment. The second population sampled was that of EFNEP program assistants. The third population was that of urban, low-income homemakers who lived in Robert Taylor homes in Chicago.

Two questionnaires were used to accommodate the expected levels of verbal, reading and writing skills of the subjects, as well as their span of interest and ability to handle complex verbal material. Questionnaire I contained 50 items and Questionnaire II 40 items. True-false items were used with one of five degrees of certainty.

Items on the 50-item questionnaire were divided with 12 items testing concept 1 (nutrition as a physiological process), 18 items for concept 2 (foods as nutrient sources), 7 items for concept 3 (food handling), 12 items for concept 4 (nutritional needs through the life cycle), and 1 item relating to concept 6 (nutrient supplements). The simplified instrument maintained the substantive content proportions used in Questionnaire I.

Possible responses to questions included: I know it is true; I think it is true; I don't know whether it is true or false; I think it is false; I know it is false. Possible scores ranged from 50 to 250 for the 50-item questionnaire and from 40 to 200 for the 40-item questionnaire.

Scores of extension advisors on the 50-item Questionnaire I ranged from 151 to 207 with a mean of 183.3 ± 12.1 (mean $\pm$ standard deviation). The 40-item Questionnaire II was completed by program assistants and homemakers. Scores of program assistants ranged from 146 to 173 with a mean of 159.9 $\pm$ 10.4. For homemakers, scores ranged from 116 to 162 with a mean of 144.7 $\pm$ 11.8. The percentage of correct responses to questions was 64%, 70% and 55% for the extension advisors, program assistants and homemakers, respectively. The Kuder-Richardson formula-20 reliability of Questionnaire I was 0.71 and for Questionnaire II was 0.41 for program assistants and 0.81 for homemakers.

Linn (1972) delineated 70 generalizations to use in identifying nutrition concepts held by family food aides in Iowa. Sixteen basic concepts were selected from the generalizations. They were daily food guide, nutrition, vitamins, calories, iron, weight control, protein, fat, nutrients, energy, diet, enrichment, carbohydrates, snacks, calcium, and milk.

An open-ended questionnaire was administered to 14 food aides in Polk County. Seven aides defined one set of eight terms; the other seven aides defined the other eight concepts. Responses were used to help word the objective questionnaire at a level appropriate for family food aides. Some of the answers were used as distracters.

A 59-item, four-option, multiple-choice test was prepared using the basic concepts. Items were reviewed by experts in nutrition and home economics extension. The questionnaire was revised and reduced to 50 items. The revised questionnaire was administered to a group of eight family food aides in Polk County. Wording and item distracters were changed for some items.

Home economists from 19 counties in Iowa administered the refined questionnaire to family food aides. The scores of 150 family food aides who completed the questionnaire ranged from 14 to 48 on the 50-item questionnaire. The mean score was 33.33 ± 6.61. The standard error of measurement on the questionnaire was 2.93 and the Kuder-Richardson formula-20 reliability coefficient was 0.80. Twenty-seven of the items had difficulty indices above 0.70 and three of the items had difficulty indices below 0.30. Some of the items were very easy. Twelve items had discrimination indices below 0.20. Nine items had one or more nonfunctioning distracters.

Ninety percent or more of the aides considered milk essential in the diets of all people; knew that young children need nutrients for growth; that citrus fruit contains vitamin C; and that peanut butter is a substitute for meat for protein value. More than 85% knew that nutrients have specific functions; that fruits and vegetables should be cut in large pieces for cooking to conserve nutrients; that weight control means maintaining desired body weight; and that milk is important to make bones strong.

The importance of including a variety of foods in the diet and obtaining foods which meet criteria for the Daily Food Guide were concepts that more than 80% of the subjects held. That percentage knew also that water is an important part of cells and that energy needs differ for individuals and decline with age.

Seventy-five percent or more knew the minimum numbers of servings for fruits and vegetables according to the Daily Food Guide, nutrients in foods in the guide, the chief functions and classes of carbohydrates, and nutrients added in enrichment of breads and cereals.

Many (55%) thought that vitamin C was the sunshine vitamin. Other misconceptions were that fat is a part of carbohydrates, iron is needed to strengthen the walls of blood vessels, and vitamin A is easily destroyed by heat.

Significant differences in scores were found with age, education and home economics background. The length of time employed was not related to test scores.

Préfontaine (1975) developed a 25-item nutrition test based on 15 goals which related to the concepts presented by the Interagency Committee on Nutrition Education (ICNE) (Leverton, 1968). A team of experts, consisting of two university professors of nutrition, two professionals in adult education, and four graduate students in nutrition, examined nutrition goals and 100 test items. The readability of the items and the time required to answer them were checked with different groups of adults: 12 homemakers, 12 secretaries, 12 librarians, 14 adults attending night classes, and 23 freshman students. Seventy-four items were pretested with 111 women students in waiting rooms of beauty parlors and 93 adults attending night classes. A Kuder-Richardson formula-20 reliability coefficient of 0.81 was achieved with the 30 items that were retained.

The questionnaire was administered to 169 home economics teachers, 668 health science students, 127 mothers of infants, and 208 immigrants. All home economics teachers had previous training in nutrition, 19% of the health science students had taken a course in nutrition, and 34% of the mothers identified past learning experiences in nutrition at different levels.

The reliability of the 25 items finally used was 0.68 for home economics teachers, 0.64 for the health science students, 0.67 for the mothers, and 0.69 for the immigrants. The highest mean score was 19.6 for the home economics teachers; the health science students had a mean score of 15.7; and the mothers and immigrants obtained mean scores of 12.5 and 10.2, respectively. The ideal mean score (a point midway between the maximum possible score and the expected chance score) for all groups was 15.9.

Of the health science students, those who reported previous courses in nutrition obtained higher scores than those without previous courses ($p < 0.001$). Those mothers reporting previous nutrition work obtained higher scores than those without previous nutrition instruction ($p < 0.10$). When the number of years of schooling was held constant, the influence of previous nutrition courses had a marked effect on test scores.

A study was conducted in a Beirut, Lebanon, suburb to investigate the relationships between formal education of 60 mothers selected from 500 families and their nutrition knowledge, practices and the growth pattern of their children (Al-Isi, Kanawati and McLaren, 1975). The nutrition knowledge test consisted of 50 questions with possible responses of "yes," "no," or "do not know." Mothers were asked, for example, to compare nutritional values of fresh and powdered milk; to assess the value of milk in providing nutrients needed by a young child; to decide whether excess food can be stored as muscle; and how the food intake for men and women would likely compare.

The reliability coefficient of 0.86 was calculated using the split-half method and corrected using the Spearman-Brown formula.

Mean scores for the nutrition knowledge test were reported based on a total possible score of 100. The mean score was significantly higher ($p < 0.01$) for mothers with 7-9 years of schooling (50.7 ± 5.2) than for those with no schooling (30.3 ± 6.5); 1-3 years of schooling (33.3 ± 6.1); and 5 years of schooling (37.9 ± 6.0). Nutrition practices varied in much the same way.

In looking at performance related to specific questions, those that were answered similarly by all groups and were easy for most subjects were related to functions of nutrients in milk, similarity of nutritional value of rice and bread, and the fact that weight can be lost if less food than what is needed is eaten. The difficult questions that were answered similarly by all groups related to ways of gaining weight and quality of protein in meat and eggs.

Nutrition practices were evaluated with a 25-item questionnaire. Topic areas included: sources of food, food budget, food selection and preparation, and infant feeding. The growth pattern of two children under five years of age in each family was evaluated using weight, height, head circumference, and mid-arm circumference measurements.

The investigators felt that the mothers were deficient in knowledge and poor in practices, especially in areas related to infant feeding.

Some positive relationships were found between knowledge, practices and child growth. The Pearson product-moment correlation between knowledge and practice was 0.68, between knowledge and child growth pattern 0.64, and between practice and child growth pattern 0.73. All values were significant ($p < 0.001$). Children in each group were below standard for weight, height and growth patterns. Children whose mothers had 7-9 years of schooling had better growth patterns than other children but were still below the standard.

Two studies were done with large samples of homemakers or food shoppers in 48 of the 50 states. They include studies done by Walker and the U.S. Department of Health, Education and Welfare in 1975.

Walker (1975) prepared a series of 18 statements designed to measure awareness of general nutrition facts as well as specified knowledge about the selection, handling and preparation of food. Three percent of the 2,545 homemakers correctly answered all 18 questions. The mean number of correct responses was 14.5. The high individual totals were based largely on the homemaker's knowledge of handling or storing foods to maintain nutritional value and quality and not on knowledge related to the nutrient content of foods and differing nutrient needs of people depending on age and sex. Many homemakers were not aware that nutrients work best in combination with other nutrients, that food is the only source of energy, or that snacking can upgrade a family's diet.

Another dimension of knowledge was measured when subjects were asked to respond to five daily food plans in terms of nutritional desirability. The percentage of respondents correctly identifying the nutritional desirability of each day's food plan was 66, 47, 71, 16, and 69. Food plans 1, 3 and 5 were considered nutritionally desirable based on the Basic Four Food Group Plan. When asked why a food plan was or was not nutritionally desirable, most respondents commented on numbers of servings of fruits and vegetables in the plan.

Food practices of respondents were also evaluated based on recalls of foods eaten for family members on a weekday and a weekend day. Fifty-five percent of the individuals had diets containing the assortment of foods recommended in the Basic Four Food Group Plan.

Results of this survey indicated that homemakers had a better knowledge of some food and nutrition facts than had been found in many other studies. They also showed some ability to select meals and snacks to meet food group recommendations.

The U.S. Department of Health, Education and Welfare, Public Health Service, Food and Drug Administration (1975) developed a questionnaire to identify nutrition knowledge and attitudes among food shoppers in the United States. Fourteen multiple-answer questions were developed regarding nutrient content of foods, nutrient functions in the body, and food substitutions.

Questions were asked about the nutrients protein, fat, carbohydrate, vitamin A, thiamin, riboflavin, vitamin C, calcium, and iron. The questions included (pp. 11-16):

Nutrients easy for the body to get are. . .

Nutrients hard for the body to get are. . .

Nutrients stored by the body are. . .

Milk (Beef, Tomatoes, Enriched Bread) is/are a good source of. . .

The section on foods included the questions (pp. 13-16):

Foods having the same benefits as milk (beef, tomatoes, enriched bread) are fish, rice, oranges, chicken, white potatoes, carrots, eggs, macaroni, pork and beans, broccoli, peanut butter, cottage cheese.

The questions relating to functions of nutrients were (pp. 13-16):

Milk (Beef, Tomatoes, Enriched Bread) is/are important for the eyes, strong bones and teeth, building body tissues, building blood cells, fighting infection, the nervous system, healthy skin.

One hundred food shoppers and eighty-five students in an introductory nutrition class pretested the instrument. Reliability coefficients, as calculated by the Spearman-Brown procedures, were 0.80 for students and 0.77 for shoppers.

The mean score of the 1,664 food shoppers who then completed the test was 69.28 $\pm$ 22.83 with a range of scores from 8 to 115 out of a total possible score of 134. The mean for shoppers ages 18-34 ($n = 659$) was 75.17 (52% correct); for ages 35-49 ($n = 561$) was 71.92 (54% correct); and for ages 50 and over ($n = 433$) was 63.20 (47% correct). Scores from the youngest and oldest groups differed significantly ($p < 0.05$). For those with less than a high school education ($n = 212$) the mean score was 48.18 (36%); for high school graduates ($n = 948$) 68.88 (51%); and for those with a college education ($n = 497$) 81.13 (61%). Significant increases ($p < 0.05$) in knowledge were noted with increasing educational levels. Females ($n = 1,298$) had slightly lower scores than males (n = 366). The mean scores for those groups were 65.03 (49%) and 70.25 (52%), respectively. Scores were grouped in knowledge levels of low (less than 94 points), medium (94 to 107 points) and high (more than 107 points) with approximately one-third of the shoppers in each group.

In addition to determining shoppers' factual knowledge in the nutritional area, respondents were asked a series of questions regarding nutrition beliefs. Results in decreasing order of belief were (U.S. Department of Health, Education and Welfare, 1975):

Do not get a benefit from added vitamins as from natural vitamins (62% believed).

Can stay healthy without eating meat (48%).

Between meal foods are never as good for a person as food at regular meals (40%).

Can get enough nutrition from eating a variety of foods from a supermarket (39%).

By weighing the right amount, a person is properly nourished (24%).

Canned or frozen vegetables are just as nutritious as fresh vegetables you cook (18%).

Get enough nourishment if people just eat what they like (13%).

Any food sold in a supermarket is good for you (9%).

From the results, 51% of all food shoppers were considered "not well informed" about nutrition.

Customers of 14 health food stores located in rural and urban areas of Oahu, Hawaii, were interviewed using an open-ended questionnaire to assess their nutrition knowledge in a study by Anderson and

Standal (1975). Seventy-three males and 67 females participated. Two were under 15 years of age, 23 between 15 and 20, 62 between 21 and 30, 30 between 31 and 50, and 14 over 50 years of age. Only 15 had not completed high school and 90 had some college education. When asked where he/she would go for nutrition information, 45 responded with answers of health food stores, 21 with health food books, 11 with physicians, and only 6 with professional nutritionists. Many participants (114) considered the Food and Drug Administration (FDA) ineffective in regulating the nutritional quality of foods and 119 thought the safety of foods was not controlled.

Respondents were asked to name three foods they ate regularly which they considered to be health foods and to give the health benefits for each food. Respondents were also asked to list foods they avoided, considered harmful and why.

The top rated health foods listed in order were whole grain products, fresh vegetables, granola, fresh fruit, wheat germ nuts, soybeans, brown rice, honey, and yogurt. Foods avoided and considered harmful in rank order included white sugar, processed and canned foods with additives, white flour products, carbonated drinks, meats, MSG, salt, animal fats, chocolate candy, eggs, white rice, and coffee. Reasons were categorized as valid, questionable, and invalid. There were as many questionable and invalid reasons listed for the groups of foods as valid ones. Investigators noted a need for more nutrition education and better preparation for classroom teachers. Elementary teachers in Hawaii were not required to take nutrition in college and home economics teachers were currently required to take only three credits of elementary nutrition.

Grotkowski and Sims (1978) investigated nutrition knowledge, attitudes and dietary practices of 64 persons over 62 years of age who were attending one of the three area senior citizens' groups. Nutrition knowledge was assessed by an instrument containing 25 true-false and multiple-choice items from the research of Eppright et al. (1970), Wang (1971), Harrison, Sanchez and Young (1969), and Dwyer, Fėldman, and Mayer (1970). Inter-item analysis revealed that maximum reliability could be obtained by reducing the number of items to 20. The Cronbach alpha reliability coefficient was 0.80.

Scores on the nutrition knowledge instrument ranged from zero to sixteen. The mean score, 7.2 (36%), indicated a very low level of nutrition knowledge. Approximately 84% of the group replied correctly to fewer than 55% of the questions. Fourteen percent had scores ranging from zero to two, suggesting that they had little knowledge of basic concepts. Six percent of the sample had scores of 15 or 16.

Nutrition knowledge was highly correlated with the attitude that "nutrition is important" and negatively related to misconceptions about weight-reducing diets" and the belief that "food and supplements can be used as medicine" (Grotkowski and Sims, 1978, p. 503). There was a positive association between nutrition knowledge and desirable attitudes toward nutrition.

The association between knowledge of nutrition and intake of nutrients was not sufficiently strong to be statistically significant. The positive relationship between nutrition knowledge and caloric value of the diet ($p < 0.06$) was of interest, since calories were strongly associated with all other nutrients except vitamin A. Significant negative correlations were found between intakes of kilocalories, fat and calcium and misconceptions about weight-control diets. Nutrition knowledge was positively correlated with socioeconomic status and with the attitude that nutrition is important. Nutritional adequacy of the diets was highly related to socioeconomic status and self-evaluation of nutrition knowledge.

Rountree and Tinklin (1975) compared food beliefs and practices of residents in special housing for the elderly with those of nonresidents. Fifty residents of a high-rise apartment complex and 54 nonresident senior citizens were interviewed. Household composition of both populations was approximately 90% single females, 4% single males and 6% couples. About half (52.5%) of the total sample was between 60 and 74 years of age; others were older. Both groups had similar health problems; apartment residents reported less formal education ($p < 0.05$) and lower income ($p < 0.001$) than nonresidents. Thirty percent of the apartment residents and 15% of the nonresidents had no schooling beyond the eighth grade. Incomes of less than $3,000 were reported by 66% of the apartment residents and 30% of the nonresidents.

Knowledge of nutrition was assessed by reactions to 20 three-option, multiple-choice questions on nutrition. Content areas included were functions of nutrients (35%), food sources of nutrients (35%), balanced diets (5%), and energy and weight control (25%) (Rountree and Tinklin, 1975). Nutrition knowledge of both groups was low. More than three-fourths of the respondents answered only 35% of the questions correctly. Differences between knowledge scores on each item between groups were significant ($p < 0.05$) for only a question about the importance of carbohydrate foods in the diet. Forty-two percent of the apartment residents and 61% of the nonresidents knew that carboyhydrates are important for food energy. About 95% of each group knew that a balanced diet includes the Basic Four Food Groups, and that the best way to lose weight is to eat a balanced diet low in calories. Practices were not always related to knowledge.

The nutrition knowledge of 217 Nebraska grocers was evaluated by Stansfield and Fox (1977). Some statements in the questionnaire were taken from surveys done by Petersen and Kies (1972), Krause and Fox (1977) and Vickstrom and Fox (1976). Items emphasized food composition, nature of saturated and polyunsaturated fats, special dietary foods, consumer issues, and general functions of nutrients. Grocers were asked to respond to 36 statements which tested knowledge and 14 statements which reflected attitude by marking one of the following for each item: "strongly agree," "agree," "undecided," "disagree," "strongly disagree." Knowledge scores for the 194 independent grocers ranged from 67 to 151 out of a possible 180 with a mean of 124, whereas the 23 chain store managers' scores ranged from 100 to 148 with a mean of 123.

The questions most commonly missed were related to general food composition, fats, polyunsaturated fatty acids, and general nutrient functions. Grocers were misinformed about the calorie value of meat versus bread and margarine versus butter. Only 13% knew that gelatin is not a source of good quality protein. Thirty-three percent knew that strawberries, cantaloupe, and green peppers are sources of vitamin C. Ninety-seven percent knew that milk and milk products are good sources of calcium. Less than one-half of the grocers could recognize a margarine high in polyunsaturated fatty acids. Thirty percent thought that healthy children require some concentrated sweets for energy needs. Eighty-three percent were aware that not all people need vitamin supplements. Significant correlations existed between nutrition knowledge and education and between nutrition knowledge and attitude ($p < 0.05$).

Nutrition knowledge of elementary, junior high and senior high school students

As indicated earlier, Ombwara (1972) identified concepts and generalizations of food and nutrition for teaching disadvantaged youth ages eight to eleven, in the Expanded Food and Nutrition Education Program in Iowa. Knowledge and comprehension of the concepts were examined with a pictorial test. A knowledge test of 15 multiple-choice items with four options each was prepared.

A 20-item questionnaire was administered to disadvantaged youth ages eight to eleven in 21 counties ($n = 145$). Knowledge scores ranged from 3 to 19 out of 20. The mean score was 11.22 ± 3.69. The standard error of measurement was 1.92; and the Kuder-Richardson formula-20 reliability coefficient was 0.73.

The difficulty index for items ranged from 0.16 to 0.90. Five items had difficulty indices above 0.70 and one had a difficulty index below 0.30. Two items had discrimination indices below 0.20.

Questions that were answered correctly by more than 80% of the respondents were related to food sources of iron, nutritious snack items, and energy needs with different activities. More than 60% of the youth could choose the most nutritious breakfast from a selection, could choose four foods representing each use of the four food groups, and could select foods high in vitamin A.

More than one-half knew good sources of calcium, that bones need calcium, and that foods in the bread and cereal food group must be whole grain or enriched.

Low scores were found for items relating to vitamin A function, energy value of foods, and the choice of the most nutritious dinner and lunch. More than one-fourth of the subjects were unaware of the minimum number of servings recommended for their age groups from each of the Four Food Groups.

Watson (1975) revised the questionnaire prepared by Ombwara (1972). Five items were revised; one item was eliminated; and six items were added, resulting in a final questionnaire of 25 items. The test was reviewed and the instrument converted into a slide-tape presentation. Foods were photographed for the 25 slides which showed four alternative answers to questions. A tape was made of the answers.

The slide-tape presentation was administered to youth ages eight to eleven years in 12 Iowa counties (n = 148). The Kuder-Richardson formula-20 reliability was 0.64. Four items were outside of the 0.30 to 0.70 range of difficulty. Three items did not discriminate positively.

More than 60% of the youth knew good sources of protein, calcium function, servings recommended in the Basic Four Food Groups, and the activity requiring the most energy from a selection of activities. Most subjects were unaware of energy values of foods. More youth seemed to be aware of energy use in activities than food sources of energy. Ombwara (1972) found similar results. Subjects on the two studies had quite different scores on the item recognizing knowledge of minimum numbers of servings from the Basic Four Food Groups recommended for their age group.

Hinton (1962) investigated relationships between factors that could be related to eating behavior and the selection of an adequate diet for 140 12- to 14-year old girls in Iowa. To determine the relation of knowledge of nutrition to eating behavior, a nutrition test was developed. The test was designed to measure the ability of students to recognize nutritionally adequate meals, make substitutions within food groups, evaluate fallacies about food practices, plan good reducing or weight-gaining diets, identify nutrient content of basic foods, and select best buys in food.

The test was given to approximately 100 eighth grade girls to determine clarity and level of difficulty. After revision, the test consisted of 30 multiple-choice and true-false items. Reliability was determined by the split-half method and corrected for length with the Spearman-Brown formula. Reliability coefficients were 0.74, 0.86 and 0.82 for 12-year old, 13-year old and 14-year old girls, respectively. Girls with adequate diets scored higher in knowledge of nutrition than did girls with poor dietary intakes.

Thompson and Schwartz (1977) investigated the nutrition knowledge, attitudes and practices of 366 eighth grade students in Vancouver, British Columbia. Students had received no formal nutrition education by that grade level. The nutrition knowledge test consisted of 20 true-false statements related to knowledge of basic nutrition principles. One of four degrees of certainty was to be designated. Some questions were similar to those used in assessing nutrition knowledge of high school graduates (Schwartz, 1973, 1975). For example, subjects were asked if teenagers need vitamin pills daily and whether dry beans, peas and nuts could be used to replace part of the daily need for meat.

Attitudes were measured with 15 statements which reflected attitudes toward food selection and dietary adequacy and the importance of nutrition with regard to health. A score for nutrition practices was assigned each subject. Scores were based on an evaluation of a 24-hour dietary recall according to criteria in the British Columbia Dairy Foundation's Guide to Good Eating Every Day (McClinton, Milne and Beaton, 1971).

The nutrition knowledge of eighth grade students appeared satisfactory to the investigators. The mean percent score was 66.67 ± 8.91. Students scored highest on items relating health to nutrition and on statements concerning the function of nutrients in the body.

They held misconceptions concerning the need for supplements. Knowledge of nutrient composition of food was another area where more knowledge was needed.

Girls scored higher than boys on the knowledge and attitude tests ($p < 0.05$), and students from the highest socioeconomic levels had significantly higher scores on knowledge and attitude tests ($p < 0.05$). No significant relationship was found between socioeconomic status and dietary practices. No difference was found between the nutrition practices of boys and girls. Significant positive correlations were found for nutrition knowledge and attitudes ($p < 0.05$) and nutrition attitudes and practices ($p < 0.21$). The correlation between nutrition knowledge and practices were not significant.

Nethers (1968) prepared a nutrition knowledge-attitude test for junior high students. The content areas and number of multiple-choice items used to test the content at various cognitive levels are shown in Table 3.

The test was administered to 145 ninth-grade girls in health education classes in Illinois. The students had been introduced to an experimental nutrition unit of a School Health Education Study. The range of scores was 7 to 31 and the mean was 21.48 ± 4.28. The Kuder-Richardson formula-20 reliability was 0.47.

Thirty-two items were selected which were within the accepted 0.10 to 0.90 difficulty range. Nine items were below the 0.20 discrimination index. Item analysis of the 32-item instrument revealed seven distracters were nondistracting to at least two percent of the subjects. Based

Table 3. Test specifications for knowledge-attitude instrument[a]

	Knowledge	Comprehension	Application
1. There is an influence on food choices caused by social, economic and cultural factors.	1	1	
2. Nutritional status influences personal physical, mental and social attainments.	2	1	1
3. Improper food choices cause problems in maintaining proper weight control.	2	4	
4. Lack of some nutrients causes specific diseases.	5	3	
5. Knowledge concerning the four basic food groups is needed for proper food choices.	2	1	2
6. Proper choices among food groups supply all necessary nutritional requirements of the body.	10	1	
7. There are common misconceptions concerning nutritional quackery.	2	1	1
TOTAL	24	12	4

[a]SOURCE: Nethers, 1968, pp. 70, 72.

on the 32 items, the mean score was 17.13 $\pm$ 4.23 and the range was 7 to 28. The Kuder-Richardson formula-20 reliability for 32 items was 0.57. There was a slight positive correlation (0.32) between nutrition knowledge and attitude.

Food and nutrition knowledge statements were administered by Garton and Bass (1974) to 73 junior and senior high school students from the Tennessee School for the Deaf and 93 junior and senior high school students with adequate hearing from the Knoxville schools. The 53 true-false statements were modified from a food information survey prepared by Wang (1971). Possible responses to statements included "agree," "disagree" and "don't know."

A comparison of deaf students and students who could hear indicated average knowledge scores of 47% and 57%, respectively ($p < 0.05$). Scores for incorrect answers were 28% for students with adequate hearing and 22% for the deaf, with deaf students marking "don't know" for more of the answers (25% for deaf, 11% for hearing). Deaf students answered certain questions concerning food safety, storage and energy content correctly more frequently than hearing students. Erroneous information may have been more available through contacts that children had who were able to hear. Statements related to calorie values of butter versus margarine and the special health-giving properties of some foods were marked incorrectly by at least 50% of both groups. This suggests that both groups were misled. Deaf students marked "don't know" for a question involving costs of foods. This response might reflect less contact with buying situations for the deaf students than that found for students with adequate hearing.

Jacklin (1964) studied the depth of understanding of food and nutrition principles of 109 seventh and eighth grade girls and 250 tenth grade students in New York. Depth of understanding involved the levels of knowledge, ability to use principles and facts in solving routine problems, and ability to solve novel problems requiring scientific reasoning.

Food and nutrition principles on which multiple-choice items were based were taken from foods and general homemaking tests, and were submitted to homemaking teachers, one professor in food and nutrition, and two professors in home economics education to be reviewed for content validity. The principles included use of the Basic Four Food Groups; functions of nutrients in milk and the importance of milk as a source of nutrients; comparison of whole wheat and white bread; processes involved in pasteurization, homogenization and skimming of milk; and the use of baking powder as a leavener in quick bread.

Nineteen participants in a home economics education graduate seminar course were asked to classify items according to levels. Results from 11 judges in which items were best distributed among the three levels were used. Approximately 50% of the items represented level one items, 35% level two and 15% level three.

Pretesting was done with 59 freshman girls. Items whose difficulty level was outside the 0.20 to 0.80 range, or items with a discrimination index below 0.20 were discarded or revised.

The 57-item test was administered to 109 seventh and eighth grade girls and 250 tenth grade students. The reliability coefficient, calculated using the split-half method and adjusted with the Spearman-Brown formula, was 0.84. The mean score for seventh and eighth grade girls was 23.2. Mean scores were 31.9, 30.9 and 28.6, respectively, for tenth grade girls ($n = 92$), tenth grade boys ($n = 88$) and tenth grade girls with additional home economics coursework ($n = 70$). The total sample of tenth grade students ($n = 250$) had a mean score of 30.6.

There was a significant difference between means of the seventh and eighth grade girls with each group of tenth graders. The mean score for tenth grade girls was not significantly different from that of tenth grade boys, but was significantly different from the mean score of the girls with extra homemaking ($p < 0.05$). The mean for the boys group was not significantly different from the mean for the girls with extra homemaking.

Dwyer, Feldman and Mayer (1970) summarized nine nutrition knowledge studies previously completed. None suited the purpose of their study--that of assessing the nutritional literacy of high school students in Boston.

They first identified concepts from chapters on nutrition in health, home economics and general science textbooks used in high schools. Multiple-choice questions were formulated and judged by a panel of five nutritionists, two high school teachers, two home economics professors, and one agricultural extension worker specializing in home economics who had subject matter competence and experience in dealing with the public in the area of nutrition. The final test was composed of 100 multiple-choice items.

Groups expected to score higher or lower on the test than high school students were tested. Results from the study are shown in Table 4.

Mean scores of 50.0 $\pm$ 9.18 and 48.0 $\pm$ 10.81 (n = 22) and 63.5 $\pm$ 16.25 and 64.6 $\pm$ 16.77 (n = 8) for subjects tested and retested two weeks later showed Pearson correlation coefficients of 0.777 (n = 22) and 0.950 (n = 8) for junior and senior high school girls. Mean scores were similar and the correlation coefficients were highly significant.

High school subjects tested included ninth, 10th and 12th graders. The mean score for all high school students (n = 1,338) was 55.9 with a standard deviation of $\pm$ 11.59. Scores ranged from 14 to 85. Mean score for males (n = 616) was 53.4 $\pm$ 0.49 and for females (n = 722) 58.0 $\pm$ 0.40. Girls had higher mean scores on items in six of the eight areas on the test. Boys had slightly higher mean scores in the subject matter areas of energy output and weight loss and gain. There were insignificant but consistent increases in the level of nutrition knowledge from grade to grade. This may have been due to additional information gleaned from biology, chemistry, and other education or experience obtained. Scores of college-bound students were significantly higher than those of vocational students.

Difficulty levels established for test items were 0.10 to 0.90. When tested with the high school students, 32 of the 100 items had difficulty levels between 0.40 and 0.60. Ten of the items were outside the

Table 4. Nutrition knowledge scores of subjects expected to score high and low[a]

Description of Subjects		N	Mean $\pm$ Standard Deviation[b]
Adults			
Expected to Score:			
High--	Practicing Dietitians	15	88.1 $\pm$ 13.1
	Dietetic Interns	53	89.7 $\pm$ 5.0
	Physicians: Interns and Residents	22	85.4 $\pm$ 11.4
	3rd and 4th Year Medical Students	15	85.0 $\pm$ 6.0
	Nursing Students:		
	3rd Year	33	77.4 $\pm$ 5.2
	2nd Year	60	77.7 $\pm$ 4.9
	1st Year	204	78.0 $\pm$ 7.8
	Physical Education Students--Seniors in College	27	71.7 $\pm$ 5.1
Low--	Lay Instructors in Diet Club	37	61.3 $\pm$ 15.8
Adolescents			
Expected to Score:			
High--	Senior (11th and 12th grade) Girl Scouts	8	63.5 $\pm$ 16.3
Low--	Junior (7th and 8th grade) Girl Scouts	22	50.0 $\pm$ 9.2

[a]SOURCE: Dwyer, Feldman and Mayer, 1970.

[b]Total possible score 100.

limits of 0.20 and 0.80, five above and five below. Thirty-four of the items tested failed to have satisfactory discrimination indices ($\geq$ 0.20). The authors stated those items would need to be discarded or revised in future studies using the instrument with similar populations.

The opinion of the investigators upon completion of the survey was that the level of nutrition knowledge of the high school subjects was inadequate, particularly for those students who would not be getting more formal coursework in nutrition or in the sciences.

Dwyer, Stolurow and Orr (1981) reduced the 100-item test developed by Dwyer, Feldman and Mayer (1970) to 74 items. They eliminated items that were rated unimportant or irrelevant by 7 or more of the 30 educators, research investigators and nutrition practitioners that reviewed the items. Mean scores and standard deviations for criterion groups tested were 63 $\pm$ 4.5 for dietitians and dietetic interns (n = 88), 53 $\pm$ 7.8 for practicing physicians (n = 146), 52 $\pm$ 8.5 for public health graduate students (n = 41), 51 $\pm$ 5.8 for medical students (n = 83), and 38 $\pm$ 8.5 for high school girls (n = 299). Based on test results of the high school girls, the Kuder-Richardson formula-20 reliability was 0.88.

Investigators eliminated five items with difficulty indices over 0.90 and ten items with difficulty indices of 0.10 or less. Ten items were eliminated which had discrimination indices of 0.20 or less. Factor analysis techniques were used to examine the similarity between content areas covered by the test (Hill, 1966) and item clusters. Factor analysis concepts were nutrients in foods and effects of processing on nutrients, variation in human nutrient needs and substitution of various foods for each other, and meeting nutrient needs through diet. Nineteen items did not appear to correlate well with other items when factor analysis was completed. The result was a 27-item test. No report was made of results of administration of the 27-item test.

Knowledge of nutrition was low for girls, ages 15 to 19, in a study reported by Duyff, Sanjur and Nelson (1975). A sample of 75 girls was drawn from participants of a summer educational program for the Spanish-speaking in Chicago. A multiple-choice nutrition knowledge test that covered several nutrient content areas was developed. It was pretested with a group of Puerto Rican-American teenage girls from Rochester, New York, that had social characteristics similar to the test population. A reliability coefficient of 0.82 was found for the test. The test scores indicated that the teens knew little about nutrition principles. The spread of scores made it possible to correlate nutrition knowledge with food intake reported by keeping three-day food records. Higher intake of vitamin A and vitamin C and greater dietary diversity were all significantly and positively related to better scores of knowledge of nutrition.

The purpose of a study by Nece (1979) was to develop a food and nutrition test and measure the knowledge of 10th, 11th and 12th grade students in Iowa. The content areas covered were: 1) physical, social, cultural, and psychological aspects of food; 2) consumer aspects; and 3) food preparation and management (Iowa Department of Public Instruction, 1978).

Two test forms were developed so that the best items could be selected for the optimum test. Each test form contained 12 true-false and 48 multiple-choice items. Questions were developed with each of the content areas represented equally. Fifty percent of the items tested at the knowledge level, 25% tested at the comprehension or application levels and 25% tested at the synthesis or evaluation levels. Nine jurors reviewed the test items. Jurors included two food and nutrition specialists, three evaluation specialists and four high school home economics teachers.

Test analysis showed that the range of test scores on Test Form A (n = 253) was 17 to 53 and on Test Form B (n = 241) was 17 to 51. The mean score for Test Form A was 36.8 $\pm$ 7.2, and for Test Form B was 36.3 $\pm$ 7.3. The standard error of measurement was 3.4 for Test Form A and 3.3 for Test Form B. The estimated reliabilities, as calculated by Kuder-Richardson formula-20, were 0.78 and 0.80 for Test Forms A and B, respectively. The calculated reliability of the optimum test when the Spearman-Brown procedure was used was 0.85.

Nutrition knowledge of junior college and university students

Ofei (1978) developed an instrument to identify competencies needed by older adolescents (18-23 years old) for personal and family living. A list of 171 competencies were submitted to 14 experts to judge as to whether they were necessary competencies for personal and family living.

A test consisting of 33 multiple-choice items was developed based on the 29 competencies judged important by at least 91% of the experts. Content areas included in the test were significance of food, nutrient sources, nutrient requirements, food habits, food selection, food safety, sanitation, meal planning, marketing, home food preservation, and food storage. The test was reviewed by the same 14 experts for validation.

Pretesting was accomplished with a subgroup of the subjects just beginning a basic nutrition course at Iowa State University. The 45 subjects involved in pretesting had studied food and nutrition in high school. Scores ranged from 9 to 24 with a mean of 18.20 $\pm$ 3.69. The reliability coefficient as calculated by the Kuder-Richardson formula-20 was 0.55. Six items had difficulty indices between 0.30 and 0.70, functioning distracters (chosen by 1 of 50 respondents), and discrimination indices between 0.20 and 0.40.

The questionnaire was completed by 89 college students at the beginning of an introductory nutrition course at Iowa State University, 74 students from the Des Moines Area Community College, and 45 Iowa high school graduates presently pursuing no further studies. The mean score for all subjects ($n = 208$) was 17.16 $\pm$ 3.67 and the range of scores was 7 to 24. There were no significant differences in scores between those who had studied nutrition in high school and those who had not. University students had a mean score of 18.09 $\pm$ 3.65 and a range of scores of 8 to 24. Community college students had a mean of 16.18 $\pm$ 3.65 and a range of scores of 7 to 24. For high school graduates pursuing no further study, the mean score was 16.93 $\pm$ 3.28 with a range of 9 to 23.

Scores of university students were significantly higher ($p < 0.05$) than those of community college students but not significantly higher than those of high school graduates not attending school. Females had higher mean scores than males ($p = 0.006$).

Results indicated that out of the 29 competencies evaluated by the test, 5 competencies were achieved by all subgroups and 16 were not achieved by any subgroup. In order for competencies to be achieved, correct answers to items had to be selected by more than 65% of the respondents.

The five competencies achieved by all subgroups included: identifies the role of advertising in food selection; selects nutritious snacks; applies safety precautions in food handling; maintains a clean environment in the kitchen; and stores cleaning agents closed tightly apart from food products and beyond the reach of children.

In a study conducted by Avery (1978), nutrition knowledge, related specifically to energy relationships, was assessed for 194 San Diego State University students. Thirty-five multiple-choice questions tested the following areas of knowledge: principles of energy balance and weight control (54%), nutrient composition of foods (23%) and calorie value of foods (23%). The items were reviewed by two faculty members with expertise in nutrition and foods. The instrument was pretested in a biology class of 17 students. A reliability of 0.52 was calculated using the Kuder-Richardson formula-20.

The mean score for the 194 students tested was 19.2. When the sample was distributed among groups of underweight (n = 21), normal weight (n = 125), overweight (n = 31), and obese (n = 17), the mean scores were 21.0, 19.1, 19.2, and 18.1, respectively. The only significant difference ($p < 0.05$) was between the scores of the underweight group and those of the obese group. The underweight group knew more about principles of energy balance and weight control than did the normal or obese groups, and more about nutrient composition of foods than the obese group. There were no significant differences in knowledge among groups with regard to the calorie value of foods. Students who had completed a college-level nutrition course (32% of the sample) had significantly higher scores ($p < 0.01$) on the test than students who had not studied nutrition in college. Males scored lower on the test than did females ($p < 0.01$).

A study was undertaken by Aboul-Ela (1976) to investigate the nutrition knowledge, food preferences and dietary practices of women residing in residence halls of two universities in Texas with different board payment plans. At University A students paid for their meals on a contract system, while University B employed an à la carte method of payment.

The nutrition knowledge instrument was based on the knowledge test of Dwyer, Feldman and Mayer (1970) with some revisions. The 60 multiple-choice items included in the questionnaire covered basic nutrition concepts concerning energy, vitamins, fats, protein, and minerals; nutrient requirements of various age groups; and deficiency diseases. The mean score for the total sample was 41.20 $\pm$ 8.08. The mean score was 40.26 $\pm$ 8.77 for the 122 women from University A and 42.18 $\pm$ 7.21 for the 119 women from University B. Differences between scores for students at the two universities were not significant. Scores ranged from 4 to 57. Eight items had discrimination indices below 0.20.

The question that most students missed (88%) asked the number of calories in a pound of fat. Other questions concerning calories were missed by more than 60% of the respondents. The fact that one pound of sugar or carbohydrate would contribute approximately the same number of calories as a pound of protein was answered correctly by only 22% of the students. Fewer than half knew names of vitamin deficiency diseases. Other questions missed by half of the respondents were related to nutrient requirements.

Some of the questions answered correctly by more than 90% of the respondents included the definition of a calorie, the body's need for energy, food sources of ascorbic acid, foods high in fat, functions of calcium and fluorine, the Basic Four Food Groups, calories in fried as compared to broiled chicken, and the increased need for nutrients during pregnancy. Thirty-four questions were answered correctly by 70% or more of the students. Only five questions were missed by 70% or more of the participants.

The nutrition knowledge scores were positively related to the food preference scores ($p < 0.01$) for the students at University A, and for the combined university sample ($p < 0.05$). A positive relationship was also found between the quality of the diet (based on an analysis of nutrient intake as calculated from foods included in three-day food intake records) and knowledge of nutrition ($p < 0.01$) at University A, the university employing the contract system of board payment. The students from University A had higher mean intakes for the nine nutrients investigated and calories than did the students from University B. A positive relationship was found between the quality of the diet scores and the food preference scores for University B and for the total of the two universities ($p < 0.05$).

Werblow, Fox and Henneman (1978) surveyed nutrition knowledge, attitudes and food patterns of 94 women athletes at the University of Nebraska. The nutrition knowledge and attitude sections of the questionnaire consisted of 31 knowledge and 19 attitude statements related to general nutrition and nutrition for the athlete. Provisions were made for reporting one of five degrees of certainty. The instrument was reviewed by experts in nutrition and test construction and pretested with women athletes. The statistical sample included 40 freshman, 26 sophomores, 15 juniors, and 14 seniors. Only eight percent had taken a college nutrition course. The athletes attained a mean score of 105, and scored higher on the nutrition for athletes portion of the test than on the items which tested general nutrition concepts. The questions most often missed included questions about organic foods, synthetic versus natural nutrients, and the role of carbohydrates in the diet. There was a significant positive relationship ($p < 0.01$) between nutrition knowledge and attitudes.

Cho and Fryer (1974) assessed the nutrition knowledge of 138 junior, senior and graduate physical education majors and of a control group of 81 students who were just completing a course in basic nutrition for nonnutrition majors at Kansas State University. Of the physical education students, 82 were male and 56 were female; all students in the control group were female.

Students responded to 50 true-false statements relating to general knowledge of nutrition, food composition and misconceptions about food. Topics were divided according to protein (10%), vitamins (12%), minerals (6%), lipids (12%), energy (8%), weight control (6%), digestion and metabolism (14%), and general nutrition (32%). Respondents could indicate one of five degrees of certainty, giving a possible range of scores from -400 to +400.

The mean test score for the physical education (PE) students (93.3) was significantly lower ($p < 0.01$) than that for the control group (156.6). Scores ranged from -36 to +260 for PE students and from -20 to +283 for basic nutrition students (Cho, 1972). Most scores were in the range of 1 to 200. If degree of certainty information is disregarded, the PE students averaged 40% and the control group 74% correct responses. The score of 74% by the control group was close to the optimum for a true-false test (0.75). Students in the control group expressed greater certainty in answering questions correctly than did the PE majors. Male PE majors had a significantly lower ($p < 0.01$) mean score (85.0) than did female PE majors (116.5). The mean score for graduate students (124.0) was significantly higher ($p < 0.05$) than that of junior (84.2) or senior PE students (91.1).

The reliability coefficient was not calculated for the test. Percentages of correct responses were included by test question. Sixteen questions were answered correctly by 91 to 100% of the basic nutrition students, 11 questions by 71 to 80% of the respondents. Thirty-two out of 50 questions were answered correctly by more than 70% of the respondents. Some of the questions could have been more difficult for this group, but fewer were answered by more than 70% of the PE students. Four questions were answered correctly by 91 to 100%, eight questions by 81 to 90%, and seven questions by 71 to 80% of the PE students. There were fewer very difficult items. Two items were answered correctly by as few as 10 to 19% of the basic nutrition students and only one item by 20 to 29% of that group. For the PE students, only one question was answered correctly by as few as 10 to 19% of the group and three questions by 20 to 29% of the students.

Students who ranked college courses as their primary source of nutrition information had significantly higher ($p < 0.05$) test scores than those who ranked parents or coaches as their primary source. High school courses, whether ranked first, second, or third, had no significant effect ($p < 0.05$) on test scores.

<u>Health knowledge and misconceptions of senior high school, junior college and university students</u>

Items related to nutrition have been included in tests designed to measure knowledge and misconceptions for various aspects of health. In a study in New Jersey, specific areas of health knowledge were assessed

(Washnik, 1957). Included were mental health; health in the home, school and community; nutrition; and safety and first aid. The test used was validated empirically from health texts and syllabi, and reviewed by physicians, nurses, nutritionists, biologists, and health education teachers. The reliability coefficient was 0.92. The number of high school students tested was 1,171 (545 males and 626 females) from 20 schools.

The mean score was 67.45, which fell in the 50th percentile based on the national norm for the Shaw-Troyer Health Knowledge and Application test used. There was no significant difference between the mean scores of boys and girls.

The students scored in health knowledge (with decreasing order of difficulty) as follows: a) safety and first aid; b) nutrition; c) health in the home, school and community; and d) mental health.

An attempt was made to determine the relationship between health knowledge test scores and the application of health knowledge. The coefficient of correlation was found to be 0.42 indicating only a moderate correlation between knowledge and the application of health knowledge.

The Kilander Health Knowledge test was administered by Coleman, Burkhardt and Highfill (1972) to 42 high school students enrolled in an educational program for under-achievers at Texas Tech University. The test consisted of 100 items divided according to the following nine categories: personal health (36%), nutrition (12%), community health

(15%), consumer health (9%), stimulants and depressants (8%), safety education (3%), first aid (5%), family living (7%), and mental health (5%). The mean score on the test was 41.26 $\pm$ 10.06 for students and 51.37 $\pm$ 13.84 for their parents.

The 100-item Kilander Health Knowledge Test was administered to 45 students, 25 males and 20 females, in a University of Texas freshman health science course at the beginning and end of a semester (Campbell and Early, 1969). The parent of the same sex as each student in the class was also tested for health knowledge. The mean pretest score was 65.78 $\pm$ 10.72 and the mean post-test score 70.64 $\pm$ 9.42 for the students. Scores ranged from 36 to 84 and 44 to 88 for the pre- and post-test, respectively. The mean scores for the nine items dealing with nutrition were 6.24 and 6.73 for the pre- and post-tests, respectively. Females scored higher than males on the total test and on nutrition items. The correlation coefficient between pre- and post-test instruction test scores was 0.88.

The mean knowledge score for the 45 parents was 75.57 $\pm$ 10.93 with a range of individual scores from 43 to 96. For the 12 items dealing with nutrition, the mean score was 8.49. The correlation coefficients for test scores between the parent scores and pre- and post-test scores of students were 0.32 and 0.27, respectively.

Parents knew significantly more ($p < 0.01$) about health and nutrition than their children in spite of the significant gains in knowledge of students following instruction. Little if any relationship existed between a parent's knowledge of health and the health knowledge of their son or daughter. The authors reported that the results support the need for a college course in health science to supplement the instruction received at the secondary school level.

Seffrin and Veenker (1972) prepared a standardized test of health knowledge. The 10 conceptual areas were represented equally on the test. Fifty percent of the items were at the knowledge cognitive levels, 33% at the comprehension level and the remaining 17% at either the application or analysis level.

One hundred twenty items were prepared from which 60 were to be selected in relation to content and cognitive level test specifications after preliminary testing. Criteria for selecting items included: items must have a difficulty level in the range of 0.10 to 0.90; distracters must be selected by one percent of the students and items must discriminate between students who score high and low on the test ($p < 0.05$).

Since the testing time (50-minute class) was more than adequate for 60 items, 10 items were added, one from each conceptual area and at the comprehension, application or analysis cognitive levels.

The final test was administered to 1,082 students in Indiana high schools. Test results were analyzed. The mean score was 33.42 ± 10.47. Scores ranged from 9 to 63 on the 70-item test. The Kuder-Richardson formula-20 reliability was 0.87. The standard error of measurement was 3.74.

Pupils from urban school systems performed significantly better than did those in rural or inner-city school systems. No information was available about the number or difficulty of items related to nutrition.

Dearborn (1963) tested the health knowledge of students in 34 California public junior colleges. The range of scores for individual students on the 100-item multiple-choice test was 3 to 93%. The mean pretest score for students ($n = 5,267$) in all junior colleges on the standardized test was 46.6. The post-test score after a two-unit regional health course was 58.8, significantly higher ($p < 0.001$) than that on the pretest. The variation in gain was 4 points to 37 points among the different classes and 7 to 26 points among colleges. The range of mean scores on the pretest between classes was 33 to 61 and between different institutions was 39 to 58. A wide difference in knowledge of different aspects of health was noted. The range on the pretest was 8 to 84, and on the post-test 14 to 90. No indication was made of relative nutrition knowledge compared with knowledge of the other 10 health areas tested. The section "exercise and body mechanics" showed the lowest scores on both the pre- and post-test.

Health misconceptions of 535 junior and senior level college elementary and secondary education majors at the beginning of the only required health education course at the University of Texas were assessed by Haag (1963). A jury of 29 medical specialists reviewed the list of 295 health misconceptions compiled based on the literature, previous studies, books, and advertising media. A questionnaire containing a list of the 130 misconceptions remaining after the review was pretested with 1,044 freshmen prospective elementary school teachers at 17 state colleges in New England. The pretest reliability coefficient was 0.89.

In the survey population the mean number of rejected misconceptions was 63.4% with a range of 52.3-74.6%. Only 31.8% of the statements were correctly answered by 75% of the prospective teachers. Thirteen health misconceptions were accepted by 75% or more of the sample population. No information was available about the number of nutrition misconceptions included in the health questionnaire or the degree to which they were misconceived.

The purpose of a study conducted by Williams (1956) was to assess the health misconceptions held by high school students in North Carolina. Misconceptions were defined as beliefs commonly held as true but which are not in accord with scientific evidence to date.

A checklist of 171 health misconceptions was administered to 255 high school pupils. The mean percent score was 51 with a range of scores of 25 to 80% correct.

Findings showed that the highest degree of health misconceptions was in the area of nutrition. Personal and environmental health ranked second and dental health third in health misconceptions. In the area of nutrition, ninth graders showed a higher degree of health misconceptions than did students in the other three grades. In general, there was a decline in the degree of health misconceptions as pupils moved from grade to grade. Boys subscribed to a higher number of nutrition misconceptions than did girls.

Of the 25 items related to nutrition (15%), the item most frequently missed was one where more than four-fifths of the students thought that shellfish and ice cream may not be safely eaten at the same meal.

The purpose of a study completed by Stephens (1970, 1971) was to determine the prevalence of health misconceptions of 12th grade students in 24 public high schools of three different sizes in Colorado. Eight schools of each size were included. A list of 155 health misconceptions was compiled in the areas of personal health (7%), nutrition (11%), rest and exercise (5%), care and prevention of disease (15%), habit-forming substances (13%), first aid and safety (13%), consumer health (10%), family living (12%), and mental health (14%).

A jury of experts evaluated the misconceptions for content and for degree of harmfulness. The jury was composed of four health educators, four physicians and two school nurses. A test of 100 statements (85 misconceptions and 15 camouflage items) was administered to high school seniors in 24 schools. The test included nine nutrition misconceptions. They related to vitamin supplements, fluoridation of water, obesity, chewing gum, toothpaste, coffee breaks, nutritional status of Americans, and nutrition and infections.

Two camouflage items dealing with nutrition were related to cultural and family influence on patterns of eating and a decrease with age of calorie needs for adults.

The mean score of correct responses on the 100-item questionnaire for the statistical sample of 240 was 67.81. For small schools the mean score was 65.95, for medium-sized schools 66.39, and for large schools 71.08. The range of correct scores was from 9 to 97. There was no significant difference between scores of students of different sexes, but there was a significant difference ($p < 0.05$) in misconceptions by school size.

The nine subject matter areas were ranked according to health misconceptions. The greatest percentage of misconceptions was found in the area of consumer health (77.7% misconceptions) followed by nutrition (55.5% misconceptions).

Adams (1959) studied health misconceptions among students enrolled in freshman health classes at the University of Oregon. Seventy-five statements represented misconceptions in the areas of food, diet and nutrition (25%); organic functioning and disorders (21%); prevention of disease and treatment of injury (12%); mental health (10%); eyes, teeth, hair, and skin (21%); and first aid (11%). Five professors of health education reviewed the statements.

Results of the test showed mean percent scores of 61 for females ($n = 63$) and 59 for males ($n = 63$). The percentage of error found for the section relating to nutrition was 43% for females and 49% for males. Nutrition ranked highest in error for males of any of the categories and second highest for females.

In order to help correct problems of lack of health knowledge or prevalence of health misconceptions, projects such as the Tennessee

Health Education Project have been instituted. Results of surveys of nutrition knowledge (Kirk, Hamrick and McAfee, 1975) have shown low mean scores for nutrition knowledge for students in elementary, junior and senior high schools, in spite of a high emphasis on nutrition education.

Nutrition misconceptions of senior high school students and adults

A number of investigators have examined nutrition misinformation or misconceptions separately from other health areas. Dwyer, Feldman and Mayer (1970) noted that correct responses were low in the area of weight loss and gain in their study of nutrition knowledge of adolescents. Since that was one of the topics of greatest interest and concern, there was an indication that there was wrong learning or misinformation rather than a lack of knowledge.

Wodarski (1976) studied food and nutrition misconceptions of 185 students, 10th through 12th grade, from a selected sample of Knoxville, Tennessee high schools. The questionnaire measured knowledge and misconceptions in the following areas: food additives, vegetarian diets, "health" foods, weight reduction, food labeling laws, nutrient requirements and functions, and food fads and myths. The items were grouped into the following seven categories: 1) diet and weight watching; 2) "organic" and "health" foods and vegetarian diets; 3) diet in relation to disease; 4) foods my body needs; 5) food safety; 6) nutrition and pregnancy; and 7) miscellaneous.

True-false items were developed with a five-point scale of certainty. Knowledge was defined as a correct response with a high level of certainty. Misconceptions were defined as wrong answers in which the respondent expressed a high degree of confidence.

Six food and nutrition professionals from the University of Tennessee served on the panel of experts reviewing the questions. Fifty-six questions were included in the final instrument.

Students of both sexes and all grade levels were found to possess a limited knowledge of food and nutrition and to maintain a considerable subscription to misconceptions. The mean misconception score for the total population was 14.9 $\pm$ 6.2 with a range of 1 to 34 out of 56. The greatest proportion of misconceptions was found in the areas of "food my body needs" (33.5% misconceptions) and "diet and weight watching" (32.1% misconceptions). There was no significant differences between sexes or among grade levels.

The mean knowledge score was 17.0 $\pm$ 7.1 with scores ranging from 2 to 38 out of 56. This low level of nutrition knowledge is consistent with findings of Dwyer, Feldman and Mayer (1970) and Kirk, Hamrick and McAfee (1975). No differences were observed between sexes or among grade levels. Knowledge scores were positively associated with degree of training in chemistry (γ = +0.37) and biology (γ = +0.38), but were not significantly associated with amount of training in home economics or health education. Students who studied chemistry and biology may have obtained general scientific knowledge which could be applied to food and nutrition. Kirk, Hamrick and McAfee (1975) also noted a low association between knowledge of health and knowledge of food and nutrition.

Sondgeroth (1968) administered a 78-item questionnaire to determine misconceptions of ninth and twelfth grade girls in Iowa about nutrition and weight control. The true-false items were divided into subgroups with 46% of the items concerned with nutritive value of foods, 14% indicating a knowledge of the calorie value of foods, 18% on sound weight control practices, and 22% related to nutrient sources and functions.

The mean score was 42.5 for the 64 girls in the ninth grade and 49.8 for 54 girls in the twelfth grade. The mean number of correct responses of twelfth grade girls was significantly higher ($p < 0.01$) than that for ninth grade girls for all groups of test items except those concerning weight control ($p < 0.05$). There was no significant difference in scores of girls who had studied home economics and those who had not.

Fifteen questions were missed by more than 50% of the subjects. Five dealt with calories in foods, three with nutrient sources and functions, five with nutritive value of foods, and two with weight control practices. Most subjects knew functions of protein, the recommended milk intake for teenagers, and similarity in nutrient contribution of grapefruit and oranges to the diet.

Tifft and Stanton (1972) administered the Osman (1967) nutrition misconception instrument to 912 senior high school students. The mean score was 65.84 ± 22.32 on the 144-item test. The number of students who had a misconception of only a single item ranged from 44 to 79%. Girls held fewer misconceptions than boys ($p < 0.05$). The mean score for girls was 69.17 and for boys was 62.02. Those students who had previously health instruction had significantly higher ($p < 0.05$) mean scores (69.40) than did those who had not (64.33).

Children whose fathers held professional jobs had significantly higher ($p < 0.05$) scores (71.28) than those whose fathers' jobs were nonprofessional (63.93). No difference existed between children whose mothers had professional occupations and those whose mothers had nonprofessional jobs.

Osman (1967) determined the prevalence of nutrition misconceptions held by college freshmen prior to instruction in nutrition. Two hundred forty misconceptions were identified. A jury of 12 experts in the field of nutrition reviewed the statements. Pilot testing was completed with a sample of 221 freshmen students in Health 5 at the University of Maryland. Statements with difficulty ratings of 6% or lower or 94% or higher were eliminated. The Kuder-Richardson formula-20 reliability was 0.85.

The final instrument was administered to 1,331 freshmen in Health 5. It contained 144 statements, 104 of which were false. Responses were "true," "false" or "don't know." The reliability of the instrument in its final form was 0.94.

Most students thought that potatoes are fattening (85%); athletes have higher protein needs than nonathletes (75%); it is dangerous to leave food in an open can in the refrigerator (72%); polyunsaturated fats are lower in calories than saturated fats (69%); and food is low in vitamins if grown on depleted soil (53%).

The incorrect responses of the students ranged from 5 to 77. The mean misconception score was 30.90. The number of questions to which the response was "don't know" was 33.84, leaving the mean number of questions answered correctly at 79.26. The range for correct responses was 19 to 132. There was no significant difference between scores of men (n = 787) and women (n = 544). The mean score for men was 77.62 $\pm$ 20.17 and for women 81.57 $\pm$ 20.30. Students would later receive nutrition instruction in only one lecture and one discussion period to combat the misinformation (Osman and Ahrens, 1972).

McCarthy and Sabry (1973) measured nutrition misconceptions of students registered in the first semester at the University of Guelph, Guelph, Ontario. From an original collection of over 3,000 true-false statements, 80 were selected to represent the seven areas of nutrition knowledge: health foods; environmental factors; weight loss and gain; sources of nutrients; nutrient requirements and functions; digestion, absorption, metabolism, and excretion; and food purchase, storage and preparation. The statements were reviewed by 17 nutritionists including university professors, public health nutritionists, hospital dietitians, government health officials, and medical doctors.

After revision, 10 statements represented each of the seven areas of knowledge. The 70-item questionnaire consisted of 55 false and 15 true items. Subjects could respond with "true," "false" or "don't know" to the items.

The Kuder-Richardson formula-20 reliability coefficient, when items were pretested with 40 students, was 0.86. The test reliability was 0.59 with the sample population of 274 students. The mean misconception score was 18.6 (27%) and the mean "don't know" score was 13.6 (19%), a discouragingly high score. The highest number of misconceptions was found in the area of environmental factors (33.4%). The highest number of correct answers occurred in the area of food purchase, storage and preparation (62.2%). The fewest correct answers were in digestion, absorption, metabolism, and excretion (43.7%). The largest number of "don't know" answers was in the area of health foods (33.4%).

Females (n = 133) held significantly more misconceptions than males (n = 141) in the area of health food and had significantly more correct answers in the area of weight loss and gain. There was no statistically significant difference between males and females in mean scores in misconceptions or correct responses. The overall means for misconceptions were 18.2 ± 6.4 for males and 19.2 ± 6.3 for females; and the means for correct responses were 37.1 ± 7.6 and 38.6 ± 7.0 for males and females, respectively.

Students with exposure to one year of home economics in high school had fewer misconceptions ($p < 0.01$) than did those without home economics (17.6 ± 3.5 versus 20.6 ± 3.9, respectively). Additional years of study in high school home economics had no further effect on scores.

Bell (1975) administered a 50-item questionnaire to examine misconceptions about food and nutrition principles. Possible answers were "true," "false" and "uncertain." The questionnaire was reviewed for validity by several nutritionists and health educators. Of the approximately 200 questionnaires distributed to seven Sunday school classes, 156 were returned. Participants were divided into five age groups: 20-30, 31-40, 41-50, 51-60, and over 60 years. Participants were asked to indicate their three major sources of nutrition information from a list of 15.

The mean score was 33.2 correct out of 50. The nutrition scores of misconceptions about nutrition ranged from 1 to 23 with a mean score of 11.1 $\pm$ 4.61. The item stating that margarine contained less calories than butter was answered incorrectly by 66% of the respondents. An item which stated that canned vegetable products do not have approximately the same nutritive value as fresh, cooked ones was missed by 60% of the subjects.

There was no significant difference between the number of misconceptions held by males (n = 57) and females (n = 99). Respondents over 60 years of age held significantly more misconceptions ($p < 0.05$) than the other age groups except the 51-60 year group. The mean misconception scores were 13.0 $\pm$ 4.82 for the over 60 age group and 11.0 $\pm$ 4.85 for the 51-60 year age group. Of the respondents over 60, 70% believed that foods grown on depleted soils are low in vitamins. There were no college graduates in the 51-60 year age group. Of the subjects over 60, nine percent were college graduates.

The education level of the participants was significantly associated with belief in misconceptions about nutrition. The group having the lowest level of education (eighth grade or less) had a significantly higher ($p < 0.01$) number of misconceptions (14.6 $\pm$ 3.26) than any other educational group. Those with master's degrees had the fewest mean misconceptions about nutrition ($\bar{x}$ = 7.6 $\pm$ 2.91).

The respondents who had taken a nutrition course in college had significantly fewer ($p < 0.01$) misconceptions (6.7) than those who had taken a high school course (11.2) or those who had not had coursework in nutrition (11.5).

In this study, books were listed most frequently as a source of nutrition information. Magazines ranked second and third as sources of information. Respondents who chose books and magazines as sources of information averaged a significantly lower number of misconceptions on the test than those who did not consider books and magazines as a source of information. Television was considered the next most popular choice for information on nutrition. Only 19% of the population considered newspapers an important information source.

Books were chosen more frequently by women than by men and also by respondents with a high school or college education as compared to those with an eighth grade education. More men than women chose television. Books were selected more frequently by the 20-30 and over 60 year age groups. In the 31-40 year age group, books and magazines were both popular choices, and in the 41-50 and 51-60 year age groups, magazines were the most frequently chosen source. The 20-30 year age group chose television more than any other group.

The nutrition misconceptions of the Maryland Cooperative Extension Service's clientele were assessed by Wang (1971). The survey population included 1,406 subjects. Of these, 1,050 were homemakers in organized clubs, 97 were low-income homemakers and 259 were 4-H youths. The Nutrition Knowledge Inventory (40 statements) included eight categories of statements regarding facts and fallacies or misconceptions about food. The eight categories were: bread and cereal, milk and milk products, meat and protein foods, fruits and vegetables, sweets and fats, vitamins and minerals, weight control, and miscellany. Subjects responded to statements by marking "true," "false" or "don't know."

Results were similar for low-income women (54% correct) and 4-H youths (56%), and more than 10% higher for homemaker club women (67%). In comparing scores of club women to those of 4-H youths, club women scored significantly better on 22 of the 40 questions, whereas 4-H members scored significantly better on only two items. In particular, club women scored better on statements dealing with cost and food values.

Low-income women had lower scores on questions about food habits than did the other two groups. There was no significant difference in responses of club women and low-income homemakers on those items dealing with nutritive values of foods (margarine and butter, white enriched and whole wheat bread, fresh and frozen orange juice). Fewer than 50% of each of the three groups responded correctly to eight of the forty statements.

The investigator noted that differences in scores were only ones of degree; all groups performed poorly. It was possible that women from homemakers clubs, who were largely from middle-income families, had a better knowledge than low-income women and 4-H youths due to a greater variety of experiences and possibly higher levels of education.

The purpose of a study by Jalso, Burns and Rivers (1965) was to determine if there was a relationship between food faddist beliefs and practices and such variables as age, socioeconomic status and educational level. Participants were members of community organizations in New York such as Parent-Teacher Associations, nursing associations, church organizations, nutrition clubs, home demonstration units, and senior citizen groups.

The nutrition opinions questionnaire, which was completed by 340 people, consisted of 30 statements arranged in eight categories. The categories included: special health foods, self-prescribed vitamins, diet as related to health, diet adjustments, sources of information (advertising, nonadvertising), refined and processed foods, and chemicals, soil depletion and fertilizers. Respondents could be classified as "faddist"or "non-faddist" based on "agree" or "disagree" responses.

Nutrition practices were investigated with a 30-statement questionnaire including use of food supplements, use of special health foods, methods of weight control, special diets, and the avoidance of certain foods.

Scores on the opinions questionnaire ranged from 38 to 90 out of a possible 90 points. The reliability index was 0.75. The mean score was 67.7 $\pm$ 10.3. The 48 subjects with the highest scores were classified as "non-faddists" and the 53 with the lowest scores were "faddists." The mean scores--52.9 (59%) for the "faddists" and 82.0 (91%) for the "non-faddists"—were significantly different ($p < 0.001$). When correlations among age, income, education, and nutritional opinion scores were calculated, correlation coefficients were all significant at the one percent level with age negatively correlated with all other variables. "Faddists" had received substantially less nutrition education than "non-faddists." Nutritional supplements and "health" foods were used to a greater extent by "faddists" and more foods were avoided by the "faddists" group than those in the "non-faddists" group. According to the investigators, the high positive correlation (0.63) between opinion scores and scores on practices indicated that nutritional opinions are reflected in practice.

Nutrition knowledge of health practitioners and students

The premise that nutrition should be an integral and essential part of medical education has been voiced with increasing concern in recent years. The need has been recognized in the Congress--Senator Richard Schweiker (R-Penn.), a member of the Senate Select Committee on Nutrition and Human Needs, introduced a bill in 1973 which would provide funds for support of nutrition education in medical schools. In making recommendations for a National Nutrition Policy, the 1974 Senate Nutrition Policy Study strongly recommended that the training of physicians should have high priority (Young and Weser, 1975). Teaching nutrition in medical schools was the subject of the first position paper of the National Nutrition Consortium (Frankle, 1976a).

Wen, Weerasinghe and Dwyer (1973) analyzed and classified nutrition components of courses in a review of catalogs of 94 American medical schools.

Studies used to determine the nutrition knowledge of medical students and physicians have provided evidence of the need for nutrition in the medical curriculum. From such studies (Phillips, 1967, 1971; Podell, Gary and Keller, 1975; Krause and Fox, 1977) efforts were made to incorporate nutrition into the curriculum of some medical schools. Examples include Mount Sinai School of Medicine, Columbia University, Vanderbilt University School of Medicine, Boston University Medical School, University of Michigan School of Medicine, University of Southern California School of Medicine, University of Texas Health Science Center, and University of Missouri School of Medicine (Christakis, 1972; Flynn, Keithly and Colwill, 1974; Frankle, 1976a, b; Frankle, Williams and Christakis, 1972; and Young and Weser, 1975).

At the Mount Sinai School of Medicine the curricular effort in nutrition included 40 hours in the four-year medical school program. The Tyler model (1949) was used to develop the curriculum around essential principles that the physician should master (Frankle, 1976a). Included were the science of nutrition, in which the student would have instruction in normal and therapeutic nutrition, and the sociology of nutrition.

The general objective for the nutrition component at the University of Missouri School of Medicine was that the family physician should be able to: "master the basic nutrition concepts, food economics, common nutritional problems, critiques of popular dietary regimens, and interrelationships of cultural, ethnic, economic, and psychological influences on food and eating in reference to patient care within each family" (Flynn, Keithly and Colwill, 1974, p. 271).

In a study by Phillips (1967, 1971), the level of knowledge attained by second-year medical students in the areas of normal nutrition and diet therapy was determined with multiple-choice test items. The content coverage included recommended allowances of nutrients, food sources of nutrients, amounts of food groups recommended for an adequate diet, and dietary principles relating to disease conditions such as obesity, heart disease and diabetes. The questions reflected practical application of nutrition principles.

Five physicians in internal medicine, six general practitioners, four obstetricians, five pediatricians, and six nutritionists served on a panel of experts to review the concepts and test questions. A concept or test question was included if a total of two-thirds or more of the jury members rated the question as important. The Kuder-Richardson formula-20 reliability coefficient for the 100-question revised pretest administered to 111 student nurses was 0.65. The test was administered to 254 second-year medical students from four New England medical schools and a control group of 13 nutritionists and dietitians.

The range of scores for medical students was 15 to 61 correct and for the control group 73 to 92 correct out of 100 questions. Scores by schools are shown in Table 5.

Table 5. Nutrition knowledge scores of medical students from four schools[a]

School	N	Range	Mean ± Standard Deviation
A	89	15-61	40.37 ± 9.16
B	60	36-64	47.90 ± 6.70
C	59	29-68	47.11 ± 8.33
D	46	26-65	48.45 ± 7.65
Control Group	13	73-92	82.62 ± 5.94

[a]SOURCE: Phillips, 1967, 1971.

There was a significant difference ($p < 0.01$) between mean scores of the medical students and of the control group of nutritionists and dietitians. Students at School A scored lower than students at the other schools ($p < 0.05$).

Performance on the nutrition test indicated that the majority of the second-year medical students tested were not familiar with many of the basic concepts and information related to nutrition that the panel of experts considered important. The basic principles of normal nutrition and diet therapy needed to be strengthened in the curriculum of the medical schools.

In a study conducted by Podell, Gary and Keller (1975) the clinical knowledge of medical students and practicing physicians was assessed. An examination consisting of multiple-choice questions was constructed. It was revised and pilot tested with five family practice residents, ten internal medicine residents, two practicing family physicians, one practicing pediatrician, and six practicing internists. Two of the internists and one pediatrician were considered to be knowledgeable in nutrition. Each subject indicated whether each question was clear and relevant. Questions which were judged as not clear and relevant were excluded with two exceptions. The revised, validated examination consisted of two parts: 19 questions (Test A) and 20 questions (Test B).

The revised examinations were distributed by mail to practicing family physicians, internists and pediatricians at Overlook Hospital, Summit, New Jersey. Third-year students at two New York State medical schools, and fourth-year students at one school, were tested. There were 36 practicing physicians; 48 third-year students at medical school 1, 44 at medical school 2; and 35 fourth-year students. There were 36%, 60%, 42%, and 70% of the possible participants represented, respectively. Questions which were not relevant were again noted. The test questions covered the following areas: lipids and heart disease; sodium-restricted diets; obesity and calorie values; food additives; vitamins, carbohydrates, fats, and proteins; and politics and personalities. The overall mean for the 83 completing Test form A was 58%, for the 80 completing Test form B the mean was 41%, or 50% correct overall. The results were very similar to those of Phillips (1971). Scores of 70% were achieved by only 15 individuals (9% of the total). Only two individuals (1% of the total) scored 80% correct or better. All three of the "knowledgeable" pilot-tested physicians scored 80% or more correct. The practicing physicians scored lower than the medical students (44% versus 51%, respectively). The scores among groups of students were quite similar.

The knowledge of clinical nutrition was low but what was most surprising was that within specific areas of nutrition there was remarkable variation in knowledge. Most subjects knew foods for lowering serum cholesterol but only 18% could identify foods for reducing serum triglycerides. Sixty-six percent correctly identified the Atkins diet. Only 20% could estimate the calorie value of an hour of daily exercise. Ninety-one percent knew the dosage of vitamin C recommended for prevention of the common cold, but only 53% correctly estimated the dosage of vitamin C for prevention of scurvy. Adelle Davis was identified by 85% and Linus Pauling by 96% of the respondents, the president of the American Medical Association, the director of the Food and Drug Administration, and the secretary of the American Medical Association Council on Food and Nutrition were identified by only 32%, 40% and 28%, respectively. Only 18% knew the group who prepared the Recommended Daily Allowances. Medical students and physicians may have learned about nutrition in a rather haphazard way and, like the general public, obtained information from popular materials.

In another study of the nutrition knowledge of physicians, Krause and Fox (1977) found that physicians scored higher on basic nutrition knowledge questions than on those related to therapeutic nutrition. Knowledge questions of the true-false type covered the content areas: nutrients and their functions; general nutritional information; food composition; food needs during pregnancy and lactation, infancy, and childhood; and illnesses which required modified diets. Questions were primarily directed toward practical application of basic nutrition concepts and current theories in therapeutic nutrition. Attitudes toward nutrition, the profession of dietetics, the role of the physician in nutrition education, and nutrition education in medical school were also assessed.

The questionnaire, consisting of 55 true-false questions, was based on recommendations of a panel of 20 nutritionists and dietitians and a statistician. The mail-out questionnaire was completed by 292 physicians (22% of the physicians on the mailing list of the Nebraska Medical Association). Only nine percent of the respondents had received their nutrition education in the form of specific coursework. Twelve percent reported that they had received no nutrition education in medical school, either in a specific course or integrated with other coursework.

The mean score on the test was 134 with a possible range of scores of -385 to +385 with the five-point degree of certainty (Krause, 1973). Disregarding degree of certainty information, 65% of the questions were answered correctly and 24% were incorrectly marked on the average. There was a significant negative correlation between years in practice and nutrition knowledge. The categories of general information, nutrition related to convalescence, and nutrition in infancy and childhood had the highest percentage of correct answers, 85, 82 and 73%, respectively. Categories related to anemia and gastrointestinal diseases received the lowest percentage of correct responses, 48 and 51%, respectively. In general, concepts of diet therapy posed the most problem for physicians.

Responses by physicians to the 20 attitude statements supported the belief that physicians had favorable attitudes toward nutrition and the profession of dietetics. Their attitudes were less favorable toward the concept of allowing the dietitian to assist in prescribing diets.

In a study by Bozdech et al. (1978) a nutrition knowledge test developed at the University of Kentucky for undergraduates completing an introductory nutrition course was used to assess nutrition knowledge of dental students in each of the four years in school. Completed tests were returned by 175 students. Results showed a mean percent score for all students of 58.7 $\pm$ 10.2 with a range of 21 to 86% on the 123-item true-false and multiple-choice test. Dental faculty (n = 65) had a mean percent score of 65.4 $\pm$ 9.0 with a range of scores of 41 to 83% (Bozdech, 1974). By comparison, of 87 undergraduate students, those who received As in the college introductory nutrition course averaged 87.6% on the test and students receiving Bs, Cs and Ds attained mean scores of 79.8, 69.7 and 591.%, respectively.

Categories for nutrition knowledge questions included: nutrients, biochemistry and physiology (39% of questions); disorders (8%); foods (34%); diets (85); behavorial and social sciences (1%); organisms (5%); and organizations and programs (5%). Dental students had the lowest mean score (41.7 $\pm$ 14.4%) on the category "diets." The other category where students scored below the mean for the total test was that of "nutrients, biochemistry and physiology" (55$\pm$ 13.5%). Dental faculty scored lowest in the categories of foods (69.5 $\pm$ 8.6%); nutrients, biochemistry and physiology (62.1 $\pm$ 11.9%) and diets (44.6 $\pm$ 14.8%).

Results showed that the mean score of dental students (58.7 $\pm$ 10.2%) was below the mean for undergraduate students who had completed a basic course in nutrition with a grade of "C" (69.7%). A gain in nutrition knowledge was evident only in the first year of dental school ($\bar{x}$ = 61.1 $\pm$ 8.1 for second-year students versus 53.3 $\pm$ 11.4 for first-year students) and only in the areas of nutrition, biochemistry and phsyiology, disorders, diets, and organisms.

A questionnaire was developed to assess the nutrition knowledge and attitudes of first- and fourth-year dental students at the University of Missouri-Kansas City (UMKC) (Pietz, 1979; Pietz, Fryer and Fryer, 1980).

Most of the students were 20 to 30 years old. Eighty-seven percent of the combined classes had received bachelor's degrees and an additional six percent had received higher degrees prior to enrollment in dental school. Sixty-eight percent of the students had majored in biological science.

Content areas for the knowledge test included normal and therapeutic nutrition, foods, nutrients, diets, nutrition and dental health, and nutritional assessment. A portion of the test questions were taken from a knowledge questionnaire used by Krause and Fox (1977). Additional questions were used. All questions were reviewed by two nutrition faculty members at Kansas State University and one biochemistry faculty member at UMKC. The revised instrument was pretested. Results obtained were used to prepare the final form of the questionnaire which contained 50 knowledge questions with possible responses of "true," "false" or "uncertain," and a five-point scale for degree of certainty. Correct responses were scored from +1 to +8, uncertain responses as zero, and incorrect responses from -1 to -8. The range of possible scores was from -400 (minimum) to +400 (maximum). The reliability of the knowledge test, computed by Cronbach's coefficient alpha, was 0.61.

Attitude statements, for which responses were a choice of "strongly agree" (+5), "agree" (+2), "undecided" (0), "disagree" (-2), or "strongly disagree" (-5) were tested. Possible scores ranged from -75 to +75, with higher scores indicating more positive attitudes. The attitude scale had a reliability of 0.75.

Tests were administered to dental students during a regularly-scheduled class period. Responses were received by 97 first- and 133 fourth-year students. Scores on the nutrition knowledge test ranged from 59 to 298, with 67% of them in the range of 101 to 200. The mean score for the first-year class was 183.1 which was significantly higher ($p < 0.001$) than that of the fourth-year students 148.1. Overall, 68.6% of the questions were answered correctly as true or false by the combined group.

Knowledge scores of dental students were highest for questions relating to oral health and diseases (76.5% correct) and lowest for those on nutritional assessment (52.2% correct). Fewer than 60% knew that analysis of a blood sample could not determine the status of nutrients in the body. About one-fourth understood that Recommended Dietary Allowances are not minimum daily requirements of individuals. Students scored poorly on questions dealing with diets (60.8% correct). Bozdech et al. (1978) found similar results for dental students at the University of Kentucky.

The mean attitude score was 39.1 out of a possible 75 points. No differences were observed between scores of first- and fourth-year students. Knowledge and attitude scores were not correlated ($r = -0.086$).

Although scores were higher for first-year than for fourth-year students, the investigators reported that the score for neither group was high. In some content categories, responses of "uncertain" accounted for approximately 10% of the responses.

Other health professionals have also been tested to see how much they know about nutrition. According to Newton, Beal and Strauss (1967), nurses do a significant amount of nutrition education. Nurses in that study had expressed negative reactions toward nutrition courses in their educational programs. Better response was obtained from nurses who were taught nutrition as an integral part of nursing care rather than as a separate course offering.

Public health nurses with bachelor's degrees scored higher on a test of nutrition knowledge than did those with diplomas or associate degrees; but experience negated some of the differences attributable to educational level (Harrison, Sanchez and Young, 1969). Nutrition knowledge was evaluated with a 67-item questionnaire in the form of statements to be answered "true," "false" or "don't know." These questions measured four categories of knowledge: common tools used in the planning and evaluation of diets; physiological factors which influence food intake and nutrient needs; psychological, cultural, social, and economic factors which influence food intake; and functions, sources, digestion, and metabolism of nutrients in foods. These categories were adapted from Newton's (1960) suggested categories of knowledge of nutrition desirable for nurses.

The sample for the study consisted of 144 nurses employed in health agencies in Michigan. The scores by content category are shown in Table 6.

Table 6. Scores of nurses in four categories of nutrition knowledge[a]

Category	Range (%)	Mean $\pm$ Standard Deviation (%)
I	30.0 - 90.0	62.2 $\pm$ 11.90
II	20.0 - 100.0	59.7 $\pm$ 19.53
III	27.5 - 100.0	73.4 $\pm$ 20.33
IV	15.4 - 92.3	57.6 $\pm$ 13.83
Total Questionnaire	23.8 - 85.0	62.0 $\pm$ 8.87

[a]SOURCE: Harrison, Sanchez and Young (1969).

It appeared that there was greater variability in knowledge of physiological and psychological factors which contribute to nutrition and food intake than there was in knowledge of the more direct facts of nutrition, such as specific nutrients and tools used in planning and evaluating diets. The mean score for category III was substantially higher than those for the other categories, 73.4% versus 62.2, 59.7, and 57.6% for I, II and IV, respectively.

Nurses holding graduate or bachelor's degrees scored higher than nurses with diplomas or associate degrees or than licensed practical nurses. Scores for the entire questionnaire were positively correlated with years of experience in public health nursing with categories of less than one year, one to nine years, and ten or more years of experience, which showed that experience seemed to negate some of the differences in scores due to educational level. This was most pronounced in the agency which employed a full-time nutrition consultant.

The investigators commented that the findings showed great variation in all areas of nutrition knowledge measured which has implications for the necessity of gearing to a variety of background knowledge in in-service programs. Responses also indicated a general lack of understanding of the tools used in evaluating and planning diets, such as the Recommended Dietary Allowances.

A study by Vickstrom and Fox (1976) was undertaken to determine the nurses' knowledge of nutrition and attitude toward nutrition. Knowledge questions were selected from other questionnaires (Eppright et al., 1970;

Petersen and Kies, 1972). Other true-false questions were written specifically for this study. When the questionnaire was completed, it was reviewed by two faculty members in the area of test construction and two faculty members in the area of nutrition at the University of Nebraska. The questionnaire was revised and pretested with a randomly selected portion of the sample. Questions which were too easy or too difficult were identified and those which were not understood were reworded or eliminated. The areas covered in the knowledge section were food composition; basic nutrition, functions of nutrients; rationale and prescription of therapeutic diets; and foods allowed or restricted on therapeutic diets.

Attitude statements were developed for the following six attitude parameters: nutrition; nurse's participation in a health care team; modified diets; nurse's role in nutrition education of patients; dietitians and professionals; and nutrition education in nursing school. This part of the questionnaire was treated similarly to the knowledge section.

The final form of the questionnaire contained 30 knowledge questions, 28 attitudes statements and a ranking question to assess the nurse's perception of the role of the dietition along with demographic questions. Questions were answered with "true," "false" or "undecided': one of five degrees of certainty were also indicated for each response. A correct answer received a score of +2; -2 delineated an incorrect answer; and 0 indicated an uncertain response. Points were given for the degree of certainty ranging from +5 to +1 for a correct answer and from -1 to -5 for an incorrect answer. The highest possible score for each question was +7; the lowest possible score was -7. The range of scores possible was -210 to +210.

Attitudes were measured by value statements. The subjects responded "strongly agree (SA)," "agree (A)," "undecided (U)," or "strongly disgree (SD)." Positive statements were scored from +5 for SA to +1 for SD. Negatively worded statements were scored the opposite way with +5 being given for SD and +1 for SA. High scores indicated a favorable attitude toward the statements.

Questionnaires were mailed to 1,536 members of the Nebraska Nurse's Association. Approximately 20% of the employed registered nurses belonged to that organization. Of the 867 questionnaires returned (56%), 500 were from hospital nurses. Those 500 nurses (approximately 7% of the employed registered nurses in the state) were used as the sample population. The age range was from 21 to 69 years. One fourth held bachelor's degrees. Nutrition teaching had been integrated in the nursing curriculum for 25% of the respondents.

Favorable attitudes to all attitude parameters were indicated by the mean scores (5 represents SA): nutrition 4.59, nurse's participation in a health care team 4.25, modified diets 4.19, nurse's role in patient care education 4.07, and dietitians as professionals 4.02. The least favorable attitude expressed was toward nutrition education in nursing school 3.95. Nearly all (99%) of the nurses regarded dietitians as important members of the health care team. Nurses felt that their role in nutrition education should be supportive rather than active but that they were in contact with the patient more than the dietitian was. In this study nutrition knowledge declined with age and experience while attitudes improved.

The level of nutrition knowledge of the nurses was low. The mean score was 112 out of a possible 210 points. Although 77% of the questions were answered correctly, the nurses apparently lacked confidence in the correctness of the answers on the basis of degree of certainty responses. Nurses saw dietitians in nutritional care of patients first as teaching diet therapy; then, in order of importance, serving as a resource person, teaching nutrition, providing foods which follow a patient's dietary prescription, dealing with patient's food problems, and catering to patient's food requests.

In another study of knowledge and attitudes of public health nurses (Schwartz, 1976), a mail questionnaire was developed and responses obtained from 352 (90% of sample surveyed) nurses in British Columbia. The nutrition knowledge test consisted of 40 statements to which the nurses responded "true" or "false" with one of four degrees of certainty about their responses, ranging from "very certain" to "very doubtful." This test was developed and validated by Harrison, Sanchez and Young (1969).

Attitudes toward nutrition were measured by a test consisting of 14 statements. In this research an attitude was defined as a "learned, emotionally toned predisposition to react in a particular way toward something."

The mean percent test score on nutrition knowledge was 74.9 with a range of 47 to 89%. The areas in which nurses achieved the poorest scores differed somewhat from those found by Vickstrom and Fox (1976). In the study by Schwartz (1976), the poorest scores were achieved in the areas of nutrition and pregnancy, nutrient requirements, nutrient value of foods, and function of nutrients. Vickstom and Fox (1976) found very high scores for functions of nutrients and basic nutrition. The nurses who had received nutrition instruction from a nursing instructor during their training program scored significantly lower on the knowledge test than did those nurses who received nutrition instruction from a nutritionist or dietitian.

The mean score for attitudes was 87.7% with a range of 52.4 to 98.3%. No areas reflected poor nutrition attitudes among the nurses studied.

<u>Nutrition knowledge of educators</u>

In light of the increased interest in nutrition education in the last decade, several investigators have studied the nutrition knowledge of groups of educators. In a study conducted by Semrow (1956), the vast majority of 1,237 public educators surveyed agreed that nutrition education should be included at the early elementary school level. Recommendations from the White House Conference on Food, Nutrition and Health (1970) supported a comprehensive nutrition education program for preschool and school age children and recommended funding for the preparation and education of teachers. Eighty-eight percent of the 191 elementary school teachers Territo (1978) studied believed that nutrition should be an integral part of the elementary school program.

School teachers must be prepared to teach nutrition in their classes if nutrition education programs are to be effective. O'Farrell and Kendrick (1972) found a positive attitude toward teaching nutrition but a lack of effective teaching because teachers felt unprepared to teach the subject. Chethik (1974) reported similar results.

The lack of teacher training was emphasized in a number of other studies. Few of the teachers in Semrow's study (1956) had any formal education in nutrition. Hankin (1959) found that of 114 teacher-education institutions in Florida, Kentucky, California, Pennsylvania, and Wisconsin, only 16 schools required and 9 recommended that elementary teachers complete a nutrition course. Health courses were required by 95 and recommended by 5 schools. Cortes and Standal (1973) interviewed elementary teachers in Oahu, Hawaii. Results showed that 39% of kindergarten to third grade teachers and 15% of teachers of grades four to six had taken nutrition or health courses in college. Fewer than 10% had received nutrition training after college. Petersen and Kies (1972) reported that of 910 Nebraska elementary school teachers surveyed, 33% had no nutrition education background at the college level. Fifty-nine percent of the teachers had taken courses in biology or health, but only nine percent had taken a separate course in nutrition. Eighty-three percent reported no preparatory instruction in methods of teaching nutrition. Results of a study of Territo (1978) in Louisiana showed 45% of the teachers had received nutrition instruction in high school and 27% had completed a college nutrition course. Since 1977, two certification hours of nutrition education have been required for elementary teachers in that state.

Studies of nutrition knowledge of elementary school teachers have been conducted by Petersen (1971), Petersen and Kies (1972), Knudtson (1972), Territo (1978), Franklin (1971), Carver (1976), and Carver and Lewis (1979). Kolasa, Lackey, Penner and Mutch (1979) studied knowledge of Michigan teachers for grades kindergarten through 12.

Petersen (1971) determined knowledge and attitudes of kindergarten to third grade teachers in Nebraska. The instrument used was evaluated and pretested by a small group of elementary school teachers. General knowledge of nutrition, food composition, application of nutrition principles, and food misconceptions were tested in the knowledge portion. Attitudes relating to school lunch quality, school feeding program directors, coordinated classroom-lunchroom programs, and attitudes and techniques related to teaching principles and methods were evaluated (Petersen and Kies, 1972).

Some items used in the test (Petersen and Kies, 1972) were adapted from questions in the knowledge test prepared by Eppright et al. (1970). The highest possible score on the 20-item true-false test was 140, with 2 points being given for correct answers, -2 for incorrect answers, and points for degree of certainty from +5 to +1 for a correct answer and from -5 to -1 for an incorrect answer. Knowledge scores ranged from 0 to 119 with a mean score of 58.3 for the 910 teachers.

When response was considered without degree of certainty information, 10% of the teachers recognized the importance of a good breakfast, 92% indicated that the term well-balanced diet includes food groups in amounts recommended, 96% were aware that a diet was not necessarily adequate when appetite was satisfied, 99% knew that milk was a good source of calcium, and 63% indicated that three daily meals did not ensure a nutritionally adequate diet.

Few (20%) knew that concentrated sweets were not needed for energy, but 97% stated that carbonated beverages were not beneficial to young children. Seventeen percent considered vitamin pills necessary in maintaining good health in young children while 12% were uncertain. Only 59% knew that broccoli, cabbage and tomatoes were good vitamin C sources, but 80% knew that green, leafy vegetables help meet vitamin A needs.

The investigators considered the overall knowledge scores to be low. Items related to food composition were more often missed than items of a general nature.

A questionnaire, including a knowledge test, an attitude scale, a section on sources of nutrition information, and a nutrition teaching opinion section, was prepared and administered to 191 elementary school (K-6) teachers in 10 schools in Baton Rouge, Louisiana (Territo, 1978).

The knowledge test consisted of 21 statements to which teachers responded agree, disagree or uncertain. The attitude section consisted of 12 statements and the opinion section 7 statements, which were also answered agree, disagree or uncertain.

The nutrition content coverage included general nutrition knowledge (33%), food composition (19%), application of basic nutrition principles (19%), and food misconceptions (29%). The mean percent nutrition knowledge score was 65% with a standard deviation of 14%. The range in scores was from 28 to 92%.

Teachers scored better on items relating to general nturition than those that dealt with specific facts. The items most frequently missed assessed knowledge of nutrient functions, nutrient requirements and food misconceptions. Twenty-six percent of the teachers did not agree that vitamin D increases absorption of calcium from the intestine. Twenty-two percent knew that the recommendation for milk intake for one day for an eight-year-old is a minimum of two eight-ounce servings. Only 21% knew that foods containing zinc are important. Seventy percent indicated that grapefruit dissolves body fat. Thirty-seven percent indicated that knowledge of the basic food groups would insure the selection of a nutritionally sound diet. Fifty-three percent believed that vitamin supplements are necessary to insure the good health of all school age children. Sixty-six percent knew the best dietary sources for calcium and that a menu consisting of a hamburger, French fries and coffee will not provide one-third of all nutrients needed daily by adults. Most teachers knew how protein needs related to individual differences (85%), and that a major factor in the onset of dental caries is frequent between-meal eating of concentrated sweets.

Attitudes toward nutrition were positive. There was a significant positive correlation ($p < 0.01$) between knowledge and attitudes, in contrast to findings of Petersen and Kies (1972). Eighty-one percent were interested in attending nutrition education workshops. Teachers needed to know more about where to get reliable nutrition information since most relied upon magazines to stay informed.

Knudtson (1972) measured nutrition concepts held by fifth and sixth grade teachers in Iowa. Students graduating in elementary education from Iowa State University, the University of Iowa and the University of Northern Iowa were not required to take a college course in nutrition. Of the 192 teachers surveyed, 29% had taken a basic course in nutrition in college.

Knudtson identified 33 nutrition concepts important for teachers. Three nutrition experts judged the concepts for accuracy and importance.

Twenty-seven concepts were selected as the basis for developing the test items. Twenty items prepared were of the alternative response type; and 24 were multiple-choice items.

The mean score on the test for the participants who completed all items was 26.40 $\pm$ 4.42 out of 44 possible, with a range of scores from 14 to 27. Eighteen percent of the subjects had scores less than 50% correct. At least 20% of the teachers were unsure of the answers to over nalf of the alternative-response questions. Sixty-eight percent of the group scored between 21.98 and 30.82.

The Kuder-Richardson formula-20 reliability coefficient for the test was 0.62. The standard error of measurement was 2.73. Nineteen questions had difficulty indices above 0.70 and seven questions had indices below 0.30.

Eighty-five percent of the respondents were aware of differences in nutrient needs for individuals and functions of calcium. Subjects knew about energy values of food for some items but not for others. Two misconceptions held by 44% of the teachers were that a candy bar (150 calories) is more fattening than 175 calories worth of roast beef, and that vitamin D-fortified milk is not high in riboflavin. Many teachers considered vitamins an energy source. Similar misconceptions were noted by Linn (1972) for family food aides and by Whistler (1966) for junior high students. On some items respondents seemed confused by information in advertising.

Franklin (1971) compared the nutrition knowledge, attitudes and practices of 84 elementary student teachers and 80 experienced teachers of elementary grades in Texas. Knowledge was assessed with 30 multiple-choice items selected from a test prepared by Carruth (1968). Twenty statements were constructed for the Likert-type attitude scale.

Three categories of learning were used for both the knowledge and attitude scales: knowledge (50%), comprehension (33%) and application (17%). Dietary quality based on the Basic Four Food Groups, dietary regularity based on the concept of three meals a day, and a snack score were determined from a survey of meals eaten daily, kinds and amounts of foods eaten at meals and snacks, and snack times during the day.

The mean score for the student teachers on the 30-item knowledge test was 18.79 $\pm$ 3.30 with a range of scores of 8 to 24. Experienced teachers had a mean score of 20.85 $\pm$ 3.15 with a range of scores of 12 to 27. The difference between the mean scores for the two groups was significant ($p < 0.01$). More of the experienced teachers had science or home economics background and more experiences in teaching health than did the student teachers. This may have accounted for some of the differences in knowledge scores.

The average percent correct responses of 62.6% (student teachers) and 69.5% (experienced teachers) on the 30 items were compared with scores of two groups of college students from Carruth's study (1968). The college students were tested prior to instruction in an introductory food and nutrition course. Average scores for the college students were 67.0% ($n = 127$) and 69.6% ($n = 151$) on the 29 items that were the same between tests for the groups on the two studies. The average score for the student teachers ($n = 84$) for the 29 items was 63.2%.

The difference between the mean scores for attitudes for student teachers and experienced teachers was not significant. There was no relationship between general knowledge and attitudes. For each group, only two attitude items were significantly correlated with knowledge items. Dietary quality was greater for the experienced teachers than for student teachers ($p < 0.05$) and snack scores were significantly higher ($p < 0.01$) for student teachers than for experienced teachers. There was no difference in dietary regularity between the two groups.

Spollen (1974) assessed the nutrition knowledge and attitudes of 102 elementary teachers in New York. Elementary schools were selected from urban, rural and suburban-village areas. Thirty-six multiple-choice items were developed based on the subject matter areas: 1) factors which influence food intake and nutritional status (6 items); 2) nutrient sources, functions and characteristics (25 items); 3) energy needs and diet (4 items). Sixteen items were tested at the knowledge, 12 items at the comprehension, and 8 items at the application cognitive levels. Four faculty members in the Human Nutrition and Food Department at Cornell University reviewed the items. The reliability coefficient for the knowledge instrument obtained using a Pearson Product-Moment correlation and corrected by the Spearman-Brown formula was 0.81. Sixteen items were used to determine attitudes toward nutrition education. The reliability coefficient of the attitude scale was 0.72.

The nutrition knowledge scores on the 36-item test ranged from 8 to 32, with a mean score of 18.4 $\pm$ 5.47. The possible range of attitude scores (on a five-point scale) was from 16 to 80. The actual range of scores was from 16 to 80 with a mean of 59.3 $\pm$ 6.09.

In a study conducted at Pennsylvania State University for the School Nutrition Education Study (Carver, 1976; Carver and Lewis, 1979), a test was designed to assess competencies in both nutrition subject matter and in interpretation of lay literature on nutrition. The first part of the test included 24 true-false questions with provision for degree-of-certainty responses. On a five-point scale, a rating of 1 indicated the most confidence in an answer. Correct responses with degrees of certainty of 1, 2, 3, 4, 5 were scored 9, 8, 7, 6, 5, respectively, where as incorrect responses with degrees of certainty 1, 2, 3, 4, 5 were, respectively, scored 0, 1, 2, 3, 4. Questions were modified from those used by McCarthy and Sabry (1973). Content categories covered concepts outlined by the Interagency Committee on Nutrition Education (Hill, 1971). Content areas were: food fads (12.5%); environmental factors--food attitudes, pesticide residues, food processing, food enrichment (8%); weight loss and gain (12.5%); sources of nutrients (25%); nutrient functions and requirements (17%); digestion, absorption, metabolism, and excretion (17%); and food storage, purchase and preparation (8%).

The second part of the test involved the reading of paragraphs from five references on nutrition. Fifteen questions were answered with either: a) True (stated in paragraph); b) True (implied in paragraph); c) True (know from outside sources); d) False (stated in paragraph); e) False (implied in paragraph); f) False (know from outside sources); or g) Don't know whether true or false. The correct answers to all questions in this part were either c) or f).

Three groups of nutritionists participated in the study: preservice elementary school teachers at Pennsylvania State University (n = 74); inservice elementary school teachers at two Pennsylvania and two New York schools (n = 40); and nutrition majors and faculty at the University of Wisconsin-Stout and Cornell University (n = 22). Results are found in Table 7. On each section of the test, the mean score for the nutrition group (21.5 for True-False (TF), 9.7 for Multiple-Choice (MC)) was significantly higher ($p < 0.05$) than the mean scores for either the preservice (14.5 for TF, 4.3 for MC) or inservice teachers (15.3 for TF,

Table 7. Means, standard deviations and reliability coefficients on a nutrition knowledge test[a]

Description of Subjects	N	True-False		True-False with Degree of Certainty	Multiple-Choice	
		Mean ± S.D. (Maximum = 24)	K-R Formula-20 Reliability	Mean ± S.D. (Maximum = 216)	Mean ± S.D. (Maximum = 15)	K-R Formula-20 Reliability Index
Preservice teachers	74	14.5 ± 2.7	.44	125.6 ± 20.8	4.3 ± 2.5	.52
Inservice teachers	40	15.3 ± 3.2	.60	134.4 ± 26.8	3.2 ± 2.5	.58
Nutrition students and faculty	22	21.5 ± 2.1	.57	185.1 ± 17.9	9.7 ± 1.9	.22
Total sample	136	15.8 ± 3.7	.72	137.8 ± 30.7	4.8 ± 3.1	.73

[a]SOURCE: Carver, 1976; Carver and Lewis, 1979.

3.2 for MC). The pre- and inservice teachers did not differ significantly in their performance. The range of scores for the true-false section of the test was 16 to 24 for those trained in nutrition and 9 to 21 for a combination of the two groups. The range of scores for the multiple-choice items was 6 to 13 for those trained in nutrition, and 0 to 11 for the other two groups.

Nutrition students and faculty scored highest on items dealing with environmental factors (food attitudes, pesticides, food processing, and food enrichment) and on weight gain and loss. Inservice teachers did nearly as well as those trained in nutrition on questions relating to food storage, purchase and preparation. The mean score for preservice teachers was significantly lower ($p < 0.05$) than those of inservice teachers on one content area, that of food fads.

Test reliabilities (0.57 for TF, 0.22 for MC) for nutrition students and faculty were low. The reliabilities might have been improved by including more test items, modifying items to make them more similar in style or complexity of subject matter, including more difficult test items, or testing a larger and less diverse group of subjects. Correlation coefficients between scores on the two parts of the test increased as the background in nutrition increased.

Byrd-Bredbenner (1981) developed a nutrition knowledge test for nutrition educators. Three broad nutrition concepts--basic nutrition principles (50% of items), sources of nutrients (28% of items) and functions of nutrients (22% of items)--served as the framework for this test. A group of 20 graduate students and staff in nutrition and home economics education completed a pilot test of the 94 multiple-choice items. For the final 50-item test instrument, test items that met the difficulty index criterion of 0.70 or greater were selected preferentially. Items tested at the cognitive levels recall (24%), comprehension (52%), application (18%), and analysis (6%).

A group of 35 college students from a variety of majors completed a pilot test of the final 50-item instrument. The mean score was 38.5, with a range of scores from 20 to 50. The Kuder-Richardson formula-20 reliability was 0.86.

One to ten years had elapsed since subjects had received baccalaureate degrees. Of the 1,800 subjects surveyed, 576 (32%) returned completed mail-out instruments. The difficulty index was 0.80 to 1.00 for 28 of the 50 test items. The Kuder-Richardson formula-20 reliability for all subjects was 0.816. Table 8 presents the mean scores and reliabilities on the nutrition knowledge test for each group of subjects.

Table 8. Nutrition knowledge scores and Kuder-Richardson formula-20 reliability estimates of subjects including nutrition educators

Group (n)	Score Mean $\pm$ S.D.	Reliability
Nutritionists (134)	44.1 $\pm$ 3.4	0.64
Home economists (93)	40.9 $\pm$ 4.6	0.73
Nurses (105)	37.1 $\pm$ 4.6	0.68
Health and physical educators (77)	35.7 $\pm$ 5.2	0.72
College graduates, general (88)	35.6 $\pm$ 5.4	0.74
Elementary educators (79)	33.0 $\pm$ 5.0	0.68
Total (576)	38.4 $\pm$ 6.0	0.82

Nutritionists received significantly higher ($p < 0.05$) mean scores on the nutrition knowledge test than all other groups; home economists scored significantly higher ($p < 0.05$) than did all other groups except nutritionists; and nurses, health and physical educators, and college graduates in general all scored significantly higher ($p < 0.05$) on the nutrition knowledge tests than did elementary educators.

A nutrition knowledge test for teachers, kindergarten through twelve, was developed by Kolasa et al. (1979). The instrument was to be used as a pre-post-test for teachers attending nutrition training sessions. Concepts were identified from curriculum guides and basic nutrition textbooks. Concepts were categorized according to the seven concepts outlined by the White House Conference on Food, Nutrition and Health (1970). Five hundred four test items were developed or selected from existing instruments. Faculty and graduate students at Michigan State University reviewed the items for accuracy of content. Three test forms were compiled from the 109 items that remained after evaluation. Twenty-four attitude or behavior items were included on each form. Instruments were pretested with 270 education and 230 nutrition students on a take-home basis. Pretest forms were mailed to 435 teachers.

Items were selected for a second round of testing based on results of item analysis. Items which had a discrimination index below 0.30 were deleted; those with indices between 0.30 and 0.40 were revised; and those with indices of 0.40 or above were retained for further testing.

Tests which contained 50 knowledge and 33 attitude and behavior items were mailed to a random sample of 477 teachers who were members of the Michigan Education Association, 403 teachers who had attended Dairy Council Workshops, and 526 members of the Society for Nutrition Education. Mean knowledge scores were 27, 28 and 47 for the teachers (n = 153), Dairy Council teachers (n = 40) and Society for Nutrition Education (SNE) members (n = 234), respectively. The overall mean was 43. The reliability estimate for the test administered to the Michigan Education Association teachers was 0.73 (0.24 for the 16 true-false and 0.63 for the 34 multiple-choice items). For the Dairy Council teachers, the reliability was 0.57 (0.40 for the true-false and 0.48 for the multiple-choice) and for the SNE members 0.71 (0.50 for the true-false and 0.63 for the multiple-choice). The reliability index for all respondents was 0.93 (0.77 for true-false and 0.86 for multiple-choice). The items that had discrimination indices of 0.40 or above were included on the final test form. Reliability estimates for the final 40-item test were 0.73 for Michigan teachers (0.28 for 12 true-false and 0.69 for 28 multiple-choice), 0.59 for Dairy Council teachers (0.43 for true-false and 0.48 for multiple choice), and 0.73 for SNE members (0.42 for true-false and 0.68 for multiple-choice).

Lackey et al. (1981) reported test scores of groups of education students (n = 64), nutrition students (n = 173) and teachers (n = 284) on three forms of a test prepared using concepts from the White House Conference on Food, Nutrition and Health (1970). The tests consisted of 20 multiple-choice and 15 true-false items. Mean scores and standard deviations were 23.9 $\pm$ 3.82, 24.6 $\pm$ 3.92 and 24.4 $\pm$ 7.25 for education students; 27.6 $\pm$ 8.02, 27.5 $\pm$ 7.95 and 27.3 $\pm$ 9.50 for nutrition students;

and 25.4 ± 5.07, 26.3 ± 3.39 and 27.8 ± 2.96 for teachers. Kuder-Richardson formula-20 reliability coefficients for the three test forms were 0.87, 0.82 and 0.90 for test forms A, B and C, respectively, for all subjects (n = 521). Reliability coefficients for education students were 0.59, 0.62 and 0.92; for nutrition students were 0.94, 0.94 and 0.96; and for teachers were 0.79, 0.55 and 0.54, for test forms A, B and C, respectively.

Based on the results obtained from forms A, B and C, the investigators constructed test form D, containing 16 true-false and 34 multiple-choice items. Test forms were mailed to subject groups. Nutrition educators (n = 299, 57% response) had a mean score and standard deviation of 38.38 ± 14.99. The two groups of teachers tested had scores of 25.14 ± 9.04 (n = 208, 44% response) and 14.57 ± 14.63 (n = 61, 15% response). The Kuder-Richardson formula-20 reliability for test form D calculated from data of the entire sample was 0.93. Another form of the test was constructed which included 40 items but no results of test administration were reported.

Nutrition knowledge of groups receiving nutrition education

Intervention efforts have been made to improve the nutrition knowledge of various groups. Pre- and post-tests have been employed in most instances to assess whether knowledge increased as a result of the intervention.

Nutrition instruction was given by Boysen (Boysen and Ahrens, 1972) to a class of 30 second graders from Maryland in 30-minute daily segments for four weeks. The aims of the program were to create an awareness of the need for good food and to have the children understand and apply the four food group plan. Pretests comprised of 16 true-false and multiple-choice questions were administered to both the experimental (n = 30) and control (n = 29) groups. Mean scores on the pretest were 7.77 and 7.52 for the experiment and control groups, respectively. Knowledge increases of 70.5% and 28.7% resulted in mean post-test scores of 14.89 and 10.88 for the experimental (n = 27) and control (n = 26) groups, respectively, on the 18-item post-test.

Students in the experimental group improved their scores both on the test as a whole and on questions that were repeated. Improvement was not as great for the control group, although they had received some nutrition information during health lessons in the regular curriculum. Scores increased more than 100% for the experimental group for reported items dealing with amount of meat recommended each day, the need for vitamin pills, a comparison of white and dark bread, and selection of foods from each of the four food groups for a meal. The control group showed a similar increase in ability only on the last-mentioned item. The data were not analyzed statistically.

The percentage of students in the experimental group who ate an adequate breakfast (juice or fruit, plus milk, plus a main dish such as cereal or eggs) increased from 20 to 44%. Pretest results from the control group showed 30% eating an adequate breakfast. Nineteen percent were evaluated as eating an adequate breakfast on the post-test.

The experimental group was better able to selected a well-balanced meal than was the control group at the end of the experiment. On the post-test, 74% of the experimental group and 31% of the control group selected a well-balanced breakfast.

Increased knowledge did not relate to application of knowledge in surveys of lunches brought from home and those eaten at school. The waste of fruit and milk was high and lunches brought from home were of poor nutritional quality. Twenty to 46% of the students left half or more of their fruit and from 10 to 20% left half or more of their milk. The number of students in the experimental group who left all of their milk decreased from 14.7% before nutrition education to 4.8% two weeks following the program.

Fanalow, Brun and Hausafus (1981) developed and validated three nutrition achievement tests for kindergarten through sixth grade. Test I was for kindergarten, first and second grades; test II, for third and fourth grades; and test III, for fifth and sixth grades. Concepts tested included physiological facts, nutrients, food handling, life cycle, social/psychological aspects of food, food technology, and food and society. Two prototypes of each test were constructed from multiple-choice items paired for content. Accuracy of content was reviewed by dietitians and nutrition specialists. Evaluation specialists examined items for adherence to item-writing principles and elementary teachers evaluated the tests for appropriateness of the content and of the reading level.

Tests were administered to students from seven different states as well as from low, middle and high socioeconomic levels. In order to ensure that test statistics would apply to achievement or post-instructional situations, the sample included only school systems in which pupils had received at least eight hours of nutrition instruction within the three months prior to test administration. Test statistics were determined by averaging data from the two prototype tests. Results are noted in Table 9. Reliability coefficients were calculated by the Spearman-Brown procedure. From test results, the best test items from the paired sets of items were selected for the final tests.

Table 9. Test statistics for nutrition achievement tests

Data	Grade Level						
	K	1	2	3	4	5	6
Number of items	20	30	40	30	40	50	50
Sample size	179	249	313	240	234	244	241
Reliability coefficient	0.71	0.80	0.78	0.75	0.86	0.83	0.87
Mean score	12.6	20.4	27.4	16.7	21.9	21.5	25.0
Standard deviation	3.3	4.3	4.5	4.5	6.3	6.7	7.8
Range of scores	3-20	6-30	10-39	7-29	6-37	6-50	8-50
Average difficulty (%)	60	67	69	55	56	43	51
Average discrimination	0.39	0.37	0.31	0.34	0.39	0.33	0.37

The purpose of a study by Lovett, Barker and Marcus (1970) was to evaluate the effectiveness of the Dairy Council program "Big Ideas in Nutrition Education and How to Teach Them" (Dairy Council of California, 1970). Results of pre- and post-testing of second grade teachers on 12 items concerned with nutrients, the Four Food Groups, and cultural aspects of food, showed an increase in knowledge of 69%, from 57.8 to 97.5%

after attending training workshops. The range of individual scores on the post-test, 91 to 100%, showed that all participants had attained a high level of knowledge of the subject matter tested.

Second grade students also served as subjects for nutrition assessment. Three student groups were involved: an experimental group (n = 569) whose teachers had been trained and who taught the nutrition program to the second grade students; a semi-control group (n = 765) whose teachers taught the program with no prior training, and a control group (n = 286) whose teachers were supplied only with general objectives. Each group was taught nutrition an average of one hour per day for three weeks.

Identification of the Four Food Groups was one pre-post-test measure of knowledge of nutrition. The mean score for the experimental group improved 360% between pre- and post-testing from a percent score of 16 to 75. The scores for the pre- and post-test for the semi-control group were 24 and 37%, respectively, and for the control group 18 and 31%, respectively.

On the second measure of knowledge, that of ability to select a balanced breakfast, lunch and dinner, the experimental group showed a 151% increase; and the semi-control and the control groups showed increases of 39 and 22%, respectively, between pre- and post-testing periods. Pre- and post-test scores on the second part were for the experimental group 0.54 and 1.35, for the semi-control group 0.59 and 0.82, and for the control group 0.64 and 0.78, respectively.

The experimental group showed significantly more improvement ($p < 0.01$) in knowledge of nutrition than the other two groups. The semi-control and control groups did not differ significantly from each other.

One aspect of behavior or food habits assessed was that of selection of a balanced breakfast. The improvement for the experimental group between pre- and post-test periods was 60%, for the semi-control group 25% and for the control group 35%. When 109 parents were surveyed about their child's attitude toward nutrition, fewer of the parents of children in the experimental group were aware of the three-week nutrition course than the other two groups, even though there had been a greater change in behavior of the children in the experimental group.

The objective of a study by Norton (1974) was to develop and present a nutrition education program for third grade children and to assess changes in knowledge of nutrition, attitudes toward nutrition and their nutritional practices and status. The experimental design involved a pretest, post-test and retention test administered to experimental and control groups of subjects. The school selected for the study was Dodge Park Elementary School, a racially-balanced school in a low socio-economic suburb of Washington, D.C. Four third grade classes ($n = 128$) were involved in the study.

The conceptual framework for nutrition education in schools (White House Conference on Food, Nutrition and Health, 1970) formed the basis for the program. Knowledge level objectives were formulated for the general statements. Content areas included nutrient functions and sources, energy and the Basic Four Food Groups.

Twenty multiple-choice items were designed to test knowledge of nutrition. Twenty-five statements related to eating habits, food preferences, and beliefs about nutrition of two fictitious eight-year-old children were used to assess attitudes. A food frequency questionnaire containing 53 food items was used to identify usual eating habits. The frequency of intake was recorded: eat every day, frequently, occasionally, sometimes, never, and these were rated on a five-point scale. A panel of experts in nutrition reviewed the three test instruments for content; and a group of third grade teachers assessed the language level. Hemoglobin values were used as a measure of iron nutriture. Height and weight measurements were recorded.

Pretest information was obtained in the four days before the three-week nutrition education unit was taught. Post-test and retention test results indicated no significant change in attitudes, eating habits or knowledge of nutrition. There was only an insignificant gain in knowledge of nutrition between the pre- and post-test for both the experimental and control groups. Mean scores were 42.23, 47.90 and 47.64 out of 100 points for the experimental group on the pretest (n = 53), post-test (n = 58) and retention (n = 52) test, respectively.

The control group actually increased its mean score between the post-test (42.07) and a retention test given after three months (47.30) because a unit on food had been taught between the two test periods.

The mean hemoglobin value of the control group decreased during the period from the pre- to post-test, then increased slightly by the time of the retention test. The mean hemoglobin value for the experimental group increased during the time from the pretest to the retention test. There was no significant difference in the mean pretest hemoglobin values between groups. At the time the retention test was given, the mean hemoglobin value for the experimental group was significantly increased ($p < 0.05$) over that of the control group. The author interpreted the results to indicate that nutritional status can be an objective measure of the success of a nutrition education program.

Smith (1977) measured the influence of a nutrition education program, "More Vegetables Please," and a parent education program on the comprehension and application of knowledge of nutrition by third grade students. Students from 12 classrooms in five urban Indiana elementary schools participated. In two classrooms, the parents received the parent education program; in two classrooms, the nutrition education program was introduced to students; and in two classrooms, both educational programs were utilized. The experimental classrooms were randomly selected. There were approximately 29 to 30 students per class. Two classes served as the control group (assigned) and four classes pretested the instruments (randomly selected).

The investigator conducted the student nutrition education program, which consisted of eight 45-minute nutrition lessons. One lesson was presented each week for eight weeks. The program included such facts as that vegetables come from different parts of plants; that different foods, including vegetables, are important to growth and health; and that good food habits and favorable attitudes toward vegetables can be developed.

For the parent education program, students took a series of six letters home to parents, one each week, plus an invitation to visit the satellite lunch kitchen and eat lunch at school for one day. The objectives for the parent education program were to make parents aware that a variety of foods, including vegetables, can make a difference in the growth and health of children; to have parents become more supportive of the school lunch program; and to have parents become more knowledgeable about nutrition.

Results of a 20-item multiple-choice nutrition knowledge test, a vegetable hedonic rating scale, and a lunch questionnaire, administered two weeks before and two weeks after the eight-week experimental period, were used for student evaluation. An evaluation form requesting the opinion of the program was sent to parents.

The nutrition knowledge evaluation instrument used had a reliability of 0.81 and a mean test difficulty of 0.49 when tested with 51 students. The index of discriminability was calculated by dividing the number of high third scorers passing the items by the total number in both the high third and low third groups passing the item. All 20 items had an index of discriminability above 0.67 when pilot tested.

There was a slight improvement in the cognitive nutrition scores from pre- to post-tests for all groups of students. There was, however, no significant improvement in knowledge of nutrition for the experimental groups as compared to that of the control group. Mean knowledge scores on the pretest were 13.81 $\pm$ 3.13, 13.29 $\pm$ 3.98, 12.51 $\pm$ 3.50, and 14.09 $\pm$ 3.25 for the control, student education, parent education, and parent and student education groups, respectively. In the last two groups, it was the nutrition knowledge of students whose parents had been involved in the program that was assessed. Mean scores on the post-test for the same groups were 14.82 $\pm$ 2.75, 14.15 $\pm$ 3.95, 14.02 $\pm$ 3.21, and 14.25 $\pm$ 3.51, respectively. There was no significant difference in scores between pre- and post-tests for any of the groups (Smith and Justice, 1979).

Trends toward significance in ratings for 11 of the 16 vegetables for the control and the three experimental groups was noted, but the only significant change ($p < 0.05$) was in the rating for lettuce made by the parent education group compared to the rating made by the control group. All groups receiving nutrition education accepted vegetables better after the treatment.

Nutrition education workshops were conducted by the Ontario Milk Marketing Board for teachers of kindergartern through third grade. Groups of third grade children were tested on ability to classify foods into the Four Food Groups and to select a balanced meal (Cooper and Philp, 1974). The control group consisted of students who had not yet received nutrition education as the result of their teacher attending a workshop. Two test groups were comprised of students whose teachers had attended a workshop from five to nine months prior to the tests.

One group was selected from areas where the school board strongly endorsed the nutrition education programs.

Students were given pictures of eight foods and asked to classify them into food groups. The control group (n = 375) had an average score of 39%. In contrast, the board-endorsed test group (n = 170) had a mean percent score of 81%.

When students were asked to choose four foods, one from each food group to provide a balanced meal, 14% of the students in the control group were able to perform this task. In the first test group (n = 544) 22% of the students accomplished the objective, and 38% in the board-endorsed group were able to reach this goal. From the results, the investigator concluded that the students were able to perform better when the workshop information reached them.

Differences in knowledge of nutrition before and after the nutrition education program "Mulligan Stew" were measured with a 37-item test administered to 129 fourth graders in Wisconsin (Jenkins, Stumo and Voichick, 1975). In addition, the change in dietary adequacy was assessed using two three-day food records, one completed a week before the program started and one completed a week after the conclusion of the program.

The knowledge test, consisting of 37 multiple-choice and fill-in questions, was administered to four experimental groups and two control groups of students before the program started. The same test, with the order of the items changed, was given eight weeks later. The control group served as a check on the effect of using the same pre- and post-test items.

Classroom teachers from four participating schools served as instructors. A training session was held to standardize elementary classroom activities.

Knowledge tests were completed by 129 students. Scores for experimental and control groups are given in Table 10.

Table 10. Pre- and post-test knowledge scores of fourth graders in Wisconsin[a,b]

	N	Pretest Mean ± S.D.	Post-test Mean ± S.D.
Experimental			
Group 1	24	9.8 ± 0.9	19.5 ± 0.8
Group 2	26	12.4 ± 0.7	20.3 ± 1.1
Group 3	23	10.8 ± 0.6	13.3 ± 0.8
Group 4	19	10.8 ± 0.8	22.0 ± 0.9
Total	92	11.0 ± 0.7	20.7 ± 0.9
Control			
Group 1	22	12.4 ± 0.9	14.3 ± 0.9
Group 2	15	11.1 ± 0.9	12.3 ± 1.1
Total	37	11.9 ± 0.9	13.5 ± 1.0

[a]Scores are based on a total of a possible 37 correct answers.

[b]Source: Jenkins, Stumo and Voichick, 1975.

There were no statistical differences among groups of students in pretest scores. The experimental classes scored significantly higher ($p < 0.01$) on the post-test than did the control groups. Students in three experimental groups scored higher ($p < 0.01$) than those in a fourth experimental group. The graduate student observing all sessions thought this difference could be explained by the lack of discipline in the fourth group.

All questions on the test were positively discriminating. The greatest improvement was shown on questions relating to Basic Four Food Groups, weight reduction, and function of energy-yielding nutrients.

In general, food records showed that diets contained significantly smaller smounts of protein, calcium, iron, vitamin A and vitamin C after the program than before the program ($p < 0.05$).

A nutrition education program was designed for fourth grade students in a Wisconsin school (Smith and James, 1980). Six lessons were planned which involved cooperation between the classroom and the school lunch program. Lessons included the goals of good nutrition, a tour of the school kitchen and a vegetable tasting party, a Type A lunch, nutrition labeling, the importance of breakfast, and nutritious snacks. Concepts used as the basis for the lessons were related to some of the concepts recommended by the White House Conference on Food, Nutrition and Health (1970).

Changes in knowledge and behavior as a result of nutrition education were investigated. Knowledge assessment consisted of categorization of foods from two menus into food groups, identification of nutrient sources, and selection of foods for breakfast, snacks and a Type A lunch.

The mean scores and standard deviations on the 66-point test for the 57 students completing the pre- and post-tests were 37.8 ± 7.8 and 49.5 ± 6.2, respectively. The difference between pre- and post-test scores was significant ($p < 0.001$).

Lunches consumed were analyzed according to the Basic Four Food Groups on eight days throughout the unit. The only significant change ($p < 0.001$) in behavior was a change in the number of students drinking milk for lunch. The increase was apparent on the fifth survey and was sustained through the eighth survey, and in the follow-up survey conducted 40 days after the completion of the nutrition unit.

A program in nutrition education for fourth and fifth graders in Iowa was prepared by Baker (1969, 1972); and a study was designed to measure knowledge of nutrition before and after program implementation. Objectives of the program were to formulate a concept of health involving optimum well-being; comprehend the dependence of health on food; improve food habits if necessary; and recognize that diet interacts with many factors to affect health.

Experiences were organized into 13 daily lessons of 30 minutes each plus two follow-up experiences. The investigator taught each of the classes. Test items were prepared and pretested in open-ended format to 70 fourth and fifth grade students. Multiple-choice items were reviewed by an evaluation specialist. The test was administered to four graduate students in nutrition and revised. The 105 items were administered to fourth and fifth graders. When fewer than four students selected responses, items were deleted. The final 64-item nutrition test, which contained 12 multiple-choice and 52 true-false items, was administered before, immediately following, and five months after the teaching of the experimental unit. Kuder-Richardson formula-20 reliabilities were 0.28, 0.65 and 0.54 for the pretest, post-test and follow-up test, respectively.

Scores of the experimental group ($n = 127$) improved significantly more ($p < 0.01$) than did those of the control group ($n = 140$) between the pre- and post-test administrations. Pre- and post-test scores for the experimental groups were 29.7 and 36.3, respectively. Control group mean scores were 30.2 and 30.9, respectively, for the pre- and post-test. After five months the mean for the experimental group was 33.3 and for the control group 32.9.

Students apparently needed instruction in classification of foods according to relative calorie and nutritive values. They also needed experience in identifying major nutrient sources. No significant changes in dietary intake due to the program were observed. No relationship was found between scores on the knowledge test and nutrient intake.

Bell and Lamb (1973) determined the influence of The Dairy Council "Big Ideas" nutrition education program (Dairy Council of California, 1970) on knowledge of nutrition, and school lunch, milk and vegetable consumption of fifth grade students. Students ($n = 1,464$) from five midwestern states served in either the experimental group, which participated in the nutrition education program for six weeks, or the control group. Fifth grade classes were randomly selected with one class serving as a control, one as an experimental group, and one as a placebo group, in each of 33 schools.

School lunch, vegetable, and milk consumption were measured one week before and one week after the nutrition education program. For five consecutive school days, portions of vegetables and milk not consumed were weighed or measured to establish changes in eating practices.

Faculty at Texas Tech University and nutritionists of the Dairy Council of California developed cooperatively a 15-item objective test to measure knowledge, comprehension and application of knowledge of nutrition. Content validity was examined against behavioral objectives in the module. Content validity was established with fifth grade students. The same test was administered before, immediately following and six weeks after the conclusion of the experiences. Items representing knowledge and comprehension levels in the cognitive domain were assigned one point each for a total of 52 points, and those at the application level were given two points each for a total of 30 points. It is not certain if the test contained 15 or 67 items. Consultants for the Dairy Council administered the tests and collected and recorded food consumption data.

Post-test scores exceeded pretest scores from 4 to 64%, with a mean increase of 31%, in the combined experimental groups. For the control groups, 26 schools showed increases in mean scores ranging from 2 to 28% with a mean of 8%. Mean scores on the retention test were the same as post-test mean scores for both groups. The experimental group had significantly higher ($p < 0.001$) test scores than did the control group on the post-test and retention test.

Milk consumption increased for the experimental group an average of 8%, while the mean increase for the control group was 3.9%. Neither increase was significant. The experimental group had a greater increase ($p < 0.05$) in vegetable consumption (6.1%) than did the control group

(0%). Although some possibility for change in dietary behavior may be indicated, dietary behavior was not modified as much as cognitive learning was for students participating in the nutrition edcuation program.

Tinsley et al. (1981) developed a nutrition and physical fitness knowledge test for fifth and sixth grade students. The objectives of the curriculum from which the test was developed were derived from the basic concepts for nutrition education developed by the 1969 White House Conference on Food, Nutrition and Health. The curriculum, Nutrition Super Stars, was presented in 17 classrooms.

A test consisting of 30 four-option multiple-choice items was prepared and administered as a pre- and post-test to 330 instructed and 178 uninstructed students. The Cronbach alpha internal consistency reliability on the pretest was 0.81. The mean gain score for the instructed group (4.8 items) was significantly greater ($p < 0.001$) than that of the uninstructed group (2.7 items).

Results of a study conducted by Head (1974) showed the effect of integrating a five-month nutrition education program consisting of skits, field trips to grocery stores and tasting parties into the regular curricula of selected fifth, seventh and tenth grade classes in North Carolina. Four classes at each grade level, with an average class size of 26, served as experimental groups. Students from five schools in the same geographical area served as controls. The major objective was to determine if nutrition education would contribute to any change in food habits or acceptability of foods served in the school lunch program. A one-week workshop served as a training time for classroom teachers.

Pre-instruction data were obtained that included results from nutrition knowledge tests, 10-day acceptability ratings of school lunch foods, five-day plate waste measurements, and three-day dietary recalls. No specific information was given in the report about the nutrition knowledge test. Pre- and post-test mean scores were not reported, but it was stated that all fifth grade classes and one seventh grade class significantly improved ($p < 0.05$) their knowledge of nutrition as measured by cognitive tests when compared to the performance of control subjects. Twenty-four and 37% of the fifth graders had scores of 80% correct or higher on the pretest. Seventy-three percent of the experimental subjects had scores greater than 80% on the post-test. Post-test scores for the control groups were 80% or higher for 57 and 41% of the students. Fifty-three percent of the students in one seventh grade class had scores 80% or higher on the pretest, and 83% of the students scored that high on the post-test. Only 50% of the seventh grade control participants had scores of 80% or higher on the post-test.

Diets of seventh graders in experimental groups were significantly better ($p < 0.05$) than those of control subjects after nutrition education. The three-day dietary recalls were judged according to the Basic Four Food Group Plan. Both experimental and control groups of fifth graders markedly improved their diets. No differences between groups were apparent with post-test measures. Plate waste of fifth graders decreased significantly ($p < 0.05$) after the nutrition education program for the experimental as compared to the control groups. Acceptability ratings of school-prepared foods increased among fifth grade experimental groups more than among other groups.

A programmed instruction unit for teaching nutrition to sixth grade students was developed and evaluated by Luther (1973). The unit was based on three concepts recommended for nutrition education at the White House Conference on Food, Nutrition and Health (1970, p. 151).

1. Nutrition is the process by which food and other substances eaten become you.
2. Food is made up of certain chemical substances that work together and interact with body chemicals to serve the needs of the body.
3. All persons throughout life, have need for about the same nutrients, but in varying amounts.

Health and science textbooks were consulted to determine the appropriate level for instruction. The programmed instruction was planned to take four class periods.

A 50-item multiple-choice test was prepared and pilot tested with 122 sixth grade students. Scores ranged from 9 to 46, with a mean of 28.40 $\pm$ 6.79. The Kuder-Richardson formula-20 reliability was 0.57. Forty-two items were retained for the pre-post-test instrument.

The mean pretest score for all students ($n = 84$) was 17.25 $\pm$ 5.04. Scores ranged from 8 to 29. The mean post-test score for the 40 students who studied the programmed unit was 21.70 compared to 17.02 for the 44 students who served as the control group. The post-test reliability for the experimental group was 0.83, and for the control group 0.66. The gain in scores by the experimental group was significantly higher ($p < 0.001$) than that for the control group (10.0% versus 0.09%, respectively).

Ninety-one percent of the students were able to identify the Basic Four Food Groups, but only 21% were able to identify foods from each group. Thirty-eight percent could identify the minimum number of servings recommended from each food group for a 12-year old. Most students could select the correct definition for a cell but many did not know what happened within cells. Ninety-two percent thought that most children need to take vitamin pills. In general, students were unable to answer the questions about functions of nutrients and nutrient composition of foods.

Weber (1965) delineated concepts basic to an understanding of nutrition and stated eight generalizations about nutrition at a level appropriate to junior high school students. Content included nutrient functions, energy, and food selection according to food groups. Information was taught by means of eight units of programmed instruction, one per class period in seventh grade home economics classes. At the end of each unit students were asked to choose the formal statement best describing the generalization developed.

Pre- and post-tests were designed to measure learning. Thirty-two five-option, multiple-choice items were prepared, four for each of the eight units. Each of the four questions represented four different levels of cognitive understanding. Items were reviewed for content validity and level of understanding. After pilot testing, items with difficulty levels below 0.15 or above 0.86 and nondiscriminating items were deleted. Revisions were made with less emphasis on levels of understanding and a broader coverage of subject matter.

A second form of the test was constructed and both tests expanded to 45 items, 23 tested at the knowledge level and 22 questions tested at higher than knowledge levels. Judges agreed on levels for 78 of the 90 items. The test grid followed the pattern:

Level	Units 2 & 3 Energy	Unit 4 Protein	Unit 5 Minerals	Unit 6 Vitamins	Units 1, 7, 8 Nutrients & Food Selection
Knowledge	5	2	3	6	7
Above knowledge	6	4	4	3	5
Total items	11	6	7	9	12

Seventh grade students were involved in the program, 119 in an experimental group and 81 in a control group. There was no statistical difference between the mean age or IQ of subjects in the two groups. Subjects in each group were randomly assigned form I or form II as a pretest. Pretest mean scores for the experimental and control groups were 17.0 ± 4.9 and 15.2 ± 3.7, respectively. There were no significant differences in scores between groups, nor was there any difference between scores on the two test forms or on the knowledge versus above knowledge items on either form.

Post-test mean scores were 15.6 ± 4.5 for the control group and 24.5 ± 5.8 for the experimental group. There was a significant gain ($p < 0.01$) in knowledge of nutrition on the part of the experimental group but no significant gain for the control group. Again there was no difference in either group between mean scores on the two test forms or on the knowledge versus higher than knowledge items on either form. The most difficult unit on the post-test for the experimental group was Unit 4--Protein. The achievement on that unit was 38.3%, whereas the average test scores for the other units were above 50%. The range of difficulties on the two forms were 0.20 to 0.90 with a mean of 0.56 for Form I, and 0.16 to 0.90 with a mean of 0.54 for Form II.

Hardinger (1974) identified curriculum approaches to teaching nutrition effectively to seventh grade boys. Materials consistent with the approaches were designed. Topics included nutrients, nutrients in foods, serving sizes, the Daily Food Guide, food selection and preparation, and weight maintenance. Sanitary practices were applied in preparation of snacks.

Student achievement was measured with a test containing 32 multiple-choice items. Items were modified from a test developed by Luther (1973). The Kuder-Richardson formula-20 reliability for the total group of 265 students (boys and girls) tested was 0.73. The difficulty index ranged from 31 to 92%. One third of student scores were above 70%. Some items were answered correctly by most of the group. Those concepts dealt with recognizing foods within food groups and counting calories. Items answered correctly by one-half or fewer of the students involved specific nutrient food sources and evaluating a menu for Basic Four food group specifications. The latter required higher levels of intellectual skills. Food sources of iron were recognized more frequently than vitamin C food sources.

A teams-games-tournament (TGT) approach was used in development of two nutrition units, one for sixth graders (Lockshin, 1978) and one for high school students (10th through 12th grades) enrolled in home economics courses (Wodarski et al., 1980).

The TGT technique involved small groups as classroom work units, games as teaching devices and a reward structure which recognized group, rather than individual, achievement. The technique, when used at various grade levels (grades 3 through 12), and in a variety of subject matters (social studies, language arts, reading, and mathematics), has appeared in many instances to have more positive results than traditional approaches (DeVries and Slavin, 1978).

The approach was attempted since units could be prepared inexpensively, be easily implemented, innovative, complement the existing curriculum, and be geared to the interests and motivations of students. Petersen and Kies (1972) found these criteria to be important for reception by teachers and use in a long-range program.

The content of the TGT nutrition units focused on tne application of nutrition concepts; behavioral objectives emphasized skills which would enable students to make wise food selections. The information was presented by inquiry, discussion and discovery learning experiences, and was reinforced daily by games which were essentially skill drills. Topics covered in the sixth grade unit were food and nutrients, label reading, sugar and tooth decay, and refined versus unrefined foods. The high school unit covered, in addition to those topics, information on food preparation and service, diet in relation to health, and physical appearance.

Nutrition units were presented by classroom teachers for 45 minutes per day for three weeks in two sixth grade classes (n = 25, 22) and for 50 minutes per day for four weeks in two high school classes (n = 12, 24). Three days a week were spent introducing nutrition concepts in discussions, demonstrations and participatory activities. The fourth day was devoted to working in teams on worksheets to prepare for the tournament on the fifth day.

Students were placed in groups of four based on nutrition knowledge pretest scores. Groups included one high achiever, two average achievers, and one low achiever. When short-answer questions were asked in tournament games, students competed against students of comparable levels on other teams.

Sixty questions were developed for the pre- and post-tests for each grade level. Students checked readability for their grade levels and content validity was evaluated by a panel of three faculty members in Food and Nutrition and Institution Administration at the University of Maryland. Items were revised and questions randomly assigned to the pre- and post-tests.

College freshmen enrolled in an introductory nutrition course in groups of 20 responded to the questions for the elementary level students or for the high school students. Since there was no significant difference between the mean scores for the pre- and post-test items scored separately, the forms were considered to be equivalent.

Mean scores and standard deviations of pretests for the two sixth grade classes were 16.12 $\pm$ 3.11 ($n = 25$) and 16.50 $\pm$ 3.06 ($n = 22$). Post-test scores were 23.32 $\pm$ 3.69 ($n = 25$) and 22.86 $\pm$ 3.32 ($n = 22$). A gain in knowledge was apparent since the difference between the pre- and post-test scores for both groups was highly significant ($p < 0.001$).

For the high school classes, mean pretest scores were 19.42 $\pm$ 5.18 ($n = 12$) and 20.73 $\pm$ 4.26 ($n = 24$); and for the post-tests were 24.17 $\pm$ 3.78 ($n = 12$) and 25.33 $\pm$ 2.53 ($n = 24$). The difference between pre- and post-tests scores for both the group of 12 students ($p < 0.05$) and the group of 24 students ($p < 0.001$) was significant.

Reliability estimates for pre- and post-test items were 0.84 and 0.76 for Kuder-Richardson and Hoyt measurement methods, respectively. No item analysis information was available.

Most students (91% and 88% of sixth graders in the two classes and 60% of the combined high school classes) indicated that they believed the nutrition units would affect their future choice of foods. Follow-up information would have to be obtained to substantiate those results and also to check retention of knowledge of nutrition over time.

High school students who had an opportunity to teach nutrition to students of a different age group (cross-age teaching) scored significantly higher ($p < 0.01$) on tests of nutrition knowledge than did those who did not have that opportunity (MacKenzie and Arbor, 1979). The sample consisted of 60 high school students in food and nutrition who were assigned randomly to four classes. Two of the classes which were randomly selected served as an experimental group. One of these classes taught younger children and the other taught older adults.

The experimental and control groups were similar in terms of grade in school, proportion of males and females and prior knowledge of nutrition. Mean scores for the 25-item nutrition knowledge pretest were 13.86 $\pm$ 2.71 and 13.35 $\pm$ 2.35 for the experimental ($n = 28$) and control ($n = 31$) groups, respectively.

All students were taught the same lessons for the first eight class periods. Emphasis was placed on the content areas of nutrient functions, food selection and nutrition labeling. During the next four class periods, the experimental groups planned and taught lessons to other groups. The control group reviewed nutrition concepts. Review sessions included films, role playing, debates, and discussions.

A post-test composed of 66 multiple-choice items was used to measure nutrition knowledge of the high school students. The test was evaluated for content validity by two home economics teachers, two associate professors of home economics education and one professor of food and nutritional science. The Kuder-Richardson reliability estimate was 0.83 on the post-test. The students in the experimental group ($n = 23$) outperformed ($p < 0.01$) the students in the control group ($n = 28$) on the post-test. Mean scores were 54.65 $\pm$ 4.80 for the experimental group and 48.96 $\pm$ 8.85 for the control group. There was no significant difference in mean scores between students who tutored younger children (54.77) and those who tutored senior citizens (54.53).

The effectiveness of the mass media in extending knowledge of nutrition of teenagers was tested in a program which involved television, radio, and brochures (Axelson and DelCampo, 1978). The investigators stated that if the influence of the mass media is as great as critics and advertisers imply, it should be used as a positive influence on food intake.

Prior to and immediately following the campaign, a nutrition quiz was administered to a random sample of ninth graders in six Florida communities (experimental group) and to a control sample who lived outside the broadcast region. More than 90% of the subjects were 14 or 15 years of age.

A 10-question nutrition quiz was reviewed for validity by two university nutrition instructors. When ninth graders served as a pilot test group, the Kuder-Richardson formula-20 reliability index was 0.42. This was quite low. The 10-item quiz served as both the pre- and post-test instrument.

Six months after the pretest, a mass media campaign lasting two and one half months was conducted. Three television spot announcements were shown three times a week for eight weeks during prime viewing time (7:00 p.m. to 10:00 p.m.). This time had been established as the time the subjects frequently watched television. The spots emphasized the need for vitamin A, iron, vitamin C, and calcium. A brochure was mailed to those who responded to the announcement: "To find out how you can win cash prizes for knowing about good nutrition, call 222-8060." The brochure described nutrient functions, food sources of nutrients, energy needs of teenagers, and food selection.

After the television spots had been aired for four weeks, radio announcements were implemented at intervals of twice weekly, again at the most popular listening time. Two weeks later, brochures providing nutrition facts were distributed to all middle schools and secondary schools in the area. A radio contest (45 prizes) was conducted daily for 15 days. Information needed to answer the questions was in the brochures. A follow-up grand prize drawing was scheduled for television.

The 10-item post-test was administered at the end of the 10-week campaign. The mean pre- and post-test scores for the experimental group were 3.40 ± 0.12 ($n = 205$) and 4.25 ± 0.13 ($n = 179$), respectively. Control group mean scores were 4.08 ± 0.13 ($n = 195$) and 4.49 ± 0.13 ($n = 159$), for pre- and post-test, respectively. Pretest mean scores for the two groups were significantly different ($p < 0.05$), but post-test scores were not. The population groups had been selected based on similarities in income, age and educational levels. The difference in pretest scores made it difficult to compare gain scores since there is generally a regression toward the mean after a learning period. The difference in gain for the experimental ($n = 179$) and control groups ($n = 159$) was significant ($p < 0.03$). Mean gain scores of boys and girls or blacks and whites as groups were not significantly different within the experimental or control groups. A significantly higher ($p < 0.05$) mean gain score was noted for boys and blacks in the experimental group than for the boys and blacks in the control group.

Only limited information could be obtained from this study about increase in knowledge because of limitations of the evaluation instrument, but results indicated that knowledge can be improved to some extent through a mass media campaign.

A study was conducted to test the effectiveness of mass media techniques as compared to direct effects of education in transmitting the basic concepts of an adequate diet, infant feeding and nutritional requirements, dietary needs in pregnancy and lactation, and hygiene in food handling and preparation to mothers of preschool children (Cerqueira et al., 1979). Three rural communities in Mexico were selected; in one area, mass media techniques were used; in a second area, teachers used a direct method of nutrition education; and the third area served as a control group. The three areas were similar in population size and accessibility of radio, water, and job resources. The family groups were similar in age, educational level and in number and age of children.

The direct nutrition program for the second area was carried on in two sessions of two hours each per week, with teaching of theory one day and demonstration and practice the next. This group did not receive radio spots. During the three-month time period, there were 12 sessions in which theory was developed and 12 sessions for demonstrations.

The mass media radio program was carried out with radio spots, pamphlets and posters. The same units of material were covered as in the direct nutrition program. Radio spots were songs which lasted three minutes with each aired 12 times per day for three weeks. Three pamphlets were distributed at one-month intervals. Posters were distributed at three-week intervals to mothers and posted also in schools, churches, stores, and on trees in the community. The control group had access to radio spots but received no other formal education.

Diet surveys were completed before and one year after the educational programs. Nutrition tests, with the same questions but with the order changed, were administered prior to, immediately following, three months later, and one year later to see what concepts were learned and retained.

Based on the differences between initial and final percent scores, direct education ($\bar{x}$ (mean) 36 $\pm$ 14 versus 92 $\pm$ 13, respectively) and mass media ($\bar{x}$ of 40 $\pm$ 15 versus 94 $\pm$ 13) concepts transmitted appeared to be understood similarly by both groups. An increase of 53% in scores for the direct education group and an increase of 54% in scores for the mass media group were significant ($p < 0.001$). The scores in nutrition increased for the control group by 19% ($\bar{x}$ of 29 $\pm$ 13 versus 47 $\pm$ 11 on pre- and post-tests, respectively) which was significant ($p < 0.05$). The group had access to radio information and may have investigated answers to test questions since the same questions were administered four different times.

Differences were found in the changes in food consumption among groups. For the direct education group the most significant increases were in the consumption of fish, fruits and oil. Decreases were noted in consumption of corn, lard and carbonated beverages. The mass media group increased intake of fish, vegetables and fruits and decreased consumption of corn, lard and carbonated beverages. Many of the families in the two test groups introduced fish into meals when before it was not consumed. The control group decreased intakes of beans and chili and increased consumption of sugar, bread and carbonated beverages.

Results of pre- and post-tests showed cognitive gains in knowledge of nutrition of 11th and 12th graders in a study conducted by Picardi and Porter (1976). A food and nutrition minicourse developed at M.I.T. (Picardi and Pariser, 1975; Picardi, 1976) included approximately 30 hours of classroom instruction in nutrition.

A nutrient approach was used to study four very different meals;

1. A "Drive-in" hamburger meal contained a hamburger pattie and bun, ketchup, mustard, pickle, onion, French fries, and vanilla thick shake.

2. A Macrobiotic meal contained brown rice and instant dry tea.

3. A Basic Four Food Group meal consisted of canned chicken, iceberg lettuce, French dressing, frozen green peas, evaporated milk, peaches with heavy sugar syrup, bread, margarine, and orange marmalade.

4. A Vegetarian meal contained frozen lima beans, brown rice, roasted soybean granules, sunflower seed meal, iceberg lettuce, French dressing, frozen green peas, instant nonfat dry milk, peaches in unsweetened fruit juice, bread, and margarine.

The approximate nutrient content of each meal was determined using food composition tables. In addition, Foods Research Laboratories, Inc., Boston, Massachusetts performed chemical determinations of nutrient content of the meals.

The lecture-discussion sections of the minicourse (two-thirds of alloted time) included the nutrients present in foods, how nutrients could be determined chemically, and how the students could find out about the nutrient content of food from food composition tables and nutrition labels. Health consequences if nutrient intakes were inadequate or excessive were emphasized.

During the laboratory sections of the minicourse (one-third of the alloted time), the students were divided into four groups. Each group of students prepared one of the meals and analyzed it for water, carbohydrate, fat, and protein content. Meals were fed to young laboratory rats and their growth, development and behavior patterns were followed. Sensory properties of foods were also studied.

Investigators noted goals which included the ability to select a varied and moderate diet for good health, understand how food fads and fad diets affect health, use food labels and food composition information in making diet choices, and be aware of how the senses affect food choices.

Evaluation instruments included a knowledge test and attitude-behavior test. The 20-item (100-point) knowledge test was composed of multiple choice and completion items which tested areas of chemical constituents of food (25%), relation between common dietary habits and health (20%), use of nutrition label information (35%), and consequences of restricted fad diets (20%). The instrument was pilot tested with a reference group of 31 graduate students with majors in nutritional biochemistry and metabolism.

On the tests, subjects were asked to explain why one of two cereals would be selected for teenagers based on nutrition information available on the label. Other multiple-choice items also tested understanding of information on nutrition labeling. Specific information from Recommended Dietary Allowances and food composition tables was given. Subjects were asked to determine the quantity of a food necessary to meet energy needs and to identify nutrients present in inadequate amounts if that food were the only food consumed. Subjects were asked to identify health problems associated with diets higher in particular nutrients. They were asked also to list advantages of animal feeding experiments for determining safety of healthfulness of foods. Chemical formulas for fats, carboyhydrates and proteins were pictured, and subjects were asked to classify them.

Three field tests were conducted in the Boston-area high schools. Ninety-three percent of the difficulties for the multiple-choice items were within a "desirable" range of 0.1 to 0.9 (Dwyer, Feldman and Mayer, 1970). Seventy percent of the item discriminations were greater than 0.2. Twelve percent of the items were negatively discriminating.

Test results are found in Table 11. Pretest scores were not significantly different for the different groups. Knowledge gains were found to be significant ($p < 0.05$) for the experimental groups when compared to the gains for the corresponding control groups. The gain in test scores between pretest and post-test scores was also significant ($p < 0.05$) in control group 2. This group met in the same classroom as the experimental group. The post-test reliability was particularly low for the third trial.

Table 11. Nutrition knowledge scores and Kuder-Richardson formula-20 reliability indices for 11th and 12th graders[a]

Trial	Class	N	Pretest	
			Mean ± S.D.	K-R 20
1	Experimental	11	40.73 ± 14.35	.71
	Control	15	35.40 ± 10.67	.53
2	Experimental	20	33.30 ± 7.71	.23
	Control	20	35.75 ± 13.27	.71
3	Experimental	23	39.65 ± 8.84	.33
	Control	19	36.11 ± 9.87	.38

[a]SOURCE: Picardi and Porter (1976).

Post-test		Gain
Mean ± S.D.	K-R 20	Mean ± S.D.
59.18 ± 16.57	0.75	18.45 ± 13.24
36.20 ± 6.45	0.48	0.80 ± 8.29
52.70 ± 14.49	0.71	19.40 ± 13.79
41.95 ± 11.42	0.58	6.20 ± 10.33
64.04 ± 9.98	0.38	24.39 ± 8.12
37.74 ± 8.65	0.21	1.63 ± 10.00

The attitude-behavior test included sections related to health concerns and food choice behavior. Eight nutrition-related health problems were presented in pairs in random number. Twenty-eight pairs resulted. Students were asked to check the one of each pair he(she) was more concerned about. Included was concern about heart disease, digestive problems, diabetes, lack of pep and energy, tooth decay, skin problems, overweight or underweight, and physical growth and development. Similarly, eight food choice behaviors were presented in pairs. Included were avoidance of cholesterol, fat, sugar, and chemical additives, preference for sources of fiber, protein, vitamins and minerals,and control of calories.

Overall, heart disease was ranked as the most important health concern by almost all classes on pre- and post-tests. Concern about skin problems and tooth decay often appeared as the least important. Preference for food sources of protein, vitamins and/or minerals often appeared as the most important food choice behaviors on both pre- and post-tests. Selection of food sources of fiber and control of calories often appeared as least important. The 30-hour course could, perhaps, not be expected to result directly in attitude or behavior change because of many factors affecting these even though the minicourse appeared to be successful in imparting knowledge.

A knowledge test was developed to use as a pre- and post-test instrument in a study where two home economics classes for freshmen and sophomores and one health-occupation class for juniors studied nutrition for 50 minutes daily for 8 to 10 days (Spitze, 1976). Fifty students completed pre- and post-tests. The test consisted of 311 items of the true-false type grouped by subject. Test reliability, as measured by the Kuder-Richardson formula-20, was 0.88. The differences between mean pre- and post-test scores were +29, +28 and +18 for the home economics classes and the health-occupation class, respectively. All gains were statistically significant ($p < 0.001$). The mean post-test score for all groups was 251.

More than half of the students taking the post-test thought that vitamins provided energy for the body, that more protein was needed when a person was very active, that celery was a good source of vitamin C but broccoli was not, and that meat was a good source of vitamin A but pumpkin pie was not. They did not know which nutrients were involved in blood clotting, and which vitamins were water soluble. They thought that anyone who ate the food servings recommended in the Four Food Groups Guide were assured an adequate amount of all nutrients and that anyone who did not was bound to be short in some nutrients.

Madaras (1977) developed a knowledge test consisting of 15 true-false and 10 multiple-choice items which was administered before and after nutrition education modules were completed by pregnant teenagers.

The module consisted of a five-hour teaching experience including skills, knowledge, suggested learning experiences, teaching aids, and references. Three to nine test items were developed for each of the eight goals. Content included food habits, nutrient functions, food selection, nutritional needs of pregnant adolescents, and food fads and fallacies.

The test instrument was pilot tested with 22 home economics students. The Kuder-Richardson formula-20 reliability coefficient was 0.35. The instrument was revised.

The reliability was 0.58 on the 25-item pretest with the sample group ($n = 22$). The mean score and standard deviation was 13.41 ± 2.57. The post-test mean for the experimental group ($n = 9$) was 15.79 (63%) and for the control group ($n = 9$) 13.33 (53%). There was a significant difference ($p = 0.031$) in the mean scores of the two groups. There was no significant difference in attitudes on pre- and post-tests and students did not apply their knowledge of nutrition to food selection as determined by analysis of pre- and post-test 24-hour recalls of dietary intake scored according to the Basic Four Food Groups.

The relationship between teacher characteristics and effective nutrition education for adolescents was assessed in a sample of 71 Oregon high school nutrition teachers and 1,193 teenage students (Skinner, 1978). The teacher characteristics assessed were knowledge of nutrition, knowledge confidence, teaching confidence, flexibility, interest, values, and dietary habits. Students completed a knowledge pre- and post-test. Dietary scores and dietary scores per 1,000 kilocalories were calculated from 24-hour food records completed before and after the nutrition unit.

Objectives were prepared for the teacher nutrition knowledge test. Test questions were taken from multiple-choice items which had previously been used in tests in an introductory nutrition course at Oregon State University. Some items were revised and additional items were written when none were available. Items were reviewed by university faculty members in nutrition. All panelists had to accept items before they were included in the final test. The 87-item test was pilot tested with secondary teachers. On the basis of information obtained from the reviewers and the results of the pilot test, 45 test items were selected. Faculty classified items into basic (24.5%), advanced (18%), applied (22%), recent (24.5%), or insignificant (11%) categories. Consensus of the majority was used for classification.

An attitude scale was developed, reviewed and pilot tested. An eight-item scale assessing flexibility toward nutritional practices was included (Carruth, 1974). Four 24-hour food intakes were used to evaluate dietary intake.

Similar procedures to those used in developing the teacher knowledge test were applied in development of student knowledge tests. Two 31-item forms were developed and pilot tested with 17 teenagers. Mean scores for the two forms were 19.5 and 19.3 with a similar range in scores (11-27). One item was dropped from each test. Two items on the final test were classified as insignificant. Many questions on the student tests were not as difficult as those found on the test for teachers.

Students in 68 classes completed the knowledge pretest (n = 1,193) and students in 62 classes took the post-test (n = 1,073). Differences between mean scores on student pre- and post-tests were used as a measure of the effectiveness of the nutrition education program. The mean change was slight, +0.83 (3%), on the 28-point test (excluding insignificant items). The mean change for individual classes ranged from -2.11 to +7.40 (8 to 26%). The mean scores for the students on pre- and post-tests were 11.02 and 11.85, respectively. Class mean scores on the pretest ranged from 29 to 50% and on the post-test from 31 to 63%. Individual scores on the pretest ranged from 2 to 22 and on the post-test from 1 to 27. Kuder-Richardson formula-20 reliability coefficients were 0.37 and 0.39 for the pre- and post-tests, respectively, which were quite low. This was due, in part, to the low mean scores. The test could be lengthened to improve reliability. On the post-test, eight items had discrimination indices below 0.20. Difficulty indices were over 0.90 for two items, between 0.81 and 0.90 for one item, and between 0.10 and 0.19 for four items. Dietary intakes did not improve with instruction.

Scores for the 61 home economics and health teachers who completed the 40-item test (excluding insignificant items) ranged from 9 to 34 with a mean of 19.3 $\pm$ 5.4. This average (0.48) was somewhat lower than the optimum difficulty level for a four-option multiple-choice test (0.73). The Kuder-Richardson formula-20 reliability was 0.66.

All but two items were within difficulty levels of 0.10 to 0.90. One item was answered correctly by all respondents and another by only five percent of the group. The discrimination index was below 0.20 for eight items. Teachers averaged 6.6 (60% of 11 items) on the basic knowledge portion, 2.9 (59% of 5 items) on the insignificant information, 4.0 (50% of 8 items) on advanced knowledge, 4.5 (45% of 10 items) on applied knowledge, and 4.3 (39% of 11 items) on the recent knowledge portion of the test.

The length of time spent on nutrition education by teachers ranged from five to thirty days with an average of 12.7 $\pm$ 5.7 days with 50 minutes of instruction per day. Sixty percent of the teachers integrated the material into other units as well. Of the seven teacher characteristics assessed, only nutrition knowledge and teacher confidence were significantly correlated ($p < 0.05$) with student learning.

Groups of students were tested prior to instruction in an introductory food and nutrition course at Texas Tech University (Carruth and Lamb, 1971) for food and nutrition information at the knowledge (36%), comprehension (35%) and application (29%) levels of the cognitive domain. Generalizations taken from the literature, textbooks, or developed by university faculty who taught introductory nutrition courses were used as the basis for test items. Eighty multiple-choice items were prepared and administered to 938 students in five groups. The average percent scores for each of the five groups were 62.26 ± 11.33, 62.42 ± 11.92, 64.84 ± 10.75, 66.85 ± 10.09, and 60.93 ± 11.94, with an overall average score of 63%. Scores ranged from 34 to 89%. Fifty-six percent of the items at the knowledge level, 68% at the comprehension level, and 72% at the application level discriminated between students who did well and poorly on the test.

In a follow-up study, 225 of the 360 students in the first sample group were selected to provide data to show if this test, used as a pretest, would be a good prediction of performance in the final examination for an introductory course in nutrition (Carruth, Briley and Roy, 1971). The correlation between scores on the two tests, the one developed in this study and a test used as the final examination for the introductory course in nutrition, was significant ($p < 0.001$).

Shannon (1976) reported results of a one-credit semester university course in nutrition that was developed from concepts dealing with the identity of sources and functions of nutrients. Nutrient needs and food quality and safety was included as course topics. The basic principles were covered in self-instructional materials. Related current issues were presented in lecture. The mastery level fell within the knowledge (28.5%), comprehension (43%) and application (28.5%) areas of the cognitive domain.

Content covered in the self-instruction materials was not repeated in the lecture. Pre- and post-tests were designed to measure mainly the effectiveness of the self-instruction materials. Mastery levels selected for knowledge, comprehension and application were 95%, 85% and 75% correct, respectively. Seventy-item pre- and post-tests were administered in three terms. Results for the post-tests were 63.2 ± 4.4 ($n = 154$), 63.4 ± 5.4 ($n = 149$) and 63.4 ± 5.7 ($n = 191$). Gain scores were 38.4, 27.5 and 25.7, respectively, for the three terms. Significant increases ($p < 0.001$) in the percent of students reaching the mastery level during the term were apparent for the first and third levels of the cognitive domain for some groups. The range of students reaching mastery levels was from 68.5% to 96.9% in different terms and for different cognitive areas. The lower percentages were for the knowledge level in which case 19 out of the 20 items on the post-test must be answered correctly.

Programmed instruction in nutrition has been attempted and proved successful with university students in an elementary nutrition course at the Pennsylvania State University (Studdiford and Guthrie, 1972) and with nursing students (Kiang, 1970).

In a study completed by Studdiford and Guthrie (1972), a program was prepared and tested with 25 college students. Following this, the program was revised to include 13 chapters with 44 to 128 frames for each chapter.

Seventy-eight of 142 students who were enrolled in an introductory nutrition course volunteered to supplement classroom instruction with the programmed materials. The students were paired on the basis of sex, age, gradepoint, major, and pretest nutrition knowledge scores. Half of the students (randomly selected) completed the programmed material (experimental group) and the others (control group) were told that they would be expected to rely on lecture and text materials.

Three objective tests were given and a post-test of nutrition knowledge was administered to both groups five weeks after the course was completed. Mean scores were significantly different ($p < 0.001$) between the experimental and control groups on the first test (n = 35) and the post-test (n = 24). Post-test mean scores were 47.84 ± 6.29 for the experimental group (n = 24) and 42.10 ± 7.00 for the control group (n = 24). Pretest scores were 14.3 and 13.9 for the experimental and control groups, respectively. Study time was similar between groups.

Kiang (1970) developed a programmed unit on protein metabolism for nursing students. Field testing was accomplished in three phases. The first phase was conducted in the Department of Nursing at Columbia University. One hundred thirty-two junior year students participated. One group received programmed instruction, one was assigned readings and a third served as a control group. Group assignments were made at random.

Sixty multiple-choice questions with four options served as the pre- and post-test instrument for the first field study. Mean scores on the pretest were 23.40 $\pm$ 6.93 for the group receiving programmed instruction (n = 15), 21.94 $\pm$ 5.14 for those completing the assigned readings (n = 17) and 23.41 $\pm$ 5.97 for the control group (n = 17). There was no significant difference in pretest scores. Post-test scores were 44.73 $\pm$ 8.35, 35.47 $\pm$ 9.61 and 26.82 $\pm$ 4.23 for the programmed instruction, assigned reading and control groups, respectively. Post-test scores were significantly higher ($p < 0.01$) for the programmed instruction group than for the other two groups.

Before the second and third phases of field testing, the program was shortened from 139 frames to 111 frames and the test items decreased from 60 to 40 items. Results of the tests administered at the Department of Nursing of the Long Island University and in an introductory course at Hunter College in New York were similar to those found in Phase One. The post-test scores for the two groups (n = 10, n = 13) 29.50 $\pm$ 4.88 and 35.31 $\pm$ 3.77 were significantly higher ($p < 0.01$) than the respective pretest scores of 15.30 $\pm$ 2.98 and 18.92 $\pm$ 4.55. It can be inferred from the results that the programmed instruction in basic nutrition was an effective teaching method for the groups tested.

A multi-media course, including 20 videotapes and accompanying written materials (six self-instruction units and a student workbook), provided the instructional content for an introductory college nutrition course at Pennsylvania State University (Christopher, Shannon and Sims, 1980). Materials, tests and attitude scales were pilot tested with nutrition students. An 86-item knowledge pretest was developed. The same items were interspersed among other items in four course examinations and a final examination for post-testing purposes. The Kuder-Richardson formula-21 reliability index was 0.82 for the pretest.

Attitudes were measured using an agreement scale method. Students responded to items on a five-point Likert scale, ranging from "strongly agree" (score of five) to "strongly disagree" (score of zero). Some scale items from nutrition attitude questionnaires by Eppright et al. (1970), Sims (1978) and Grotkowski and Sims (1978) were used. Attitudes toward televised instruction were also assessed.

The two groups involved were students receiving videotaped instruction along with class discussion ($n = 61$) and students receiving traditional lecture instruction ($n = 63$). The same teachers taught both classes; content and sequences of material were the same for both groups.

Possible influences on pretest scores were studied. Included were prior chemistry courses, prior nutrition courses, sex, gradepoint average, major, prior biology courses, and term standing. Only prior nutrition courses for the media-instructed group and prior biochemistry courses for those following traditional instruction were significant predictors of pretest scores ($p < 0.05$).

Mean pretest scores for the two groups (36.4 and 36.1) were similar. There was also no difference found between post-test scores for the two groups. Those receiving multi-media instruction had a mean post-test score of 73.8, while those with traditional instruction had a mean score of 68.9. Prior chemistry courses, gradepoint average and term standing all were predictors ($p < 0.05$) of examination scores for both groups. Gradepoint averages were related more to scores for the students following traditional instruction than those involved in multi-media instruction.

The authors noted changes in responses to attitude statements between the pre- and post-tests and interpreted these changes to mean that students were more satisfied with their knowledge of nutrition at the end of the course and that their experience with or knowledge of a multi-media course caused them to regard televised instruction more favorably. Perhaps, interpretation could have been strengthened if results had been obtained from a control group which received no instruction in nutrition.

A 10-week, two-credit telenet (telephone network) course was conducted for 104 elementary school teachers in Kansas (Wakefield and Vaden, 1973). Printed materials supplemented the verbal communication. Food habits, psychological and physiological need for food, digestion, absorption and utilization of nutrients, food facts and fallacies, and food selection were content areas covered.

A 27-item multiple-choice test was used as a pre- and post-test instrument. The discrimination indices indicated that 19 items had coefficients of 0.20 or above. Four items had an index of 0.00 or a negative value. The mean pretest score was 12.97 $\pm$ 3.40 for the 104 participants, with a range of scores from 5 to 22. The Kuder-Richardson reliability coefficient was 0.53. The mean post-test score was 18.69 $\pm$ 3.45. A range of 9 to 24 was noted and a reliability of 0.70. The standard error on the post-test (1.87) was not as great as that found on the pretest (2.33). The mean score on the post-test was significantly higher ($p < 0.001$) than that on the pretest.

Carruth (1974) compared nutrition knowledge, attitudes, personality, and behavior of Nutrition Education Assistants (NEAs) in the Missouri Expanded Food and Nutrition Education Program (EFNEP) given a five-week training with NEAs in a control group with no training. Participants were matched for income, months of experience in EFNEP (mean = 19.5 $\pm$ 11.7 months), education, marital status, and age. Weight modification was the major training thrust.

A knowledge test (70 items), a standardized personality questionnaire (16 items) and an attitude instrument (40 items) were administered to the experimental (n = 9) and control (n = 18) groups. Behavior measurements were obtained based on the return of a mail-in request for nutrition information during or after the treatment period and from observations of subjects exhibiting behaviors classified as applications of nutrition knowledge to basic lifestyles.

NEAs in the experimental group received instruction on current concepts of weight control in the training sessions conducted once a week for five weeks. Twenty-nine behavioral objectives formed the base for the program and for evaluation instruments. Objectives dealt with the concepts of body weight and health, response-ability to weight modification, food intake, use of resources in weight modification, and personal and nonpersonal interrelationships with weight modification.

Objective items which represented the content at six cognitive levels were prepared. The planned literacy level was approximately ninth grade or lower. The mean number of public school grades completed by the composite group (n = 27) was 10.94 $\pm$ 1.5. A home economist and two NEAs reviewed the test items. Items were revised in line with their suggestions and those of university staff nutritionists. Items were reviewed by educational consultants and a final selection of 70 items made. Each objective was represented by one to five test items. The items were placed on the test in order of progressive difficulty. The total possible score was 86.

Item discrimination and difficulty were not computed from results of administration of the test instrument. The investigator stated that it was inappropriate to prepare an objective test of sufficient length and difficulty to establish reliability. Standardization of the instrument was not considered of primary concern since the test served as an indicator of concepts learned as a results of instruction.

The mean score on the post-test (58.06 $\pm$ 9.59) was significantly higher ($p < 0.05$) than that on the pre-test (48.44 $\pm$ 10.34) for the nine subjects in the experimental group. No significant difference was noted between the pre- and post-test scores (50.37 $\pm$ 8.97 and 49.63 $\pm$ 8.72, respectively) of the control group (n = 18).

Gassie and Jones (1972) reported an evaluation of an eight-session, eight-week nutrition education program conducted with homemakers in the Expanded Food and Nutrition Education Program in Louisiana. Results were obtained from a knowledge test with questions related to kinds and amounts of food recommended for good health in the Basic Four Food Group plan, and from a 24-hour dietary recall. Instruments were administered before and immediately after instruction to 129 program participants. Four months after instruction 240 participants completed questionnaires.

Prior to instruction, most homemakers stated that two servings of milk (90%), two servings of meat (87%), four servings of fruits and vegetables (97%), and four servings of breads and cereals (57%) were necessary for an adequate diet. The knowledge level improved in all cases after the eight lessons. Immediately after instruction homemakers correctly stated Basic Four recommendations for the milk (98%), meat (95%), fruit and vegetables (100%), and bread and cereal groups (84%). This significant increase ($p < 0.01$) in knowledge was maintained after four months with 96, 94, 99, and 88% of the homemakers stating correct recommendations for the milk, meat, fruit and vegetable, and bread and cereal groups, respectively, according to the Basic Four Food Guide.

The percentage of individuals with "minimum adequate diets" defined in terms of minimum servings from each of the Four Food Groups after four months was unchanged from the initial level (5%). Immediately after instruction, 23% ($p < 0.01$) had diets that met the Basic Four criteria. There were significant increases ($p < 0.01$), however, in milk and bread and cereal consumptions immediately after and four months after instruction when compared to consumption prior to instruction. Fruit and vegetable consumption increased significantly ($p < 0.01$) immediately after instruction, but regressed after four months ($p < 0.01$). Those subjects who included at least one serving from each food group daily increased from 61% before instruction to 81% immediately after and four months after instruction.

Dairy Council of California tested an instructional program for teaching basic nutrition-related skills to homemakers (Sullivan et al., 1976). The goal was to train consumers to select foods that are economical but meet criteria of the Basic Four Food Groups. Professional nutrition educators and paraprofessionals served as instructors in the program workshops.

A two-part criterion test was prepared which consisted of 35 items keyed to 9 of the 10 objectives of the program. Three or four items related to each objective. Participants were asked to respond to the 10th objective in an open-ended context. The objective was to plan a one-day selection of food that meets recommended numbers of servings from each food group.

Prior to instruction, a section of the test covering three of the nine objectives was administered as a pretest. This shortened the time required to take the pretest and minimized frustration on the part of participants.

The 35-item post-test performance standard was set at 80% correct responses. The post-test was administered to participants in eight workshops. The average scores for participants in workshops taught by nutritionists were 89%, 85% and 85%, and for those taught by paraprofessionals were 90%, 81%, 81%, 77% (n = 6), and 63% (n = 2). The overall average post-test score for those taught by nutritionists (n = 25) was 86.3% and for those taught by paraprofessionals (n = 19) was 80.9%. Mean pretest scores were 35% for the nutritionist-trained group and 29% for the leader-trained group.

For the 10th objective the average score for participants in both types of workshops was 90%. Responses to the workshops were consistently favorable. Eighty-eight percent of the paraprofessionals rated themselves as "very successful" or "successful" as workshop instructors and all ranked the program as "very effective" or "effective."

Two factors that may have contributed to the success of the program were that systematic development procedures were employed until satisfactory learner performance on the program objectives and highly favorable learner attitudes were obtained, and that the program was designed to teach the desired information about nutrient sources in the context of practical skills. There was little opportunity in this study done by Gassie and Jones (1972) to learn more than practical skills related to food selection based on one food selection system.

Items testing at the analysis and synthesis levels of the cognitive domain presented the greatest test dilemma for the NEAs according to the investigators. The number of items at each cognitive level was not stated nor were items identified by cognitive level.

Most NEAs disagreed with the eight statements which were judged to reflect rigidity on the attitude instrument. Seventy-five percent of the NEAs agreed, however, with an item which stipulated that the only usable tools for planning adequate diets are Basic Four Food Groups. There may be a tendency to use this system and not seek other approaches to food selection for adequate nutrient intake.

Gillespie (1978) tested the knowledge of nutrition of parents of young children before and after an intervention program designed to improve their nutritional practices. A three-way interactive communication system via mass media was used. Messages included basic nutrition concepts and application of the concepts.

Knowledge of nutrition was assessed using three clusters of items. Scale A consisted of five true-false questions with a five-point degree of certainty scale. The Cronbach's coefficient alpha for reliability was 0.67 for the post-test. The overall mean pretest score was 8.46 ± 1.84 ($n = 141$) and the post-test score was 9.04 ± 1.86 out of a maximum score of 11. Scale B consisted of nine items. The questions dealt with bread as a source of nutrients. The reliability coefficient was 0.78 in the post-test. Of a possible composite score of 1, parents ($n = 147$) had pre- and post-test scores of 0.68 ± 0.25 and 0.70 ± 0.27, respectively. Scale C consisted of seven items in a multiple-choice format. The reliability coefficient for the post-test was 0.62. The scores for parents ($n = 136$) on the pre- and post-tests out of a possible score of 1 were 0.38 ± 0.25 and 0.52 ± 0.27, respectively.

Pre- and post-test scores differed significantly ($p < 0.001$) for Scales A and C. For all three scales, mothers had higher scores than fathers, but the investigators reported that participants were not generally well informed about nutrition.

In summary, the content identified in the area of nutrition by various investigators and stated in the form of concepts, generalizations, behavioral objectives or competencies has formed the basis for nutrition instruction and for nutrition knowledge testing of various groups. Content areas covered by most of the reports included nutrition and health, functions of nutrients, nutritional needs throughout the life cycle, food selection, variation in food combinations and eating patterns for adequate nutrition, social, cultural and psychological influences on food selection, food costs, effects of food handling on nutrients, safety and cost, and energy use, needs and/or balance. Some investigators specifically mentioned consequences of excessive or inadequate intakes of nutrients; most of the others related adequate or optimal nutrient intake to health but did not specifically mention possible relationships to an alteration in nutrient intake. In a few cases, the use of available nutrition information to make food choices was noted (Gillespie, 1978; Ofei, 1978; Sherman, Lewis and Guthrie, 1978; Nutrition Education and Training Program, 1979). Global and community nutrition-related concerns and resource use were mentioned by the American Home Economics Association (1967), the White House Conference on Food, Nutrition and

Health (1970), Dillon (1972), Ikeda (1975), Home Economics Teacher Educators (1978), the Iowa Department of Public Instruction (1978), and Cunningham et al. (1981).

The worth of a research study is directly related to the quality of the instrument used to obtain the data. In a review of various tests of knowledge of nutrition, considerations used in evaluation of the development and validation of the tests were content coverage, cognitive level of knowledge assessment, types of items used, whether or not the tests were reviewed for content validity, item analysis, and reliability. Consideration was given to the overall purpose of the instruments within the context of the populations to be assessed (Talmage and Rasher, 1981).

Test reliabilities were not reported for many of the instruments. In many instances, where reliabilities were reported, tests were not pretested with a sizeable enough group of subjects with background in or knowledge of nutrition to establish reliability of the instrument.

There were also numerous studies where the number of subjects was adequate but the tests were of insufficient length to establish reliability. For example, Gillespie (1978) reported reliabilities of 0.67 for 141 subjects on five items, 0.78 for 147 subjects on nine items and 0.62 for 136 subjects on seven items. Content coverage was also of concern when the number of items was small.

In some cases, the testing procedure was adequate but the age level of subjects or content coverage differed from what was desired in the present study. For example, Nece (1979) and Seffrin and Veenker (1972) prepared tests most appropriate for high school students. Numbers of items, reliability measures and numbers of subjects were adequate for use for the intended audiences.

It was apparent from the literature review that a test with the necessary content coverage and adequate reliability and item analysis information appropriate for the intended audience was not available. Preparation of a knowledge test based on nutrition information important for young adults was considered necessary in order to assess knowledge of nutrition of young adult groups.

PROCEDURES

A questionnaire was developed to assess the knowledge of nutrition of young adults. The steps involved in development and testing of the nutrition knowledge questionnaire were: 1) to delineate nutrition generalizations and supporting facts which represent nutrition knowledge essential for young adults; 2) to prepare questions to test the content identified and to evaluate the quality of the items and of the questionnaire; and 3) to assess the nutrition knowledge of several groups of young adults.

Indentification of Generalizations and Supporting Facts

Nutrition content important for young adults was identified from information in basic nutrition textbooks, information from government sources and compilations of concepts, generalizations and competencies. In particular, the sources which included prepared concepts, generalizations and competencies were the most helpful for identification of generalizations and supporting facts in the present study. These were reported in the review of literature. The generalizations and supporting facts that were identified related to: 1) physiological aspects of nutrition, 2) food as sources of nutrients and 3) sociopsychological and economic aspects of nutrition.

The generalizations and supporting facts were reviewed for content validity by 10 food and nutrition faculty members at Iowa State

University, three of whom were state extension nutritionists. Other reviewers included a faculty member at the University of Iowa, three county extension home economists with background in food and nutrition, a nutrition instructor at Iowa Methodist Medical Center School of Nursing, and a representative of the Iowa Dairy Council. Names of the reviewers are given in Appendix B. The letter which was sent to reviewers to ask them to evaluate whether or not the information was appropriate and necessary is included in Appendix C. Revisions were made in the generalizations and supporting facts according to comments received. The generalizations and supporting facts were reviewed later with test items and editorial changes made. The final generalizations and facts used for the questionnaire development are found in Table 12, p. 189.

Development of a Table of Specifications

Behavioral objectives were formulated for each of the revised generalizations. Behaviors in the cognitive domain were classified according to the Taxonomy of Behavioral Objectives (Bloom et al., 1956). Together with an interpretation of the meaning by Gronlund (1978) these behaviors were 1) knowledge (remembering learned material), 2) comprehension (ability to grasp the meaning of material), 3) application (ability to use material in new situations), 4) analysis (ability to break materials into parts so its organization and structure can be understood), 5) synthesis (ability to put the parts together to form a new whole), and 6) evaluation (ability to judge the value of material for a given purpose). Behavioral verbs that were used were obtained from Mager (1962), Gronlund (1977, 1978) and Metfessel, Michael and Kirsner (1969).

The behavioral levels for the objectives were identified by assignment of relative weight to each of the objectives based on a judgment of the relative importance of the understanding to the practice of nutrition. This judgment was based on the author's experience in the teaching of basic nutrition courses. Texts used, course emphasis, and tests prepared in an introductory nutrition course were examined for distribution of content and cognitive levels of items used in evaluation measures. Instructors for the course, FN 107, Nutrition and Man's Food (course description: understanding and implementing present day knowledge of nutrition; the use of food for health and satisfaction of the individual and the family), were also asked to respond to the content weightings.

Also of importance in determining test specifications was an examination of nutrition knowledge tests which had been prepared for subjects similar to sample populations in the present study. In particular, tests prepared by Dwyer, Feldman and Mayer (1970), Eppright et al. (1970) and Petersen (1971) were examined for content emphasis. Identification of cognitive levels for items for some tests were available. For example, Table 13, p. 205 gives some indication of test specifications for tests which have been prepared.

The number of items for the final questionnaire was determined primarily by consideration of a practical time span for testing subjects.

Most groups were to be tested in situations where there would be some time limitation or where the rate of participation could be related to the time necessary to complete the questionnaire. The decision was made to include 50 multiple-choice items which could be completed in a testing time not exceeding 50 minutes. This amount of time and number of items was considered sufficient to sample content.

The number of items was then specified for each objective at the cognitive levels. Items were distributed among objectives with emphasis placed on items in the area of comprehension or higher levels. Sixteen percent represented knowledge, 48% comprehension and 36% application or higher levels in the cognitive domain for this study. Two faculty members in home economics education (Appendix B) evaluated the behavioral objectives when given the generalizations, the objectives and information about cognitive levels of items testing each objective. Revisions were made. The test specifications developed and revised as described for the nutrition knowledge questionnaire are shown in Table 14, p. 207, with the number of items on the final questionnaire noted by content and cognitive level.

Selection of Item Type

According to Gronlund (1977) multiple-choice items can be easily and consistently scored and be used to measure a variety of learning outcomes, ranging from simple to complex. For this reason, multiple-choice items were selected for use in the questionnaire.

In addition, Ebel (1965) reported higher reliability with a 100-item multiple-choice test than with a 100-item true-false test. Oosterhof and Glasnapp (1974) also noted a higher reliability with a multiple-choice test. In a test written with five true-false items replacing three multiple-choice items in testing, the test reliabilities were similar for the two types of items (Ebel, 1972). Frisbie (1973) and Green (1979) found that true-false tests were adequate alternatives to multiple-choice tests. Because the literature showed no clear-cut advantage of using true-false items and because many published tests included multiple-choice items, multiple-choice items were selected.

Three-option items were selected for use in the questionnaire since various investigators have found that three choices compared to more than three increased efficiency of assessment and decreased difficulty and time involved in preparation while maintaining the reliability and validity of tests (Tversky, 1964; Costin, 1970, 1972; Grier, 1975; and Lord, 1977).

Preparation of Pretest

Three-option multiple-choice questions of the best-answer type were written based on the table of specifications (Table 14, p. 207). The following principles noted and studied by Board and Whitney (1972) and Gronlund (1976, 1977), among others, were followed when possible in preparing items.

1. The problem is clearly stated in the stem of the item.
2. The stem is stated in positive form.

3. The intended answer is clearly best.
4. All alternatives are grammatically consistent with the stem of the item.
5. Verbal cues between the stem and choices are avoided.
6. The length of alternative responses is similar.
7. "None of the above" and "all of the above" choices are eliminated.
8. The correct answer is varied in position.
9. Vocabulary is appropriate for test-takers.

Items were analyzed using the Multiple Choice Test Analyzer (MCTA) prepared by Hausafus (1978). The three violations incorporated in the MCTA were 1) repetition of words between the stem and option, 2) use of negative words in stem and options, and 3) use of specific determiners in stem and options. The repetition of words was checked with the first four letters of words in the stem and options.

Negatives checked in stems and options included never, no, not, none, n't. Specific determiners included words which would most likely cause a respondent to avoid choosing an option (absolutely, all, always, any, each, every, impossible, only, whenever, wherever) or those words which would make a respondent more likely to choose the option (but, except, frequently, generally, most, often, seldom, some, sometimes, usually). The items which included repetition of words, negative words or specific determiners were revised and re-evaluated using the MCTA.

Three evaluation specialists in home economics education reviewed the test items to determine if they were in accordance with principles of test writing and specified cognitive levels for each item. They had available the generalizations and supporting facts upon which the items were based. Sixteen professional nutritionists and home economics educators reviewed the test items for content validity and appropriateness. Letters to experts and a list of evaluation specialists and professional nutrition educators are given in the Appendices B and C.

The items were planned to be expressed in vocabulary appropriate for high school students or high school graduates. A faculty member in elementary education (Appendix B) with background in reading abilities of various age groups reviewed the questions for appropriateness of vocabulary using readability indices.

A senior student in dietetics and two nutrition faculty members at Iowa State University (Appendix B) were asked to complete the test and to comment about the appropriateness of questions and about possible ambiguity. Questions which were not answered correctly were revised or discarded. Approval for administration of test items to subjects was obtained from the Human Subjects in Research Committee at Iowa State University. A copy of the consent form used is found in Appendix D.

One hundred items were tested in several sections of FN 107, Nutrition and Man's Food, which was taught at Iowa State University. Results from the 105 students who participated were analyzed with a test and item analysis computer program. Readability and clarity of the test items were ascertained from student comments. Time required to complete the test items was noted. On the basis of the information obtained from pretesting, the items were revised or rewritten.

Seventy-five items were selected because of their appropriateness for testing the objectives at the cognitive levels identified. The table of specifications served as the basis for item selection (Table 14, p. 207). Noll and Scannell (1972) recommended working with 50 to 100% more items than used in the final form. A pilot test with nine students showed that the items could be answered in the time available for testing.

The 75 pretest items are given in Table 15, p. 209. The objective that was tested and the cognitive level of each item are also identified.

Administration of Pretest

The 75-item questionnaire was administered by the investigator to 103 students in FN 107 in a class meeting the last week of classes. Questionnaire administration directions were given and information was provided about the purpose of the research and testing (Appendix E). Machine scorable answer sheets and No. 2 pencils were provided.

Analysis of Pretest Data

The mean, standard deviation, reliability coefficient, standard error of measurement, range, and item analysis information for the 75-item pretest were computed. Reliability was calculated by the Kuder-Richardson formula-20 (Kuder and Richardson, 1937). The Kuder-Richardson formula-20 is

$$r = \frac{n}{n-1}\left[1 - \frac{\Sigma pq}{\sigma^2}\right]$$

where:

n = number of test items;

p = proportion of correct responses to one item;

q = proportion of incorrect responses to one item; and

σ^2 = variance of the scores (square of standard deviation of test scores).

Item analysis information included item difficulty index, item discrimination index and standard deviation for each item. The difficulty index was computed for each item for determining the percentage of the subjects who responded correctly to the items. The discrimination index was determined by calculating the point-biserial coefficient. Distracter analysis consisted of an analysis of the frequency with which each response option was chosen.

The reliability index for the test was 0.86 and the mean score and standard deviation was 53.5 ± 9.5. The mean difficulty index was 71%; the standard error of measurement 3.5; and the range of scores was from 27 to 72. Results of item analysis are found in Table 16, p. 234.

Selection of Items for Nutrition Knowledge Questionnaire

Fifty items were selected for the final nutrition knowledge questionnaire. The table of specifications (Table 14, p. 207) was used as the basis for content and cognitive level of items. Twenty items represented physiological aspects of nutrition, 20 items represented food as sources of nutrients, and 10 items represented socio-psychological and economic aspects of nutrition. Test items were selected based on item analysis data. One criterion for analyzing items was a difficulty level of 30 to 70% (Martuza, 1977). Ahmann and Glock (1971) noted that the target zone should be slightly above 50%. Different criteria have been proposed by different investigators, for example, Dwyer, Feldman and Mayer (1970) considered 10 to 90% correct appropriate. Ebel (1965) recommended 25-75%.

The criterion for item discrimination was 0.20 or above (Ebel, 1965) if occurring in conjunction with an item difficulty of 30 to 70%. The discrimination index indicated items which did not appear to be homogeneous with the total test. Brown (1976) proposed that 0.15 to 0.20 or higher would indicate good discrimination.

Another proposed criterion for selection of items was to have each distracter chosen by at least one student out of each fifty completing the test or a total of two percent or more of the sample (Brown, 1976).

Anastasi (1976) recommended placing some relatively easy items at the beginning of the test. This arrangement could give individuals confidence in approaching the test and decrease the likelihood of spending time on items that were too difficult to the neglect of other items.

The goal for content validity for the first objective which dealt with functions of nutrients (objective I.A, Table 14, p. 207) was to retain six items at the knowledge level and one item at the comprehension level. Items 1 and 3 were judged by experts to be at the comprehension level and items 2, 4, 5, 6, 7, 8, 9, and 10 at the knowledge level. Items 1, 5 and 7 were discarded. Each of those items was too easy. The difficulty indices were 0.93, 0.86 and 0.96, respectively, for items 1, 5 and 7. Distracter A for both items was selected by only one respondent. Of the items retained, four still had difficulty indices above 0.70. Those were items 2, 3, 8, and 9 with difficulty indices of 0.82, 0.75, 0.85, and 0.75, respectively. The discrimination index was low (0.11) for one item, number 10. Item 5 tested more poorly (in terms of difficulty and discrimination indices) than item 10 on the pilot test.

When nutrient needs were considered for different age individuals and at various stages in the life cycle (I.B) (items 11-18), four items at the comprehension level and one item at the application level were selected to meet criteria in the table of specifications. Items 11, 12, 13, 14, 15, and 18 were judged to be at comprehension level and 16 and 17 at application level. Items 11, 13 and 16 were eliminated. Item 11 had one response option (B) selected by only one subject. This item and item 13 were easy. The difficulty indices were 0.84 and 0.86 for items 11 and 13, respectively. One reviewer for nutrition content stated that there would be some increase in iron needs as a possible answer to question 16. Only two persons selected the last option (C) to that question which showed that very few subjects believed that there would be considerable decreases in iron and protein needs with weight gain. The discrimination index was also lowest for that item of the group (0.20). Of the items that were retained, three had difficulty indices of above 0.70. They were items 14 (0.72), 15 (0.85) and 17 (0.73).

For the objective dealing with the effects on health of inadequate, excessive or imbalanced intakes of nutrients (I.C), the goal was to retain three items at the comprehension level and one item at the application level. Items 19, 21, 22, and 23 were identified as items testing at a comprehension cognitive level and items 20 and 24 at the application level. Items 20 and 22 were discarded. Both items were too easy and discriminated poorly between those scoring high and low on the test as a whole. Item 20 had a difficulty index of 0.89 and a discrimination index of 0.05 or negative. Item 22 had a difficulty index of 0.98 and a discrimination index of 0.10. No subjects selected distracter A and only two subjects selected distracter C as the correct answer. Items which were easy as judged by the optimum criterion being 0.30 to 0.70 were items 21 (0.75) and 24 (0.83). The discrimination index for item 24 (0.16) was below the desirable criterion of 0.20 or greater.

Energy needs and weight control were addressed in the fourth objective identified under physiological aspects of nutrition (I.D). Four application items were to be selected from the six application items (items 25-30) tested. Items 25 and 26 were discarded, item 25 because only one respondent had selected distracter C and item 26 because of the relatively low discrimination index (0.16) and the difficulty index of 0.75. Item 26 was quite similar to item 29 so discarding one of those two items was helpful. Only one other item (item 28) failed to meet all of the optimum selection criteria. The difficulty index for item 28 was 0.73.

Four objectives were included under the topic heading "food as sources of nutrients." The first dealt with good food sources of individual nutrients and energy (II.A). Eleven items were prepared to test this objective, six at the comprehension cognitive level (items 31, 35, 36, 38, 40, and 41) and five at the application level (items 32, 33, 34, 37, and 39). From those, four at the comprehension and three at the application level were retained. The comprehension level items not meeting the criteria were 40 and 41 which each had difficulty indices of 0.75. A choice of comprehension level items was based partly on content (with item 31 testing some of the same concepts as the application item 34) and partly on the basis of an incorrect keyed response to the original set of options for item 38 by one of the judges keying the test items. Items 35, 36, 40, and 41 were retained at the comprehension level. Two application level items were discarded (items 37 and 39) since they had difficulty indices of 0.85 and 0.78, respectively. Item 32 had a difficulty index of 0.72. The items retained at the application level were items 32, 33 and 34.

For the objective dealing with nutritional value as a way of grouping foods (II.B), five items at the comprehension level (items 45, 46, 47, 48, 51) and five items at the application level (items 42, 43, 44, 49, and 50) were tested. Difficulty indices were 0.78, 0.88 and 0.89, respectively, for the three items discarded, namely, items 43, 45 and 50. In addition, item 43 had a discrimination index of only 0.05. Five other items in the group had difficulty indices of over 0.70.

They included items 42 (0.89), 46 (0.86), 48 (0.72), 49 (0.81), and 51 (0.83). Item 42 was retained based on the concept tested even though items 45 and 50 had similar difficulty indices.

The use of nutrition information accessible to consumers (II.C) was tested with three application level items (items 52, 53, and 54). Item 52 was discarded because of the difficulty index (0.84). Item 54 had a difficulty index of 0.80.

The influence of food handling practices on foods (II.C) was tested using items 55 to 60. From the one knowledge (item 57), three comprehension (items 58, 59 and 60) and two application items (items 55 and 56) tested, one was discarded at the comprehension level (item 58) and one at the application level (item 56). Item 58 was considered less important by some expert judges than some of the other items. Item 56 had a difficulty index of 0.88. Item 55 had a difficulty index of 0.87, but a higher discrimination index than that of item 56.

Three objectives were included under the topic of "sociopsychological and economic aspects of nutrition." The first referred to influences on food habits (III.A). Three comprehension level items (items 61-63) were tested. Item 62 was discarded because of a low discrimination index (0.07) and a difficulty index of 0.83. The other two items, items 61 and 63, were also too easy, with difficulty indices of 0.81 and 0.86, respectively.

Food costs were addressed in the next objective (III.B). Four comprehension level items (items 64, 65, 66, and 70) and three application level items (items 67, 68 and 69) were tested. Of those, two were discarded, items 65 and 67. The discrimination indices were low for each, 0.15 for item 65 and 0.13 for item 67. In addition, the difficulty index was 0.28 for item 67. Only one other item, item 70, failed to meet all of the optimum criteria for inclusion. The difficulty index for that item was 0.72.

The final objective which dealt with eating pattern and nutritional intake (III.C) was tested with five items, one at the knowledge level (item 71), one at the comprehension level (item 74) and three at the application level (items 72, 73 and 75). Two were discarded (items 72 and 73). The difficulty indices were 0.77 (item 72) and 0.84 (item 73). Item 71 was also too easy, with a difficulty index of 0.80.

In summary, items selected included two items which did not have discrimination indices of 0.20 or greater. They included item 10 (0.11) and item 24 (0.16). Fourteen items had difficulty indices of 0.71 to 0.80. Included were items 3 (0.75), 9 (0.75), 14 (0.72), 17 (0.73), 21 (0.75), 28 (0.73), 32 (0.72), 40 (0.75), 41 (0.75), 48 (0.72), 54 (0.80), 57 (0.75), 70 (0.72), and 71 (0.80). Eleven items had difficulty indices of 0.81 to 0.90. Included were items 2 (0.82), 8 (0.85), 15 (0.85), 24 (0.83), 42 (0.89), 46 (0.86), 49 (0.81), 51 (0.83), 55 (0.87), 61 (0.81), and 63 (0.86).

Standardization of Questionnaire

Administration of the 50-item nutrition questionnaire to a total of 168 students in class sessions of FN 107 (standardization group or norm sample) was completed the last week of fall quarter, 1979. The questionnaire reliability was calculated by Kuder-Richardson formula-20. The mean score, standard deviation, standard error of measurement, and range of scores were computed. Items were analyzed for quality using the criteria of item difficulty in the range of 30 to 70% correct, item discrimination 0.20 or above and each distracter selected by two percent or more of the subjects.

Questionnaire Administration to Test Groups

Several young adult groups and other adult groups served as test groups for the questionnaire. Iowa State University students were tested on the first or second day of class in FN 107 to evaluate level of nutrition knowledge prior to formal college instruction in nutrition.

Student nurses at Iowa Methodist Medical Center School of Nursing served as subjects. One group of students had completed one nutrition course in their nursing program (n = 43) and the other group was just beginning the first nursing school nutrition course offering (n = 86).

Students at Luther College in Decorah (n = 19) and students beginning FN 301, Concepts of Nutrition Science (n = 40), an intermediate nutrition course offered at Iowa State University, were tested. The prerequisite for FN 301 was FN 107. The course description for FN 301 is exploration of the basis of nutritional science; interpretation of interrelationships between food practices and physiological, social and psychological factors.

Elementary school teachers (n = 34) were tested before and after a nutrition education course offered at Iowa State University.

Teacher educators (n = 19) attending a two-day nutrition education workshop in Marshalltown, Iowa, were tested at the completion of the workshop.

Expanded Food and Nutrition Education Program (EFNEP) aides employed by the Cooperative Extension Service were tested. Subjects were tested at times when aides met with the home economist in each area of the state of Iowa. Home economists who were involved in test administration are listed in Appendix F. Test forms and directions were mailed to the home economists. Stamped, self-addressed envelopes were supplied to return the completed questionnaires. Questionnaires were received from 79 aides. Adults attending extension and weight control meetings (n = 72) at various locations in Iowa and 4-H leaders (n = 26) in several Iowa counties served as subjects.

Parents of first graders in Iowa also participated in the testing. Questionnaires to be returned by mail were distributed by extension home economists to parents at meetings they attended in cooperation with a research study conducted at Iowa State University and the Iowa Department of Public Instruction entitled "Parents and Children--Good Nutrition Partners." An example of the questionnaire used is found in Appendix G. The design format recommended for mail questionnaires (Dillman, 1978) was followed. Dillman recommended that the questionnaire be printed in graphically reduced form on off-white paper and the final booklet be approximately 6 1/8" x 8 1/4." Fifty-one questionnaires were returned by parents.

Analysis of Questionnaire Data

The analysis of the test data consisted of determining the quality of the final questionnaire. The mean, standard deviation, standard error of measurement, reliability coefficient, and item analyses (difficulty index, discrimination index, standard deviation, distracter analysis) were computed.

Test performance by the standardization group of FN 107 students was compared with that of the adult groups examined. Mean scores were compared by t-test. Test performance by content area was calculated using difficulty indices.

Table 12. Generalizations and supporting facts in nutrition for young adults

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I. <u>Physiological Aspects of Nutrition</u>

A. The body utilizes nutrients from foods, with each nutrient performing functions in concert with those of other nutrients.

B. Needs for each nutrient vary from one person to another and also differ at various stages in the life cycle.

C. Inadequate intakes as well as excessive or imbalanced intakes of one or more nutrients over time may be injurious to health.

D. The body needs energy from foods to maintain basic internal processes and for physical activity; deficiency or excess of food energy causes under- or overweight.

II. <u>Food as Sources of Nutrients</u>

A. Certain foods are especially high or low in content of individual nutrients and energy.

B. Foods are grouped in ways which can help consumers make food choices in relation to nutritional value.

C. Information regarding nutrient and energy value of foods is accessible to the consumer and is useful in making food choices.

D. The ways a food is handled may influence its content of nutrients and energy, its safety, appearance, and storage life.

III. <u>Sociopsychological and Economic Aspects of Nutrition</u>

A. Development of food habits is influenced by the social, cultural, and educational environment as well as economic resources.

B. Combinations of foods differing widely in cost can provide nutritious food intakes.

C. Adequate nutritional intake may be achieved by using many different combinations of foods and eating patterns.

Table 12. Continued

I. Physiological Aspects of Nutrition

A. The body utilizes nutrients from foods, with each nutrient performing functions in concert with those other nutrients.

Plant and animal tissues used for food contain a variety of nutrients.

Nutrients are elements or combinations of chemical elements classified as carbohydrates, fats, proteins, vitamins, minerals, water, and alcohol.

Some nutrients supply energy, some are used for growth and maintenance of body tissue, and some are converted to substances which regulate the ways the body functions.

Nutrient intake can affect personal appearance as well as physical and psychological health.

Water dissolves and/or disperses materials and aids in their transport to and from cells throughout the body. Water is also used in regulation of body temperature.

Carbohydrates (sugars and starches), proteins, fats, and alcohol serve as energy sources. Pure carbohydrates are about equal to proteins in energy value on an equal weight basis. Alcohol furnished more energy than carbohydrates or proteins but less than fat. Weight for weight, fats furnish more than twice the energy value of either carbohydrates or proteins.

Proteins are also used to build and maintain body structures and to produce compounds which regulate body functions. Materials making up the different parts of the body turn over constantly but not necessarily at the same rate.

Fats serve as the major storage form of energy for the body.

Calcium is essential for bone and tooth formation and retention, and in small amounts for regulation of functions such as blood clotting and muscle contraction.

Phosphorus is combined with calcium and other elements in hard tissues (bones and teeth) and also functions in soft tissues.

Fluorine, if available during development of hard tissues, helps to strengthen them.

Table 12. Continued

	Iron can combine with a particular protein to form hemoglobin, a compound in blood cells which carries oxygen to tissues.
	Iodine is part of the hormone thyroxine which assists in regulating energy metabolism.
	Trace minerals other than iron, iodine and fluorine are used by the body in very small amounts to perform a variety of essential functions.
	Most vitamins are necessary for normal growth; each vitamin has specific functions as well.
	Vitamin A is necessary for visual adaptation to dim light, and for maintenance of the health of skin and of mucous membranes.
	Three of the B-complex vitamins, thiamin, riboflavin, and niacin, are important for release of energy from fats, proteins and carbohydrates; they also aid in proper functioning of organs, including those of the digestive tract and nervous system.
	Vitamin C is necessary for maintenance of normal connective tissue and for wound healing.
	Vitamin D assists in formation of strong bones and teeth because the body converts it to a substance that improves calcium absorption.
	Vitamin E functions as an antioxidant. It prevents oxidation of lipids in cell membranes which would cause cell damage. Vitamin K is essential for blood clotting.
	Nonnutritive fiber is not absorbed, but some fiber in the diet is beneficial because it provides bulk that helps to move materials through the digestive tract.

Table 12. Continued

B. Needs for each nutrient vary from one person to another and also differ at various stages in the life cycle.

Quantities of various nutrients needed depend upon an individual's size, activity, age, sex, and body composition and are influenced by stress, drugs, surgery, and disease.

During periods of rapid growth, there is an increased need for most nutrients expressed on the basis of body weight. Children often need smaller quantities of nutrients than adults but their needs are generally greater per unit of body weight and per unit of energy value of foods consumed.

Because of their rapid growth, adolescent boys need larger quantities of nutrients than are needed by younger persons and females except pregnant and lactating women. Recommendations for nutrient intake are similar for protein and most vitamins and higher for minerals involved in growth for adolescent boys than for adult men.

Men are generally larger in size than women and, therefore, have higher requirements for nutrients and energy.

Women of child-bearing age require more dietary iron than adult men because iron is lost during menstruation.

Needs for most nutrients increase during pregnancy and lactation.

Needs for most nutrients remain about the same throughout adulthood; however, as people age their energy needs are generally decreased.

The presence of excess fatty tissue does not increase the need for particular nutrients.

Increased physical activity increases the need for sources of energy for nutrients involved in energy metabolism.

An individual's state of health often affects nutritional needs.

Recommended intakes for some nutrients (Recommended Dietary Allowances) have been prepared and periodically revised by groups of experts (Food and Nutrition Board, National Academy of Science--National Research Council) and are based on their evaluation of existing information. Recommended Dietary Allowances can be used for developing plans for combinations of foods to improve or evaluate nutritional intakes of populations.

Table 12. Continued

C. Inadequate intakes as well as excessive or imbalanced intakes of one or more nutrients over time may be injurious to health.

Diets that supply less than the needed intake of nutrients may, if continued over time, affect the functional performance of an individual without necessarily resulting in distinguishable deficiency symptoms.

Severe nutrient deficiencies result in recognizable symptoms and eventually in classsical nutrient deficiency diseases such as night blindness (lack of vitamin A), beriberi (lack of thiamin), pellagra (lack of niacin), scurvy (lack of vitamin C), rickets (lack of vitamin D), simple goiter (lack of iodine), kwashiorkor (lack of protein), and severe anemia (lack of iron, folic acid and/or vitamin B_{12}). Severe deficiency diseases are rare in the United States today.

When a healthy individual consumes a diet inadequate in one nutrient, the length of time before deficiency symptoms occur will be affected by the amount of the nutrient stored or retained in the body. Iron and fat-soluble vitamins--A, D, E, and K--can be stored in the body. Water-soluble vitamins--B-complex and C--are not stored in the body in appreciable amounts.

Excessive intakes of one nutrient may affect the functioning of or needs for other nutrients.

Excessive intakes of B-complex vitamins and vitamin C are lost from the body. However, frequent intake of very high doses of these nutrients may cause adverse effects. Most minerals are less well-absorbed than vitamins and with the exception of iron are not stored in the body if excessive amounts have been consumed.

Toxicities may occur from excessive intakes of iron and of vitamins A, D, E, and K because excesses of these nutrients are stored in the body.

Excessive intakes of fiber can irritate the digestive tract.

Excessive intakes of energy sources (carbohydrates, fat, protein, or alcohol) are converted to body fat.

Excess accumulation of fat which causes overweight or obesity is one, but not the only, risk factor for a number of diseases including coronary heart disease and diabetes.

Table 12. Continued

D. The body needs energy from foods to maintain basic internal processes and for physical activity; deficiency or excess of food energy causes under- or overweight.

Energy is measured in kilocalories or kilojoules.

Physical activity, body size, age, growth and concentration of some hormones affect energy needs.

The amount, type and intensity of physical activity affects the need for sources of energy.

A balance between energy intake from foods and energy expenditure is needed for weight maintenance. An excess or deficit of approximately 3,500 kilocalories is required to gain or lose one pound of fat tissue.

For individuals who are overweight, gradual weight loss of one to two pounds per week would be recommended.

Table 12. Continued

II. Food as Sources of Nutrients

A. Certain foods are especially high or low in content of individual nutrients and energy.

Carbohydrates (sugars, starches, fibers) are generally found in plentiful amounts in plant products.

Fats from plant and animal sources are plentiful in most diets. Oils, shortenings, butter, margarine, and salad dressings are particularly high in fat content. Foods of animal origin generally contain more fat than foods of plant origin.

Fats are made from saturated and unsaturated fatty acids. Fats obtained from plant sources are generally more unsaturated than those obtained from animal products. The degree of saturation of plant oils can be increased by processing.

Animal products used for food contain differing amounts of cholesterol. In addition, cholesterol can be formed within the body from other nutrients.

Protein is provided largely by meats, milk and milk products, eggs, legumes (dried beans and peas), and nuts. Bread and cereals are also significant sources of protein. Combinations of cereal products and legumes or combinations of plant and animal sources of protein can provide adequate dietary protein less expensively than use of only animal sources of protein.

Calcium is most abundant in milk and milk products such as cheese, yogurt and ice cream, but is also found in smaller but useful amounts in other foods such as dark green leafy vegetables and legumes.

Phosphorus is found in the same foods that are good sources of protein.

Fluorine is added in minute amounts to drinking water in many communities, or may occur naturally in the water in certain locations.

Iron can be found in meats (especially the red meats and liver), enriched and whole grain breads and cereals, legumes, dried fruits, and dark green leafy vegetables.

Table 12. Continued

Iodine can be obtained from sea foods, foods produced in areas with iodine in the soil and iodized table salt.

Trace minerals in general are distributed in small amounts in a variety of foods. Eating a variety of food helps insure that a diet is adequate in trace mineral content.

Vitamin A occurs in two forms: vitamin A itself and vitamin A formed from carotenes in the body. Dark green and deep yellow fruits and vegetables contain carotene. Vitamin A itself is found in liver, egg yolks, whole milk, and butter. Carotene is added to margarine and vitamin A to skim milk.

The vitamin B-complex consists of eight or more different compounds generally occurring together naturally in a wide variety of foods.

Thiamin is found in pork, unrefined plant and animal foods and enriched grain products. Whole and enriched grain products can be the principal source because of the amounts commonly eaten each day.

Riboflavin is found most abundantly in milk and products made from milk except cream and butter. It is also present in unrefined foods, enriched grain products and liver.

Niacin is obtained primarily from a large variety of foods including lean meats, legumes, enriched or whole grain breads and cereals.

Vitamin B_{12} occurs only in foods of animal origin. Bacterial synthesis is one source of the commercial B_{12} supplies.

Vitamin C is found in a variety of fruits and vegetables but in markedly different quantities. Citrus fruits are among the most dependable sources.

Vitamin D is produced within the body when the skin is exposed to sunlight. It is also present in milks that have been fortified.

Vitamin E is found in largest amounts in oils, shortenings and margarines from vegetable sources and in wheat germ. Smaller amounts are found in many other foods.

Table 12. Continued

The energy available to the body from food is related to the amount of digestible carbohydrate, fat and protein in the food. Foods that are low in energy contain little of these nutrients. They are high in content of water and/or undigestible carbohydrate. Fats contribute more than twice the energy value for the same weight as carbohydrates and proteins.

The serving size of food should be considered as well as food composition to determine energy and nutrient combinations.

The amount and variety of nutrients contained in food in relation to its energy value determines the nutrient density of the food.

Table 12. Continued

B. Foods are grouped in ways which can help consumers make food choices in relation to nutritional value.

Cultural food habits are the basis for different food group plans.

The Daily Food Guide, currently in use in the United States, is flexible with respect to caloric intake, some subcultural and individual differences in food habits and food costs. Knowledge of energy value of food is important when using the plan to assure adequate but not excessive energy intake. The four groups of the Daily Food Guide and the amounts recommended from each group include:

Vegetable-Fruit Group:
4 or more servings/day

a. Dark green and deep yellow vegetables and fruits
At least 1 serving every other day

b. Good or fair vitamin C sources
At least 1 serving of a good source of vitamin C, or 2 servings of a fair source/day

c. Other fruits and vegetables

Milk Group:

Milk or equivalents in cheeses, ice cream or yogurt based on calcium content.
For foods with other ingredients added to the milk, it takes a larger amount to be equivalent to milk in calcium content.
2-3 cups/day for children under 9
3 or more cups/day for children 9-11
4 or more cups/day for teenages
2 or more cups/day for adults

Table 12. Continued

Enriched and Whole Grain Bread and Cereal Group:
4 or more servings/day

Meat Group:

Meat or equivalents of legumes, eggs or nuts based on protein content

2 or more servings of meat or other protein rich foods equivalent to 2-3 ounces of cooked lean meat/day.

Other Foods

Additional foods complement but do not replace foods from the four groups. Amounts should be determined by one's energy needs.

Other ways of grouping foods may involve nutrient and energy value of foods.

Table 12. Continued

C. Information regarding nutrient and energy value of foods is accessible to the consumer and is useful in making food choices.

Nutrition labeling is required for some food products. The Food and Drug Administration monitors label information.

The U.S. Recommended Dietary Allowances are the bases for nutrition labeling. Those allowances are higher than necessary for some groups of persons but closely approximate allowances of the Food and Nutrition Board for adolescent boys. The calcium recommendation is slightly below that recommended for teenagers.

Foods for infants and young children are labeled with different U.S. Recommended Dietary Allowances which have been especially defined for their needs.

Combinations of nutrients are present in most foods; daily diets which provide the needed energy and adequate amounts of the key nutrients, i.e., protein, iron, calcium, vitamin A, thiamin, riboflavin, niacin, and vitamin C for an individual probably, over time, provide also the necessary amounts of other essential nutrients. Variety in food intake is important to insure adequate intake of all nutrients.

Ingredient labels on food products can be used to compare items with more than one ingredient. The ingredient found in the largest quantity is listed first and the other ingredients are then listed in order of decreasing amount. Nutrient content for some products can be approximated from this information.

Food composition information is available to consumers. Calorie charts and tables of nutrient content of foods can be used to compare nutritional contributions of foods. Food composition information can be used along with information about nutrient and caloric needs to food intakes.

Table 12. Continued

D. The ways a food is handled may influence its content of nutrients and energy, its safety, appearance, and storage life.

Cooking food may increase or decrease availability of nutrients. Vitamin C value may decrease but some nutrients may become more available for absorption.

Water-soluble nutrients can be dissolved to some extent into the water used to cook foods.

When parts of foods are removed in processing, the nutritional value of the food may change. Nutrients are added to some foods (enriched foods) to replace those which were lost during processing. Vitamin A is added to skim milk and iron, thiamin, riboflavin, and niacin to breads and cereals.

Canning or freezing a food should not result in excessive nutrient losses as compared with cooked fresh products when recommended procedures are followed. These processing methods extend the availability of nutrients found in fruits and vegetables beyond the growing season. The nutrient content of fresh produce is variable depending on conditions of storage. The nutrient content of canned or frozen products while somewhat larger for some nutrients than when the fruits and vegetables were freshly harvested can still be depended upon in food intakes.

Exposure to air may lead to some nutrient losses and affect the appearance of food products.

Additions of preservatives to foods can increase storage life.

Amounts of additives included in foods, either deliberately to improve food quality or incidentally, are carefully monitored.

Commercial food handling and marketing are monitored so that foods will be safe when purchased. Foods should be kept hot (above 140° F) or cold (below 40° F) as much of the time as possible and reasonable to protect against food poisoning.

When consumers follow guidelines for storage and preparation of food, nutritional value and food safety should be maintained.

Table 12. Continued

III. Sociopsychological and Economic Aspects of Nutrition

A. Development of food habits is influenced by the social, cultural and educational environment as well as economic resources.

Food likes, dislikes and satisfactions associated with food affect food habits.

Religious, cultural and family traditions and beliefs about food affect food choices, the way in which foods are prepared and the manner in which foods are served and eaten.

Acceptance of a wide variety of food can depend upon experiences, knowledge and curiosity about different foods.

Parents have considerable influence on food habits of children and can teach children to know and accept a wide variety of foods.

Associations with other people (siblings, peer groups and others) affect attitudes towards food and may reinforce or hinder decisions to change food habits.

Special dietary prescriptions and advertising may influence food intakes.

Resources (money, foods available, skills in selecting and preparing foods, time, and nutrition knowledge) may limit or expand possible choices of food. Knowledge of food composition is especially important in making food choices.

Table 12. Continued

B. Combinations of foods differing widely in cost can provide nutritious food intakes.

The cost or prestige of a food does not determine its nutritional value.

Food prices are responsive to changes in food supply and may vary depending upon the season.

State and federal agencies establish policies for production and marketing of foods which may affect food availability and costs.

Foods with similar nutritional value but different costs can be substituted for one another.

Knowledge of general marketing guidelines can help one select foods which will provide nutrients at reduced costs.

Labeling of nutrients on packaged foods can enable a consumer to choose the best food buys.

There are federal programs which have been designed to provide help for people in meeting nutrient needs when resources are limited.

Table 12. Continued

C. Adequate nutritional intake may be achieved by using many different combinations of food and eating patterns.

A balanced diet is a diet that contains a variety of wholesome foods that supply nutrients and energy in the proportions needed daily by the body.

No one food is a good source of all nutrients but some foods are better sources of nutrients than others.

Most healthy individuals can get adequate quantities of nutrients from foods; however, nutrient supplements may be necessary in certain instances. Both naturally-occurring nutrients and those which have been synthesized can be used by the body.

Ethnic patterns of food intake can be planned to meet nutrient needs.

Moderation is a guide to follow when selecting food.

Development of adequate patterns for food intake may depend upon knowledge of nutrients needed by the body and their concentrations in available foods.

Table 13. Percent distribution of cognitive levels of items on nutrition knowledge tests

Investigators	Subjects
Ikeda (1975)	7th, 8th and 10th graders
Nethers (1968)	Junior high students
Weber (1965)	Junior high students
Nece (1979)	10th, 11th and 12th graders
Carruth and Lamb (1971)	University students
Shannon (1976)	University students
Yetley (1974)	Young parents
Franklin (1971)	Elementary teachers
Byrd-Bredbenner (1981)	Nutrition educators

[a]Due to rounding, total will not equal 100%.

Percent of Items at Cognitive Levels					
Knowledge	Above Knowledge	Comprehension	Comprehension and Application	Application	Above Application
50		35		15	
60		30		10	
51	49				
50			25		25
36		35		29	
28[a]		43		28[a]	
60		30		10	
50		33		17	
24		52		18	6

Table 14. Table of specifications for nutrition knowledge questionnaire (total of 50 questions)

Behavioral Objectives A Young Adult Will Be Able To:	Number of Items at Cognitive Levels Knowledge	 Comprehension	 Application or Higher	Total Number of Questions
I. Physiological Aspects of Nutrition				
A. Recognize that the body utilizes nutrients from foods, with each nutrient performing functions in concert with those of other nutrients.	6	1		7
B. Show that needs for each nutrient vary from one person to another and also differ at various stages in the life cycle.		4	1	5
C. Determine that inadequate intakes as well as excessive or imbalanced intakes of one or more nutrients over time may be injurious to health.		3	1	4
D. Consider that the body needs energy from foods to maintain basic internal processes and for physical activity; relates deficiency or excess of food energy to under- or overweight.			4	4
				20

II. Food as Sources of Nutrients				
A. Compare food as to content of individual nutrients and energy.		4	3	7
B. Use knowledge of food group classifications to make choices in relation to nutritional food value.		4	3	7
C. Use information accessible to consumers regarding nutrient and energy value of foods in making food choices.			2	2
D. Relate food handling practices to the content of nutrients and energy, safety, appearance and storage life of foods.	1	2	1	4
				20
III. Sociopsychological and Economic Aspects of Nutrition				
A. Conclude that development of food habits is influenced by the social, cultural and educational environment as well as economic resources.		2		2
B. Show that combinations of food differing widely in cost can provide nutritious food intakes.		3	2	5
C. Demonstrate that adequate nutritional intakes may be achieved by using many different combinations of food and eating patterns	1	1	1	3
				10

Table 15. Classification of nutrition knowledge pretest items by objective and cognitive taxonomy level (K = knowledge, C = comprehension and A = application)

Item Number	Objective	Cognitive Level
I. Physiological Aspects of Nutrition		
1. Jim eats a roast beef sandwich to obtain energy. In which of the following combinations of nutrients are both of the items from the sandwich energy-yielding? a. starches and minerals. b. vitamins and carbohydrates. c. proteins and fats.	I.A	C
2. The energy value of carbohydrates is a. about equal to that of proteins. b. more than twice that of fats. c. less than that of proteins and fats.	I.A	K
3. Complete the analogy: Calcium is to strong bones as vitamin A is to healthy a. nerves. b. skin. c. connective tissue.	I.A	C
4. Calcium is essential in small amounts in the body for a. contraction of muscles. b. resistance to infection. c. maintenance of connective tissue.	I.A	K

5. Iron is found in blood cells in a compound which — I.A — K

   a. carries oxygen to tissues.
   b. regulates energy expenditures.
   c. aids in blood clotting.

6. Iodine is used by the body to form a hormone which regulates — I.A. — K

   a. energy metabolism.
   b. muscle contraction.
   c. body temperature.

7. Vitamin A is necessary for — I.A. — K

   a. contraction of muscles in the body.
   b. formation of body connective tissue.
   c. visual adaptation to dim light.

8. Three of the B-complex vitamins, thiamin, riboflavin and niacin, are needed primarily — I.A — K

   a. for releasing energy from energy-yielding nutrients.
   b. as carriers for iron and calcium in the body.
   c. to form thyroxine for metabolism of nutrients.

9. Vitamin C intake is necessary for — I.A — K

   a. preventing colds.
   b. maintaining connective tissue.
   c. absorbing polyunsaturated fats.

10. Vitamin D is important because the body changes it to a substance that — I.A — K

   a. helps maintain healthy skin.
   b. improves calcium absorption.
   c. combines with minerals in bones and teeth.

Table 15. Continued

Item Number	Objective	Cognitive Level

Use the following information to answer the next eight questions.

Angela	Beth	Sue	
Just starting to walk Age: 11 months Height: 2'4" Weight: 20 lbs.	High School basket-ball player Age: 15 Height: 5'7" Weight: 126 lbs.	Chemist Age: 28 Height: 5'7" Weight: 132 lbs.	
	Bob	**Dave**	**Carl**
	High School wrestler Age: 15 Height: 5'7" Weight: 134 lbs.	Gymnastics coach Age: 26 Height: 5'9" Weight: 154 lbs.	Construction foreman Age: 54 Height: 5'9" Weight: 154 lbs.

11. Which of the following combinations of people has the highest protein needs in proportion to body weight? I.B C

    a. Angela, Bob and Beth.
    b. Beth, Sue and Dave.
    c. Bob, Dave and Carl.

12. Bob's nutrient needs differ somewhat from the nutrient needs of Dave and Carl. The most marked difference for people Bob's age generally is their higher need for I.B C

a. calcium and vitamin A.
b. vitamin A and iron.
c. iron and calcium.

13. Sue and Dave's nutritional needs are probably most similar for I.B C

a. calcium and vitamin C
b. iron and iodine.
c. kilocalories and vitamin A.

14. Dave needs more protein than Sue. The primary reason is that I.B C

a. Dave is larger than Sue.
b. Dave is younger than Sue.
c. Dave is more active than Sue.

15. In comparison with the nutrient needs of Dave, Carl probably needs I.B C

a. more protein.
b. less vitamin E.
c. similar amounts of vitamin A.

16. If Sue gained 50 pounds, how would her needs for iron and protein compare to her present needs? They would I.B A

a. increase considerably.
b. stay about the same.
c. decrease considerably.

Table 15. Continued

Item Number	Objective	Cognitive Level
17. In comparing the nutrient needs of Angela and Sue, Angela needs a. certain nutrients that Sue does not. b. larger quantities of some nutrients. c. more of most nutrients per pound of body weight.	I.B	A
18. If Dave had major abdominal surgery, which nutrient would he need in increased amounts to form new tissue? a. magnesium. b. vitamin C. c. vitamin D.	I.B	C
19. Tom needs 50 grams of protein per day. His regular diet supplies adequate sources of energy from carbohydrates and fat as well as 90 grams of protein per day. Most of the extra protein will be a. changed to fat and stored. b. used to form more muscle. c. lost from the body.	I.C	C
20. Jan (age 24) and Julie (age 4) have each been consuming diets inadequate in vitamin A for the same length of time. As they continue to eat diets containing less vitamin A than they need, symptoms of vitamin A deficiency will probably occur a. at about the same time for Jan and Julie. b. earlier for Julie than Jan. b. earlier for Jan than for Julie.	I.C	A

21. In comparison with symptoms of vitamin D deficiency, symptoms of a deficiency of vitamin C would probably be seen in   I.C   C

a. a much shorter time.
b. about the same amount of time.
c. a much longer time.

22. Marcia (age 30) is concerned whether she is getting enough vitamin C. She can be fairly certain that she   I.C   C

a. is not, if her intake is 5% less than the RDA for her age and sex.
b. is, if she is consuming a good food source of vitamin C each day.
c. is, if at a routine physical examination her hemoglobin level is normal.

23. If Jean's intake of some nutrients from supplements she is taking greatly exceeds her need for them, which nutrient would most likely be harmful to her health?   I.C   C

a. riboflavin.
b. vitamin A.
c. calcium.

24. Tim (age 48) has had a heart attack. His blood pressure is above normal, his serum cholesterol is elevated and he is 15 pounds overweight. In order to help correct some of the problems, his physician may ask him to consume more foods containing polyunsaturated fat and to limit his intake of sodium, saturated fat, cholesterol, and   I.C   A

a. vitamin E.
b. kilocalories.
c. calcium.

Table 15. Continued

Item Number	Objective	Cognitive Level
25. Sally is a 6-year old first grader who rides her bike or walks four blocks to school. Jill is a 15-year old high school cheerleader. Beth is a 32-year old high school drama coach. Which of these people probably has the highest total energy needs? a. Sally. b. Jill. c. Beth.	I.D	A
26. John is trying to lose weight. If he does not change his energy expenditure, for an average loss of one pound of fat tissue per week he should decrease his daily average intake by about a. 100 kilocalories. b. 250 kilocalories. c. 500 kilocalories.	I.D	A
27. If Nancy's average daily intake of energy is 2,000 kilocalories and her average expenditure is 1,800 kilocalories per day, in two months her body fat tissue content will increase a. by 3-4 pounds no matter what nutrients the extra energy is from. b. by 8-9 pounds whether the extra energy is from carbohydrate, protein or fat. c. more if the energy is from carbohydrate than if it is from protein.	I.D	A

28. Kathy (age 19) could lose 3 pounds of excess fat tissue in I.D A

a. about three days if she eats half as much food as her usual 2,000 kilocalorie intake.
b. less than a week if she begins to swim an hour each day (400 kilocalories per hour).
c. about three weeks by eating three-fourths as much food as her usual 2,000 kilocalorie intake.

29. John is trying to lose weight. He plans to begin bicycling 8 hours per week (250 kilocalories/hour). For an average loss of two pounds of fat tissue per week he will also need to reduce the daily energy value of his usual diet by about I.D A

a. 500 kilocalories.
b. 750 kilocalories.
c. 1,000 kilocalories.

30. Don (age 71) uses approximately 300 kilocalories less energy each day now than when he was 21 years old. His energy intake from food has stayed about the same. Approximately how many pounds of fat tissue would he gain in six months? I.D A

a. 5 pounds.
b. 10 pounds.
c. 15 pounds.

Table 15. Continued

Item Number	Objective	Cognitive Level
<u>II. Food as Sources of Nutrients</u>		
31. Which of the following groups of foods contains the highest amount of saturated fatty acids? a. 1 oz. tuna, 1/2 c. coleslaw, 1 tbsp. solid vegetable shortening. b. 1 oz. beef, 1 tbsp. corn oil, 3" piece of chocolate cake. c. 1 oz. bacon, 1 tbsp. butter, 1/2 c. strawberry ice cream.	II.A	C
Use the following three daily intakes of food to answer the next two questions. The same breakfast was eaten each day: 1/2 c. Orange Juice 3 Pancakes 2 tsp. Margarine 2 tbsp. Syrup 1 c. 2% Milk		

Day 1	Day 2	Day 3
1/4 of 16" Hamburger Pizza	3 oz. Roast Chicken	3 oz. Roast Beef
1 c. Tossed Salad	1/2 c. Rice	1/2 c. Mashed Potatoes
2 tbsp. Vinegar and Oil	1/2 c. Carrots	1/2 c. Lima Beans
Salad Dressing	1/2 c. Grean Beans	1/2 c. Corn
1 serving Apple Pie	1 large Apple	1 c. 2% Milk
1/2 c. Ice Cream	1 c. 2% Milk	1 c. Spaghetti with
1 Breaded Pork Chop	1 c. Beef Noodle Soup	2 Meatballs
1/2 c. Scalloped Potatoes	8 small Saltine Crackers	1 piece French Bread
1/2 c. Asparagus with Cheese	2 tsp Margarine	1 tsp. Margarine
1/2 c. Butterscotch pudding	1/2 c. Coleslaw	1 c. Tossed Salad
12 oz. Pepsi	1 c. 2% Milk	2 tbsp. French Dressing
1 c. Whole Milk	12 oz. Coke	1 c. Chocolate Milk

32. How do the above intakes compare in energy value? II.A A

a. Day 1 contains more energy than the other two days.
b. Day 2 contains less energy than Day 3 but more than Day 1.
c. Day 3 contains less energy than the other two days.

33. Jim (age 32) ate the foods listed above for Day 3. When looking at the nutrient contributions from the day's intake, beef is a poor source of II.A A

a. iron, but there is an adequate amount available from the pancakes, lima beans, corn, and French bread.
b. calcium, but there is an adequate amount available from the 2% and chocolate milks.
c. niacin, but there is an adequate amount available from the orange juice, pancakes, and mashed potatoes.

Table 15. Continued

Item Number	Objective	Cognitive Level
34. Two months ago Gerald was asked to reduce the total number of kilocalories from fat, and to decrease the saturated fat and increase the polyunsaturated fat coming from foods in his diet. Which of the following sets of changes would best accomplish this?	II.A	A
a. Substitute a ham sandwich for cheese pizza, custard pie (contains eggs and milk) for chocolate pudding, roast beef for a pork chop, and soft margarine for butter on a baked potato.		
b. Substitute tomato slices for a baked potato, cheddar cheese for ice cream, whole milk for coke, and 1 1/2 tbsp. for 2 tbsp. of salad dressing.		
c. Substitute angel food cake and strawberries for apple crisp and ice cream, turkey and mayonnaise sandwiches for hamburger pizza, skim milk for whole milk, and lemon juice for cheese on broccoli.		
35. Which of the following combinations of foods would provide the most calcium if average size servings are eaten?	II.A	C
a. cream cheese, enriched sweet rolls, sweet potatoes.		
b. cheddar cheese, white bread, broccoli.		
c. butter, whole wheat bread, cauliflower.		
36. Which of the following foods could Barb (age 30) eat less than her husband John since it contains little iron?	II.A	C
a. enriched sweet roll.		
b. cottage cheese.		
c. broccoli.		

Oyster Stew (4 servings)

1 tbsp. Butter
3/4 c. Oysters
2 1/2 c. Whole Milk
1/2 c. Light Cream
1 tsp. Salt
Dash Pepper

Chili (4 servings)

1/2 lb. Ground Beef
1 tbsp. chopped Onion
3/8 c. Green Pepper
1 c. Tomatoes with juice
1 c. cooked Kidney Beans
1/2 c. Tomato Sauce
1/2 tsp. Salt
1-2 tsp. Chili Powder
1 Bay Leaf

37. Use the recipes above to compare the nutritional value of oyster stew and chili. In comparison with one serving of chili, one serving of oyster stew would have more II.A A

a. iron and niacin.
b. vitamin A and thiamin.
c. calcium and riboflavin.

Table 15. Continued

Item Number	Objective	Cognitive Level
38. Which of the following groups of food contains the most vitamin B_{12}? a. pork chop, cheese, and milk. b. spinach, broccoli, and oatmeal. c. corn, dry beans, and whole wheat bread.	II.A	C
39. Mark (age 20) is a strict vegetarian. Because he does not include any animal products or nutrient supplements in his diet, which nutrient will he not get in adequate amount from food? a. vitamin E. b. vitamin K. c. vitamin B_{12}.	II.A	A
40. The combination of fresh fruits highest in content of vitamin C per serving is a. apricots and bananas. b. watermelon and grapefruit. c. cherries and peaches.	II.A	C
41. The food highest in energy value per serving is a. bread (1 slice). b. potato (1 medium). c. pork chop (1 medium).	II.A	C

42. In order for Peggy to lose weight, which of the following changes would decrease the energy value with the least change in the nutritive value of her diet? II.B A

a. substituting skim milk for cocoa.
b. substituting more meat for bread and potatoes.
c. omitting the bread and potatoes.

Use the following information to answer the next two questions.

Breakfast	Dinner	Snack
1/2 c. Apricot Nectar	1 Pork Chop	1 c. Chocolate Milk
1 c. Oatmeal with 1/2 c. Milk	1/2 c. Green Beans	1 Apple
	1 piece Cake	
	1 glass Iced Tea	

43. Of the following three lunches, the best choice for Jean (age 20), to go with the other meals and snacks listed above would be II.B A

a. 4 pieces Shrimp, 1/2 c. French-Fried Potatoes, 3 Celery Sticks, 1 Biscuit with Honey Butter, 1 c. Milk.
b. 1 c. Chicken Noodle Soup, 5 Carrot Sticks, 1/2 c. Vanilla Pudding, 2 Chocolate Chip Cookies.
c. Roast Beef Sandwich (2 1/2 oz. beef, 2 slices bread), 1/2 c. Broccoli, 1 Oatmeal Cookie, 1 c. Milk.

44. John (age 7), to meet recommendations for his nutrient intake would alter the above meals (including the lunch you selected) by substituting II.B A

a. orange juice for apricot nectar at breakfast.
b. milk for iced tea for dinner.
c. a peanut butter sandwich for the chocolate milk.

Table 15. Continued

Item Number	Objective	Cognitive Level
45. A food which could best be substituted for whole wheat bread nutritionally is a. enriched macaroni. b. baked potato. c. corn chips.	II.B	C
46. Joan wants to select doughnuts with the best nutritional value. She will select those which are a. made with enriched flour. b. fortified with vitamins C, D and E. c. made with yeast which supplies B-complex vitamins.	II.B	C
47. Mark has a broken leg. He needs lots of calcium and other nutrients found in milk but does not like to drink it. Which of the following foods could he best substitute for milk nutritionally? a. cream cheese. b. butter. c. yogurt.	II.B	C
48. Whole wheat and white enriched bread are very a. similar in nutritional value. b. different in protein content. c. different in energy value.	II.B	C

49. Sally (age 7) is eating at a fast food restaurant in the evening with a friend. She has already eaten 1 serving of each of the following foods during the day--orange juice, cinnamon roll, milk, chicken salad sandwich (1 slice bread), carrot sticks, green beans, jello with bananas, iced tea, apple, salted popcorn. Which group of foods could she order to complement nutritionally the other foods she has eaten? II.B A

a. Regular Fish Sandwich
French Fries
Coleslaw
Small Coke

b. Regular Cheeseburger
with Lettuce and
Tomato
Small Milkshake

c. Small Chef's Salad
(Lettuce, 3 strips
Ham, 3 strips cheese)
Cherry Pie Tea

50. Randy does not eat meat but would like to be sure that he is eating other foods that supply the same nutrients. Each of the following foods supplies some protein, B-complex vitamins and iron. Which would be the best substitute for meat because of the amount of those nutrients supplied in one serving of the food? II.B A

a. green peas.
b. bean sprouts.
c. dried beans.

51. How much ice cream would supply the same amount of calcium as 1 cup of milk? II.B C

a. less than 1 cup.
b. 1 cup.
c. more than 1 cup.

52. Nutrition labels as currently found on food products can be used to compare nutritional value of II.C A

a. canned lima beans with frozen spinach.
b. fresh potatoes with frozen French fries.
c. hamburger with pork roast.

Table 15. Continued

Item Number	Objective	Cognitive Level
Use the following information to answer the next two questions. Product 1--Turkey, turkey broth, peas, carrots, water, starch, flour, salt, chicken fat, colors, and flavors Product 2--Turkey broth, peas, turkey, carrots, flour, shortening, water, potatoes, colors, and flavors Product 3--Turkey broth, carrots, peas, turkey, starch, potatoes, water, colors, and flavors		
53. The ingredients as they are listed on three packages of turkey pies are printed above. Which product probably is highest in vitamin A per serving? a. Product 1. b. Product 2. c. Product 3.	II.C	A
54. Which of the above products is probably highest in protein per serving? a. Product 1. b. Product 2. c. Product 3.	II.C	A

55. Losses of vitamins A and C can occur during storage and preparation of broccoli. Which statement best describes the relative nutrient losses? If fresh broccoli is — II.D — A

a. refrigerated uncovered for a week, there will be a greater loss of vitamin A than vitamin C.
b. cooked in boiling water, there will be a greater loss of vitamin C than vitamin A.
c. kept at serving temperature for an hour, there will be a greater loss of vitamin A than vitamin C.

56. Which of these preparation methods would conserve the most nutrients in potatoes? — II.D — A

a. pared, sliced, covered with sauce, and baked at 350° F for scalloped potatoes.
b. pared, cooked, drained, cooled quickly, cubed, and combined with other ingredients for potato salad.
c. unpared potatoes brushed with oil or covered with foil, and baked at 425° F for baked potatoes.

57. A nutrient which is added in enriching bread is — II.D — K

a. calcium.
b. protein.
c. iron.

58. There is less vitamin E value in foods when — II.D — C

a. cooking water is discarded.
b. cooking oils are kept in open containers.
c. cooking methods include baking and toasting.

Table 15. Continued

Item Number	Objective	Cognitive Level
59. Roast beef should be cooled quickly after a meal because a. substantial losses of iron can result from holding meat at warm temperatures. b. food poisoning is possible even if the meat is heated before it is eaten again. c. meat pigments can change causing significant nutritive changes in meat.	II.D	C
60. In which of the following situations is the food most likely to be unsafe to eat? a. banana cream pie--baked and stored covered on the kitchen counter overnight. b. tuna, mayonnaise and pickle relish sandwich filling--prepared and stored covered in the refrigerator for one day. c. canned green beans--opened and stored covered in the can in the refrigerator for two days.	II.D	C

III. Sociopsychological and Economic Aspects of Nutrition

61. The ability of a meal to supply psychological satisfaction is least dependent upon III.A C

a. the choice of foods selected for the meal.
b. the ways in which the foods are prepared.
c. the content of essential nutrients.

62. Individual activities may make it difficult for family members to eat together. This means that each person will need to III.A C

a. take more responsibility for proper food intakes.
b. develop an individual and distinct set of food habits.
c. learn how to prepare foods to retain nutrients.

63. Children who accept a wide variety of fruits and vegetables have been influenced primarily by the III.A C

a. market availability of many fruits and vegetables.
b. kinds of fruits and vegetables preferred by their parents.
c. knowledge that fruits and vegetables are a good source of nutrients.

64. When compared with foods grown with the use of commercial fertilizers and pesticides, those foods grown with natural fertilizers and no pesticides generally: III.B C

a. are more nutritious.
b. have higher crop yields.
c. are more expensive.

Table 15. Continued

Item Number	Objective	Cognitive Level
65. Julie, who lives in Iowa, is concerned about the excess amount of money spent for food as she tries to satisfy her family's nutrient needs. In October, she would select a. cantaloupe instead of orange juice. b. grape juice instead of tomato juice. c. sweet potatoes instead of cauliflower.	III.B	C
The food costs for some dairy products are listed below: Cheddar Cheese — $2.65/lb. chunk Cheddar Cheese Spread — 2.79/2 lb. (e.g., Velveeta) Skim Milk — .93/half gallon carton Cottage Cheese — .75/12 oz. carton (uncreamed) Ice Cream — 1.69/half gallon carton Low-fat Milk — .96/half gallon carton		
66. Which of the following combinations of foods contains the most calcium for the least cost? a. cheddar cheese spread, skim milk. b. cottage cheese, ice cream. c. cheddar cheese, low-fat milk.	III.B	C

67. Which of the following meals contains the most nutritional value for the usual amount of money spent? III.B A

a.	b.	c.
Navy Beans and Cornbread	Hamburger Sandwich	Chili, Crackers
Baked Sweet Potato	Broccoli	Carrot Sticks
Cabbage Slaw	Peach Cottage Cheese Salad	Cantaloupe Wedge
Milk	Iced Tea	Milk

68. Which of the following meals contains the most nutritional value for the usual amount of money spent? III.B A

a.	b.	c.
Hamburger Sandwich	Chicken and Noodles	Spaghetti and Meatballs
Tomato and Onion	Peas and Carrots	Tossed Salad, Dressing
Asparagus with Cheese Sauce	Enriched Bread, Margarine	French Bread, Garlic Butter
Peach Pie	Chocolate Chip Cookies	Chocolate Cake
Ice Cream	Skim Milk	Ice Cream

69. Which of the following meals contains the most nutritional value for the usual money spent? III.B A

a.	b.	c.
Buffet Ham Slice	T-Bone Steak	Rump Roast
Spiced Apple Ring	Baked Potato, Sour Cream	Scalloped Potatoes
Spinach and Sesame Salad, Dressing	Lettuce Salad, Dressing	Broccoli
Cherry Pie	Coffee	Pumpkin Pie
		Iced Tea

70. An example of a convenience product which is less expensive than its home-prepared conterpart is: III.B C

a. frozen concentrated orange juice compared with fresh orange juice.
b. purchased yogurt compared with home-prepared yogurt.
c. frozen chocolate chip cookies compared with home-prepared chocolate chip cookies.

Table 15. Continued

Item Number	Objective	Cognitive Level
71. The best way for Americans to assure themselves that they are attaining good nutrition is to	III.C	K
72. Jim (age 10) eats the following foods:	III.C	A

71. The best way for Americans to assure themselves that they are attaining good nutrition is to

   a. eat three regular meals a day.
   b. eat a wide variety of different kinds of food.
   c. include vitamin-mineral supplements in their diets.

72. Jim (age 10) eats the following foods:

Breakfast	Lunch	Dinner	Multiple Vitamin Tablet
			Snack
Egg	Hot dog, Bun	Grean Beans	
Bacon	Potato Chips	Brownie	
	Chocolate Chip Cookie	Iced Tea	Crackers and Peanut Butter
	Grape Koolade		

How would you evaluate his diet?

   a. He has a balanced diet since he eats regularly and does not eat high calorie snacks.
   b. His diet is fairly good and any concern about nutritional needs is taken care of by the vitamin tablet.
   c. His diet is not adequate since it does not provide enough of all of the nutrients he needs.

73. Paul is reading this excerpt from a magazine. How should he evaluate this food intake plan? III.C A

The macrobiotic diet cannot only ward off human ailments, but can even cure them. It can be prescribed for heart disease, cancer and diabetes. It will make you feel better, look better, and increase your memory. Brown (whole grain) rice is the perfect food. It has the perfect balance of yin/yang (5:1).

a. It would be difficult to consume only brown rice but the rice is so low in fat content that there probably would be health benefits.
b. If only brown rice were consumed, vitamins C and A as well as protein would be deficient.
c. The diet would be all right if a vitamin supplement accompanied it since other nutrients are present in adequate amounts.

74. When Carol is dieting she finds that the best of the following ways to lose weight is to III.C C

a. substitute foods that have a higher water and fiber content than those now consumed.
b. divide her current food intake into six or seven meals rather than fewer.
c. take longer to eat the meals and snacks that she currently consumes.

Table 15. Continued

Item Number	Objective	Cognitive Level
75. Snacks can be planned nutritionally along with meals. Good snack items to go with the following meals for Martie (age 7) would be	III.C	A

Tomato Juice French Toast Butter/Syrup	Tuna Salad Sandwich (1 slice bread) Celery Sticks Strawberries Milk	Chicken, Lettuce, Tomato Sandwich (2 slices bread) Grapes Iced Tea

a. Blueberry muffins, banana.
b. Peanuts, applesauce.
c. Apricots, chocolate milk.

Table 16. Item analysis of the 75-item nutrition knowledge pretest

Item Number	Distracter Analysis A	B	C	Difficulty Index (%)	Discrimination Index	Standard Deviation
1	1	6	88[a]	93	.21	.26
2	84[a]	11	8	82	.33	.39
3	10	77[a]	16	75	.32	.43
4	61[a]	2	39	60	.23	.49
5	89[a]	4	10	86	.50	.34
6	69[a]	15	19	67	.32	.47
7	1	3	99[a]	96	.30	.19
8	88[a]	6	9	85	.34	.35
9	5	77[a]	21	75	.48	.43
10	7	72[a]	24	70	.11	.46
11	86[a]	1	14	84	.23	.36
12	36	6	60[a]	58	.26	.49
13	89[a]	7	7	86	.35	.34
14	74[a]	2	27	72	.30	.45
15	6	9	88[a]	85	.36	.35
16	34	67[a]	2	65	.20	.48
17	6	22	75[a]	73	.29	.44
18	3	66[a]	34	64	.32	.48
19	71[a]	5	26	70	.35	.46
20	7	92[a]	4	89	--[b]	.31
21	5	77[a]	21	75	.48	.43
22	0	101[a]	2	98	.10	.14
23	11	64[a]	28	62	.30	.49
24	13	86[a]	4	83	.16	.37
25	57	45[a]	1	44	.25	.50
26	9	17	77[a]	75	.16	.43
27	72[a]	25	6	70	.40	.46
28	4	24	74[a]	73	.27	.45
29	41	48[a]	14	47	.22	.50
30	18	44	51[a]	50	.46	.50
31	24	13	66[a]	64	.34	.48
32	74[a]	23	5	72	.51	.45
33	7	77[a]	19	75	.38	.43
34	21	30	51[a]	50	.51	.50
35	23	56[a]	24	54	.30	.50
36	33	59[a]	11	57	.32	.49
37	10	5	88[a]	85	.36	.35
38	63[a]	20	20	61	.37	.49
39	10	13	80[a]	78	.39	.42
40	16	77[a]	10	75	.20	.43

[a]Correct response

[b]Correlation below 0.05 or negative.

Item Number	Distracter Analysis A	B	C	Difficulty Index (%)	Discrimination Index	Standard Deviation
41	6	20	77[a]	75	.41	.43
42	92[a]	4	7	89	.34	.31
43	13	10	80[a]	78	.05	.42
44	7	70[a]	26	68	.21	.47
45	91[a]	12	0	88	.34	.32
46	89[a]	8	6	86	.26	.34
47	20	22	61[a]	59	.30	.49
48	74[a]	12	17	72	.46	.45
49	8	83[a]	12	81	.38	.40
50	4	7	92[a]	89	.25	.31
51	11	6	86[a]	83	.28	.37
52	87[a]	12	4	84	.36	.36
53	16	18	69[a]	67	.41	.47
54	82[a]	10	11	80	.42	.40
55	6	90[a]	7	87	.38	.33
56	3	9	91[a]	88	.31	.32
57	9	17	77[a]	75	.48	.43
58	30	50[a]	23	49	.29	.50
59	40	52[a]	11	50	.34	.50
60	46[a]	20	37	45	.27	.50
61	12	8	83[a]	81	.29	.40
62	85[a]	8	10	83	.07	.38
63	11	89[a]	3	86	.27	.34
64	24	12	67[a]	65	.33	.48
65	24	18	61[a]	59	.15	.49
66	35[a]	18	50	34	.23	.47
67	29[a]	33	41	28	.13	.45
68	20	68[a]	15	66	.33	.47
69	26	12	65[a]	63	.25	.48
70	74[a]	18	11	72	.39	.45
71	17	82[a]	4	80	.29	.40
72	4	20	79[a]	77	.28	.42
73	4	87[a]	12	84	.42	.36
74	52[a]	14	37	50	.22	.50
75	21	29	53[a]	51	.26	.50

RESULTS

Results of administration of a 50-item nutrition knowledge questionnaire to a standardization group of young adult university students and to other test groups of adults are reported. Test specifications are given in Table 14, p. 207, and the 50 test items identified by objective and cognitive level in Table 17, p. 247.

Standardization Group

The standardization group or norm sample of young adults was composed of 168 students at Iowa State University at the end of an introductory nutrition course FN 107, Nutrition and Man's Food. Forty-two percent of the students were college freshmen and 27, 15.5 and 15.5% were sophomores, juniors and seniors, respectively.

The mean score and standard deviation on the questionnaire for the standardization group was 32.9 $\pm$ 7.8 with a range of scores of 14 to 48 out of 50. The standard error of measurement was 3.1 and the Kuder-Richardson formula-20 reliability was 0.84.

Difficulty

The desirable degree of average difficulty is midway between the expected chance score and the maximum possible score (Sax, 1974; Thorndike and Hagen, 1977). For a 50-item, three-option, multiple-choice test the difficulty level should be 33. The mean test score of 32.9 was close to this ideal value.

Reliability coefficient

The reliability, as calculated using the Kuder-Richardson formula-20, was 0.84. This coefficient signified that 84% of variance in the test scores depended on the variation in the trait measured and 16% depended on error variance. A reliable test would give a highly precise indication of a person's standing with respect to that of others (Nunnally, 1970). Size and heterogeneity of the test groups and extent of variabilities in test scores affect reliability. Tests with high reliability coefficients often have items concentrated near the midpoint in difficulty (Ebel, 1965). The reliability of a test can be improved by increasing the number of items. Anastasi (1976) estimated that a test with a reliability of 0.50 when increased to nine times the original length with equivalent items, would have a reliability of 0.90. Ebel (1965) noted that a test with 40 items and a reliability of 0.67 would increase to 0.80 with 80 items. A test with a reliability of 0.90 or above is most desirable. A reliability coefficient of 0.80 or greater is adequate for a test which is to be used with other reliable evaluation devices for individual prediction.

Standard error of measurement

The standard error of measurement was 3.1. The standard error of measurement estimates the reasonable limits of the true score with any given obtained score. The test score is interpreted as a band of scores rather than as a specific score.

Item analysis

Results of the item analysis of each of the items on the questionnaire are found in Table 18, p. 263. Item analysis criteria included 1) difficulty index of 30 to 70%, 2) discrimination index of 0.20 or above and 3) all distracters selected by at least two percent of the student subjects. The 28 items that met all of the criteria are noted in Table 18.

The item discrimination ranged from 0.18 to 0.53. The discrimination index refers to the degree to which an item was answered correctly by students in the higher achievement group as compared to those in the lower achievement group. The items with low discrimination power included 11 (0.19) and 16 (0.19). Improvement of those items should improve the reliability of the questionnaire.

Item difficulty ranged between 29 and 84%, with an average test score of 66%. The mean difficulty was 72% for knowledge level items, 64% for comprehension level items and 66% for application or higher level items. The item which needed to be made somewhat easier was item 46 (0.29). Items which needed to be made more difficult were 2 (0.79), 3 (0.77), 6 (0.78), 7 (0.79), 10 (0.71), 13 (0.83), 15 (0.72), 16 (0.72), 18 (0.83), 19 (0.71), 20 (0.75), 24 (0.71), 30 (0.83), 32 (0.80), 34 (0.76), 35 (0.75), 39 (0.80), 43 (0.79), 44 (0.84), and 49 (0.73).

Distracters were functioning for each item tested using the questionnaire.

Table 19, p. 265, gives the mean difficulty for items which tested each content area and objective by subject group. For the standardization group, mean scores for the three general content areas (physiological aspects of nutrition, food as sources of nutrients and sociopsychological aspects of nutrition) were statistically similar. For the other groups, scores were higher on items which tested the last two subject matter areas than scores on items related to the physiological aspects of nutrition. Comparison of results of test analysis for students at the end of FN 107 and for those at the beginning of FN 107 indicated that scores were lower for the latter group on items testing for each of the 11 objectives.

In general, mean difficulty scores for the standardization group were lowest on items related to energy needs and weight control (objective I.D) (60% correct), food handling practices (II.D) (60% correct) and food costs (III.B) (58% correct). All items related to energy needs and weight control were at the application level so probably required more ability on the part of the students to apply information than items at the lower cognitive levels. Objective I.D was the only objective where items were all at application or higher level. In some sections of FN 107, there may be less emphasis placed on food handling practices and food costs than on other areas represented on the questionnaire.

The standardization group had a mean difficulty of 66% for all items on the questionnaire. FN 107 students had lower than mean difficulty scores on items related to objectives II.A (61%), II.C (65%) and III.C (63%). Students scored highest on items which related to the effects on health of inadequate, excessive or imbalanced intakes of nutrients

(I.C) (72% correct), use of food groups in planning food intakes (II.B) (73% correct) and influences on food habit development (III.A) (80% correct). There is much interest among students in FN 107 for information useful to them in planning their own food intakes. This interest may, in part, be responsible for their good performance on items dealing with the use of food groups. The emphasis on the other two objectives was on comprehension level and possibly required more difficult items than were included. For students at the beginning of FN 107, performance was highest on items which tested the same objectives. For two items which tested the objective related to food habit development (III.A) there was a 75% correct response. The other objectives where the standardization group of students had above average performance on items were I.A (70% correct) and I.B. (68% correct).

Twenty items had difficulty indices of 0.71 or above. These included 43% of the items for objective I.A, 40% of those for objective I.B, 75% for I.C., 50% for I.D., 14% for II.A, 57% for II.B, 0% for II.C, 25% for II.D., 100% for III.A, 20% for III.B, and 33% for III.C. Students in the standardization group scored highest as noted in the previous paragraph on items testing objectives I.C, II.B and III.A. Five of the six items testing objectives I.C and III.A could be made more difficult to meet difficulty criteria. Then the performance on items for those particular objectives would not necessarily be the highest for the test.

Mean difficulty scores for the standardization group were highest (72%) for knowledge level items. Scores for comprehension level (64%)

and application or higher cognitive level items (66%) were at or slightly below the mean difficulty for the questionnaire (66%). On the average, knowledge level items were significantly easier ($p < 0.05$) than comprehension level items. No other significant differences were noted.

Test Groups

The test was administered to several young adult groups and to other adult groups which varied more in age than the groups of young adults. The results of administering the questionnaire to test groups are found in Table 20., p. 267. Mean scores were highest for groups that had completed some nutrition training. The highest mean test scores were found for students beginning FN 301 (35.8 ± 6.4) who had previously completed FN 107, elementary teachers after a nutrition education course (41.0 ± 4.4), teacher educators after a nutrition education workshop (35.8 ± 6.03), and EFNEP aides (33.1 ± 8.6). Elementary teachers after a nutrition education course had a mean score significantly higher ($p < 0.001$) than that of the standardization group or norm sample of students completing FN 107 (32.9 ± 7.8) according to t-test analysis. The other groups noted above had similar mean scores to the standardization group. Student nurses who had completed a nutrition course had a somewhat lower mean score (30.7 ± 6.2) than did the standardization group ($p < 0.05$). It had been approximately nine months since they had taken the nutrition course.

Several groups had mean scores that were significantly lower ($p < 0.001$) than those of the standardization group. The young adult groups included students at the beginning of FN 107 (23.5 $\pm$ 5.9), student nurses at the beginning of a nutrition course (25.4 $\pm$ 5.1) and students at Luther College (21.1 $\pm$ 5.1). Other adult groups included adults in extension or weight control groups (26.8 $\pm$ 7.0), 4-H leaders (27.6 $\pm$ 7.5), and mothers (28.0 $\pm$ 6.2) and fathers (22.5 $\pm$ 5.6) of first graders.

Of the test groups, for students beginning FN 107 (n = 362) mean difficulty scores were lower than the test average (47%) for items related to physiological aspects of nutrition (44%), in particular to items relating to nutrient functions (I.A) and energy and weight control (I.D). Students scored higher than average for the content areas food as sources of nutrient (49%) and sociopsychological and economic aspects of nutrition (51%). Low scores were particularly apparent for objective III.B which related to food costs.

Student nurses at the beginning of a nutrition course (n = 86) also had lower than the mean difficulty for the test (51%) for items related to physiological aspects of nutrition (44%). For the other two content areas scores were higher than average. Within each content area scores were higher than average for objectives I.C (effect on health of inadequate, excessive or imbalanced intakes of nutrients), II.B (food groups) and III.A (development of food habits), and equal to or lower than average for the other objectives.

Scores for student nurses who had completed a nutrition course (n = 43) were similar for the three content areas. Lower than average (61%) scores were noted for objectives I.B., I.D., II.A, III.B, and III.C. They had higher scores than those of the student nurses who had not yet completed a nutrition course for all of the objectives related to physiological aspects of nutrition and food as sources of nutrients. They were already fairly knowledgeable (59% correct as compared with 60% correct for student nurses who had completed a nutrition course and 64% correct for the standardization group of FN 107 students) about the sociopsychological and economic aspects of nutrition.

Students at Luther College (n = 19) had lower than their overall mean difficulty score for the group of items testing the content areas physiological aspects of nutrition and higher than their mean difficulty score for the other two content areas.

Students beginning FN 301 (n = 40) scored somewhat higher than the standardization group on the questionnaire as a whole (72% vs. 66%) and in the areas of food as sources of nutrients (78% vs. 66%) and sociopsychological and economic aspects of nutrition (82% vs. 64%). They had 64% of the items correct as compared with 68% for the standardization group for physiological aspects of nutrition. In particular, they scored lower on nutrient needs (I.A) and variation in nutrient needs over the life cycle (I.B).

Elementary teachers who had completed a nutrition education course had knowledge increases of 28%, 14% and 19% for items testing objectives I, II and III as compared to their pretest performance. They scored higher than the mean test difficulty (82%) on items related to sociopsychological and economic aspects of nutrition (87%) and lower on items related to physiological aspects of nutrition (78%).

EFNEP aides (n = 79) and teachers after a nutrition education workshop (n = 19) scored higher than the standardization group in the content area of food as sources of nutrients (74% and 74% compared to 66% correct) and sociopsychological and economic aspects of nutrition (68% and 82% compared to 64% correct) and lower on items related to physiological aspects of nutrition (58% and 64% compared to 68% correct). For the last two content areas, scores were above the mean difficulties for the test for the two groups (66% and 72%) and lower for the first content area.

Adults in extension groups (n = 72), 4-H leaders (n = 26), mothers (n = 38), and fathers (n = 19) all had scores below their mean difficulties for the 50-item questionnaire for the content area of physiological aspects of nutrition and higher than their mean difficulty for the questionnaire for their groups for the other two content areas. Scores were particularly low for objective I.D, which related to energy needs and weight control.

Discussion of Findings

The reliability coefficient for the 50-item nutrition knowledge questionnaire was 0.84 when administered to the standardization group (n = 168) of FN 107 students. This compared favorably with the reliabilities of other tests reported in the literature for adult groups: Al-Isi, Kanawati and McLaren (1975), mothers 0.86; Avery (1978), community college students 0.52; Byrd-Bredbenner (1981), nutrition educators 0.81; Carruth and Lamb (1971), students beginning a nutrition course 0.83; Carver and Lewis (1979), elementary school teachers 0.60 and 0.58;

Christopher, Shannon and Sims (1980), students 0.82; Davis (1971), EFNEP assistants 0.41 and low-income homemakers 0.81; Gillespie (1978), fathers and mothers 0.58–0.78; Grotkowski and Sims (1978), senior citizens 0.80; Knudtson (1972), fifth and sixth grade teachers 0.62; Kolasa et al. (1979), teachers K-12 0.73; Linn (1972), family food aides 0.80; Pearson (1969), wives 0.52; Phillips (1971), student nurses 0.65; Pietz, Fryer and Fryer (1980), dental students 0.61; Préfontaine (1975), mothers 0.67; Sims (1978), lactating women 0.77; Skinner (1978), high school nutrition teachers 0.66; Spollen (1974), elementary teachers 0.81; U.S. Department of Health, Education and Welfare (1975), university students 0.80; Wakefield and Vaden (1973), elementary teachers 0.70; and Yetley (1974), parents 0.64 and 0.61. If 20 of the test items were made more difficult, the reliability coefficient of the reported instrument would likely be improved.

The mean difficulty on the questionnaire for the standardization group of FN 107 students was 66%, with difficulty levels of 68%, 66% and 64%, respectively, for the three content areas physiological aspects of nutrition, food as sources of nutrients, and sociopsychological and economic aspects of nutrition. There was no significant difference between performance in the three content areas. There was a significantly higher ($p < 0.05$) average score for the eight knowledge level items (72%) than for the twenty-four items at the comprehension level (64%). The average difficulty for application or higher level items (66%) was not significantly different from those at the other two levels.

Difficulty of individual items or categories of nutrition knowledge were reported by Cho and Fryer (1974) for college physical education majors, Schwartz (1973) for high school graduates and Vickstrom and Fox (1976) for registered nurses. Bozdech et al. (1978) found that knowledge of dental students was greatest in the area of behavior and social sciences and less in biochemistry and physiology, foods and diets of the categories of nutrition knowledge tested. With nutrition training, increases were noted in biochemistry and physiology and diets. Pietz, Fryer and Fryer (1980) found lower scores for dental students for categories of nutritional assessment, diets, nutrient needs, and nutrients, than for nutrition in disease, foods, and nutrition in oral health. In the study reported here, most test groups did somewhat better in the categories of food as sources of nutrients and sociopsychological and economic aspects of nutrition than in the area of the physiological aspects of nutrition.

In general, for the test groups, mean scores were highest for groups who had completed some nutrition training--elementary teachers after a nutrition education workshop, students completing FN 107, students beginning FN 301, and EFNEP aides. The mean score was significantly higher ($p < 0.001$) for the elementary teachers than for the standardization group. Similar means to those for the standardization group were found for the other groups noted above. Other test groups scored significantly lower ($p < 0.001$) than the standardization group.

Table 17. Classification of nutrition knowledge questionnaire items by objective and cognitive taxonomy level (K = knowledge, C = comprehension and A = application)

Item Number	Objective	Cognitive Level
I. Physiological Aspects of Nutrition		
3. The energy value of carbohydrates is: A. ABOUT EQUAL TO THAT OF PROTEINS. B. MORE THAN TWICE THAT OF FATS. C. LESS THAN THAT OF PROTEINS AND FATS.	I.A	K
4. Complete the analogy: calcium is to strong bones as vitamin A is to healthy: A. NERVES. B. SKIN. C. CONNECTIVE TISSUE.	I.A	C
5. Calcium is essential in small amounts in the body for: A. CONTRACTION OF MUSCLES. B. RESISTANCE TO INFECTION. C. MAINTENANCE OF CONNECTIVE TISSUE.	I.A	K
6. Three of the B-complex vitamins, thiamin, riboflavin and niacin, are needed primarily: A. FOR RELEASING ENERGY FROM ENERGY-YIELDING NUTRIENTS. B. AS CARRIERS FOR IRON AND CALCIUM IN THE BODY. C. TO FORM THYROXINE FOR METABOLISM OF NUTRIENTS.	I.A	K

7. Vitamin C intake is necessary for: I.A K

   A. PREVENTING COLDS.
   B. MAINTAINING CONNECTIVE TISSUE.
   C. ABSORBING POLYUNSATURATED FATS.

8. Vitamin D is important because the body changes it to a substance that: I.A K

   A. HELPS MAINTAIN HEALTHY SKIN.
   B. IMPROVES CALCIUM ABSORPTION.
   C. COMBINES WITH MINERALS IN BONES AND TEETH.

9. Iodine is used by the body to form a hormone which regulates: I.A K

   A. ENERGY METABOLISM.
   B. MUSCLE CONTRACTION.
   C. BODY TEMPERATURE.

Table 17. Continued

Item Number	Objective	Cognitive Level
Use the following information to answer questions 10-14.		

Angela	Sue	
Just starting to walk	Chemist	
Age: 11 months	Age: 28	
Height: 2'4"	Height: 5'7"	
Weight: 20 lbs.	Weight: 132 lbs.	
Bob	**Dave**	**Carl**
High school wrestler	Gymnastics coach	Construction foreman
Age: 15	Age: 26	Age: 54
Height: 5'7"	Height: 5'9"	Height: 5'9"
Weight: 134 lbs.	Weight: 154 lbs.	Weight: 154 lbs.

Item	Objective	Cognitive Level
10. In comparing the nutrient needs of Angela and Sue, Angela needs: A. CERTAIN NUTRIENTS THAT SUE DOES NOT. B. LARGER QUANTITIES OF SOME NUTRIENTS. C. MORE OF MOST NUTRIENTS PER POUND OF BODY WEIGHT.	I.B	A
11. Bob's nutrient needs differ somewhat from the nutrient needs of Dave and Carl. The most marked difference for people Bob's age generally is their higher need for: A. CALCIUM AND VITAMIN A. B. VITAMIN A AND IRON. C. IRON AND CALCIUM.	I.B	C

12. Dave needs more protein than Sue. The primary reason is that: I.B C

A. DAVE IS LARGER THAN SUE.
B. DAVE IS YOUNGER THAN SUE.
C. DAVE IS MORE ACTIVE THAN SUE.

13. In comparison with the nutrient needs of Dave, Carl probably needs: I.B C

A. MORE PROTEIN.
B. LESS VITAMIN E.
C. SIMILAR AMOUNTS OF VITAMIN A.

14. If Dave had major abdominal surgery, which nutrient would he need in increased amounts to form new tissue? I.B. C

A. MAGNESIUM
B. VITAMIN C
C. VITAMIN D

15. Tom needs 50 grams of protein per day. His regular diet supplies adequate sources of energy from carbohydrate and fat as well as 90 grams of protein per day. Most of the extra protein will be: I.C C

A. CHANGED TO FAT AND STORED.
B. USED TO FORM MORE MUSCLE.
C. LOST FROM THE BODY.

Table 17. Continued

Item Number	Objective	Cognitive Level
The next two questions refer to differences in body storage of different nutrients.		
16. In comparison with symptoms of vitamin D deficiency, symptoms of a deficiency of vitamin C would probably be seen in: A. A MUCH SHORTER TIME. B. ABOUT THE SAME AMOUNT OF TIME. C. A MUCH LONGER TIME.	I.C	C
17. If Jean's intake of some nutrients from supplements she is taking greatly exceeds her need for them, which nutrient would most likely be harmful to her health? A. RIBOFLAVIN B. VITAMIN A C. CALCIUM	I.C	C
18. Tim (age 48) has had a heart attack. His blood pressure is above normal, his serum cholesterol is elevated and he is 15 lbs. overweight. In order to help correct some of the problems, his physician may ask him to consume more foods containing polyunsaturated fat and to limit his intake of sodium, saturated fat, cholesterol and: A. VITAMIN E. B. KILOCALORIES. C. CALCIUM.	I.C	A

19. If Nancy's average daily intake of energy is 2000 kilocalories and her average expenditure is 1800 kilocalories per day, in two months her body fat tissue content will increase: I.D A

A. BY 3-4 POUNDS NO MATTER WHAT NUTRIENTS THE EXTRA ENERGY IS FROM.
B. By 8-9 POUNDS WHETHER THE EXTRA ENERGY IS FROM CARBOHYDRATE, PROTEIN OR FAT.
C. MORE IF THE ENERGY IS FROM CARBOHYDRATE THAN IF IT IS FROM PROTEIN.

20. Kathy, age 19, could lose 3 pounds of excess fat tissue in: I.D A

A. ABOUT THREE DAYS IF SHE EATS HALF AS MUCH FOOD AS HER USUAL 2000 KILOCALORIE INTAKE.
B. LESS THAN A WEEK IF SHE BEGINS TO SWIM AN HOUR EACH DAY (400 KILOCALORIES PER HOUR).
C. ABOUT THREE WEEKS BY EATING THREE-FOURTHS AS MUCH FOOD AS HER USUAL 2000 KILOCALORIE INTAKE.

21. John is trying to lose weight. He plans to begin bicycling 8 hours per week (250 kilocalories/hour). For an average loss of two pounds of fat tissue per week he will also need to reduce the daily energy value of his usual diet by about: I.D A

A. 500 KILOCALORIES.
B. 750 KILOCALORIES.
C. 1000 KILOCALORIES.

22. Don (age 71) uses approximately 300 kilocalories less energy each day now than when he was 21 years old. His energy intake from food has stayed about the same. Approximately how many pounds of fat tissue would he gain in six months? I.D A

A. 5 POUNDS
B. 10 POUNDS
C. 15 POUNDS

Table 17. Continued

Item Number	Objective	Cognitive Level

Use the following three daily intakes of food to answer questions 23 and 24.

The same breakfast was eaten each day:

1/2 c. Orange Juice
3 Pancakes
2 tsp. Margarine
2 tbsp. Syrup
1 c. 2% Milk

Day 1	Day 2	Day 3
1/4 of 16" Hamburger Pizza	3 oz. Roast Chicken	3 oz. Roast Beef
1 c. Tossed Salad	1/2 c. Rice	1/2 c. Mashed Potatoes
2 tbsp. Vinegar and Oil Salad Dressing	1/2 c. Carrots	1/2 c. Lima Beans
1 serving Apple Pie	1/2 c. Green Beans	1/2 c. Corn
1/2 c. Ice Cream	1 large Apple	1 c. 2% Milk
1 c. Whole Milk	1 c. 2% Milk	1 c. Spaghetti with 2 Meat Balls
1 Breaded Pork Chop	1 c. Beef Noodle Soup	1 piece French Bread
1/2 c. Scalloped Potatoes	8 small Saltine Crackers	1 tsp. Margarine
1/2 c. Asparagus with Cheese	2 tsp. Margarine	1 c. Tossed Salad
1/2 c. Butterscotch pudding	1/2 c. Coleslaw	2 tbsp. French Dressing
12 oz. Pepsi	1 c. 2% Milk	1 c. Chocolate Milk
	12 oz. Coke	

23. How do the above intakes compare in energy value? — II.A — A

A. DAY 1 CONTAINS MORE ENERGY THAN THE OTHER TWO DAYS.
B. DAY 2 CONTAINS LESS ENERGY THAN DAY 3 BUT MORE THAN DAY 1.
C. DAY 3 CONTAINS LESS ENERGY THAN THE OTHER TWO DAYS.

24. Jim (age 32) ate the foods listed above for Day 3. When looking at the nutrient contributions from the day's intake, beef is a poor source of: II.A A

A. IRON, BUT THERE IS AN ADEQUATE AMOUNT AVAILABLE FROM THE PANCAKES, LIMA BEANS, CORN AND FRENCH BREAD.
B. CALCIUM, BUT THERE IS AN ADEQUATE AMOUNT AVAILABLE FROM THE 2% AND CHOCOLATE MILKS.
C. NIACIN, BUT THERE IS AN ADEQUATE AMOUNT AVAILABLE FROM THE ORANGE JUICE, PANCAKES, AND MASHED POTATOES.

25. Two months ago Gerald was asked to reduce the total number of kilocalories from fat, and to decrease the saturated fat and increase the polyunsaturated fat coming from foods in his diet. Which of the following sets of changes would best accomplish this? II.A A

A. SUBSTITUTE A HAM SANDWICH FOR CHEESE PIZZA, CUSTARD PIE (CONTAINS EGGS AND MILK) FOR CHOCOLATE PUDDING, ROAST BEEF FOR A PORK CHOP, AND SOFT MARGARINE FOR BUTTER ON A BAKED POTATO.
B. SUBSTITUTE TOMATO SLICES FOR A BAKED POTATO, CHEDDAR CHEESE FOR ICE CREAM, WHOLE MILK FOR COKE, AND 1 1/2 TBSP. FOR 2 TBSP. OF SALAD DRESSING.
C. SUBSTITUTE ANGEL FOOD CAKE AND STRAWBERRIES FOR APPLE CRISP AND ICE CREAM, TURKEY AND MAYONNAISE SANDWICHES FOR HAMBURGER PIZZA, SKIM MILK FOR WHOLE MILK, AND LEMON JUICE FOR CHEESE ON BROCCOLI.

26. Which of the following combinations of foods would provide the most calcium if average size servings are eaten? II.A C

A. CREAM CHEESE, ENRICHED SWEET ROLLS, SWEET POTATOES
B. CHEDDAR CHEESE, WHITE BREAD, BROCCOLI
C. BUTTER, WHOLE WHEAT BREAD, CAULIFLOWER

Table 17. Continued

Item Number	Objective	Cognitive Level
27. Which of the following foods could Barb (age 30) eat less than her husband John since it contains little iron? A. ENRICHED SWEET ROLL B. COTTAGE CHEESE C. BROCCOLI	II.A	C
28. The combination of fresh fruits highest in content of vitamin C per serving is: A. APRICOTS AND BANANAS. B. WATERMELON AND GRAPEFRUIT. C. CHERRIES AND PEACHES.	II.A	C
29. The food highest in energy value per serving is: A. BREAD (1 SLICE). B. POTATO (1 MEDIUM). C. PORK CHOP (1 MEDIUM).	II.A	C
30. In order for Peggy to lose weight, which of the following changes would decrease the energy value with the least change in the nutritive value of her diet. A. SUBSTITUTING SKIM MILK FOR COCOA. B. SUBSTITUTING MORE MEAT FOR BREAD AND POTATOES. C. OMITTING THE BREAD AND POTATOES.	II.B	A

Use the following information to answer question 31.

Breakfast	Lunch	Dinner	Snacks
1/2 c. Apricot Nectar	Roast Beef Sandwich	1 Pork Chop	1 c. Chocolate Milk
1 c. Oatmeal with	(2 1/2 oz. beef,	1/2 c. Green Beans	1 Apple
1/2 c. Milk	2 slices bread)	1 piece Apple Cake	
	1/2 c. Broccoli	1 glass Iced Tea	
	1 Oatmeal Cookie		

31. John, age 7, to meet recommendations for his nutrient intake would alter the above meals by substituting II.B A

    A. ORANGE JUICE FOR APRICOT NECTAR AT BREAKFAST.
    B. MILK FOR ICED TEA FOR DINNER.
    C. A PEANUT BUTTER SANDWICH FOR THE CHOCOLATE MILK.

32. Joan wants to select doughnuts with the best nutritional value. She will select those which are: II.B C

    A. MADE WITH ENRICHED FLOUR.
    B. FORTIFIED WITH VITAMINS C, D, AND E.
    C. MADE WITH YEAST WHICH SUPPLIES B-COMPLEX VITAMINS.

33. Mark has a broken leg. He needs lots of calcium and other nutrients found in milk but does not like to drink it. Which of the following foods could he best substitute for milk nutritionally? II.B C

    A. CREAM CHEESE
    B. BUTTER
    C. YOGURT

Table 17. Continued

Item Number	Objective	Cognitive Level
34. Sally (age 7) is eating at a fast food restaurant in the evening with a friend. She has already eaten 1 serving of each of the following foods during the day—orange juice, cinnamon roll, milk, chicken salad sandwich (1 slice bread), carrot sticks, green beans, jello with bananas, iced tea, apple, salted pop-corn. Which group of foods could she order to complement nutritionally the other foods she has eaten? A. REGULAR FISH SANDWICH, FRENCH FRIES, COLESLAW, SMALL COKE B. REGULAR CHEESEBURGER WITH LETTUCE AND TOMATO, SMALL MILKSHAKE C. SMALL CHEF'S SALAD (LETTUCE, 3 STRIPS HAM, 3 STRIPS CHEESE), CHERRY PIE, TEA	II.B	A
35. How much ice cream would supply the same amount of calcium as 1 cup of milk? A. LESS THAN 1 CUP B. 1 CUP C. MORE THAN 1 CUP	II.B	C
36. Whole wheat and white enriched bread are very: A. SIMILAR IN NUTRITIONAL VALUE. B. DIFFERENT IN PROTEIN CONTENT. C. DIFFERENT IN ENERGY VALUE.	II.B	C

Use the following information to answer questions 37 and 38.

Product 1 - Turkey, turkey broth, peas, carrots, water, starch, flour, salt, chicken fat, colors and flavors.
Product 2 - Turkey broth, peas, turkey, carrots, flour, shortening, water, potatoes, colors and flavors.
Product 3 - Turkey broth, carrots, peas, turkey, starch, potatoes, water, colors and flavors.

37. The ingredients as they are listed on three packages of turkey pies are printed above. Which product is probably highest in vitamin A per serving? II.C A

A. PRODUCT 1
B. PRODUCT 2
C. PRODUCT 3

38. Which one of the above products is probably highest in protein per serving? II.C A

A. PRODUCT 1
B. PRODUCT 2
C. PRODUCT 3

39. Losses of vitamins A and C can occur during storage and preparation of broccoli. Which statement best describes the relative nutrient losses? If fresh broccoli is: II.D A

A. REFRIGERATED UNCOVERED FOR A WEEK, THERE WILL BE A GREATER LOSS OF VITAMIN A THAN VITAMIN C.
B. COOKED IN BOILING WATER, THERE WILL BE A GREATER LOSS OF VITAMIN C THAN VITAMIN A.
C. KEPT AT SERVING TEMPERATURE FOR AN HOUR, THERE WILL BE A GREATER LOSS OF VITAMIN A THAN VITAMIN C.

Table 17. Continued

Item Number	Objective	Cognitive Level
40. A nutrient which is added in enriching bread is: A. CALCIUM. B. PROTEIN. C. IRON.	II.D	K
41. Roast beef should be cooled quickly after a meal because: A. SUBSTANTIAL LOSSES OF IRON CAN RESULT FROM HOLDING THE MEAT AT WARM TEMPERATURES. B. FOOD POISONING IS POSSIBLE EVEN IF THE MEAT IS HEATED BEFORE IT IS EATEN AGAIN. C. MEAT PIGMENTS CAN CHANGE CAUSING SIGNIFICANT NUTRITIVE CHANGES IN THE MEAT.	II.D	C
42. In which of the following situations is the food most likely to be unsafe to eat? A. BANANA CREAM PIE--BAKED AND STORED COVERED ON THE KITCHEN COUNTER OVERNIGHT. B. TUNA, MAYONNAISE AND PICKLE RELISH SANDWICH FILLING--PREPARED AND STORED COVERED IN THE REFRIGERATOR FOR ONE DAY. C. CANNED GREEN BEANS--OPENED AND STORED COVERED IN THE CAN IN THE REFRIGERATOR FOR TWO DAYS.	II.D	C
<u>III. Sociopsychological and Economics Aspects of Nutrition</u>		
43. The ability of a meal to supply psychological satisfaction is least dependent upon: A. THE CHOICE OF FOODS SELECTED FOR THE MEAL. B. THE WAYS IN WHICH THE FOODS ARE PREPARED. C. THE CONTENT OF ESSENTIAL NUTRIENTS.	III.A	C

44. Children who accept a wide variety of fruits and vegetables have been influenced primarily by the: III.A C

A. MARKET AVAILABILITY OF MANY FRUITS AND VEGETABLES.
B. KINDS OF FRUITS AND VEGETABLES PREFERRED BY THEIR PARENTS.
C. KNOWLEDGE THAT FRUITS AND VEGETABLES ARE A GOOD SOURCE OF NUTRIENTS.

45. When compared with foods grown with the use of commercial fertilizers and pesticides, those foods grown with natural fertilizers and no pesticides generally: III.B C

A. ARE MORE NUTRITIOUS.
B. HAVE HIGHER CROP YIELDS.
C. ARE MORE EXPENSIVE.

The food costs for some dairy products are listed below:

Cheddar Cheese	$2.65/lb. chunk
Cheddar Cheese Spread	2.79/2 lb. (e.g., Velveeta)
Skim Milk	.93/half gallon carton
Cottage Cheese	.75/12 oz. carton (uncreamed)
Ice Cream	1.69/half gallon carton
Low-fat Milk	.96/half gallon carton

46. Which of the following combinations of foods contains the most calcium for the least cost? III.B C

A. CHEDDAR CHEESE SPREAD, SKIM MILK.
B. COTTAGE CHEESE, ICE CREAM.
C. CHEDDAR CHEESE, LOW-FAT MILK.

Table 17. Continued

Item Number	Objective	Cognitive Level
47. Which of the following meals contains the most nutritional value for the usual amount of money spent? A. HAMBURGER SANDWICH TOMATO AND ONION ASPARAGUS WITH CHEESE SAUCE PEACH PIE ICE CREAM B. CHICKEN AND NOODLES PEAS AND CARROTS ENRICHED BREAD, MARGARINE CHOCOLATE CHIP COOKIES SKIM MILK C. SPAGHETTI AND MEAT BALLS TOSSED SALAD, DRESSING FRENCH BREAD, GARLIC BUTTER CHOCOLATE CAKE ICE CREAM	III.B	A
48. Which of the following meals contains the most nutritional value for the usual amount of money spent? A. BUFFET HAM SLICE SPICED APPLE RING SPINACH AND SESAME SALAD, DRESSING CHERRY PIE B. T-BONE STEAK BAKED POTATO, SOUR CREAM LETTUCE SALAD, DRESSING COFFEE C. RUMP ROAST SCALLOPED POTATOES BROCCOLI PUMPKIN PIE ICED TEA	III.B	A
49. An example of a convenience product which is less expensive than its home-prepared counterpart is: A. FROZEN CONCENTRATED ORANGE JUICE COMPARED WITH FRESH ORANGE JUICE. B. PURCHASED YOGURT COMPARED WITH HOME-PREPARED YOGURT. C. FROZEN CHOCOLATE CHIP COOKIES COMPARED WITH HOME-PREPARED CHOCOLATE CHIP COOKIES.	III.B	C

50. When Carol is dieting she finds that the best of the following ways to lose weight is to; III.C C

A. SUBSTITUTE FOODS THAT HAVE A HIGHER WATER AND FIBER CONTENT THAN THOSE NOW CONSUMED.
B. DIVIDE HER CURRENT FOOD INTAKE INTO SIX OR SEVEN MEALS RATHER THAN FEWER.
C. TAKE LONGER TO EAT THE MEALS AND SNACKS THAT SHE CURRENTLY CONSUMES.

1. Snacks can be planned nutritionally along with meals. Good snack items to go with the following meals for Martie (age 7) would be: III.C A

Tomato Juice	Tuna Salad Sandwich	Chicken, Lettuce, Tomato
French Toast	(1 slice bread)	Sandwich (2 slices bread)
Butter/Syrup	Celery Sticks	Grapes
	Strawberries	Iced Tea
	Milk	

A. BLUEBERRY MUFFINS, BANANA
B. PEANUTS, APPLESAUCE
C. APRICOTS, CHOCOLATE MILK

2. The best way for Americans to assure themselves that they are attaining good nutrition is to: III.C K

A. EAT THREE REGULAR MEALS A DAY.
B. EAT A WIDE VARIETY OF DIFFERENT KINDS OF FOOD.
C. INCLUDE VITAMIN-MINERAL SUPPLEMENTS IN THEIR DIETS.

Table 18. Item analysis data for the 50-item nutrition knowledge questionnaire for the standardization group

Item Number	Distractor Analysis A	B	C	Difficulty Index (%)	Discrimination Index	Standard Deviation
1[b]	31	48	89[a]	53	.34	.50
2	26	133[a]	9	79	.33	.41
3	129[a]	24	15	77	.37	.42
4[b]	26	109[a]	33	65	.39	.48
5[b]	98[a]	3	66	59	.25	.49
6	130[a]	12	25	78	.42	.42
7	11	132[a]	25	79	.31	.41
8[b]	21	108[a]	38	65	.38	.48
9[b]	117[a]	24	27	70	.35	.46
10	17	31	119[a]	71	.37	.45
11	65	11	91[a]	54	.19	.50
12[b]	101[a]	7	60	60	.41	.49
13	14	14	140[a]	83	.33	.37
14[b]	4	113[a]	51	67	.32	.47
15	120[a]	10	37	72	.37	.45
16	121[a]	27	20	72	.19	.45
17[b]	19	107[a]	42	64	.24	.48
18	17	140[a]	11	83	.26	.37
19	119[a]	33	16	71	.37	.45
20	8	33	125[a]	75	.33	.43
21[b]	68	76[a]	24	45	.29	.50
22[b]	36	57	74[a]	44	.48	.50
23[b]	107[a]	45	13	64	.53	.48
24	15	119[a]	34	71	.38	.45
25[b]	34	55	78[a]	46	.48	.50
26[b]	42	90[a]	35	54	.41	.50
27[b]	56	93[a]	18	56	.32	.50
28[b]	32	114[a]	22	68	.20	.47
29[b]	19	31	118[a]	70	.37	.46
30	139[a]	16	13	83	.42	.38

31[b]	25	106[a]	37	63	.26	.48
32	134[a]	18	15	80	.41	.40
33[b]	33	27	108[a]	64	.27	.48
34	16	127[a]	25	76	.41	.43
35	23	19	125[a]	75	.33	.43
36[b]	115[a]	25	28	68	.41	.46
37[b]	24	37	106[a]	63	.38	.48
38[b]	115[a]	24	29	68	.43	.46
39	15	135[a]	18	80	.38	.40
40[b]	22	27	117[a]	70	.49	.46
41[b]	70	75[a]	23	45	.38	.50
42[b]	75[a]	27	66	45	.32	.50
43	20	15	132[a]	79	.30	.41
44	20	141[a]	7	84	.29	.37
45[b]	39	25	103[a]	62	.34	.49
46	49[a]	37	82	29	.25	.45
47[b]	39	108[a]	19	65	.20	.48
48[b]	42	24	101[a]	60	.30	.49
49	122[a]	31	15	73	.38	.45
50[b]	90[a]	26	51	54	.21	.50

[a]Correct response.

[b]Items that meet the three test criteria:
- --difficulty index between 30-70%;
- —discrimination index between 0.20-0.40 or over 0.40; and
- —all distracters functioning.

Table 19. Mean difficulty on questionnaire items for each content area and objective (percent)

	Subject Groups				
	Young Adults				
	Standardization Group—Students at end of FN 107	Students Beginning FN 107	Student Nurses Beginning Nutrition Course	Student Nurses Having Completed Nutrition Course	Luther College Students
I. Physiological Aspects of Nutrition	68	44	44	60	38
A. 7 items	70	36	40	64	33
B. 5 items	68	44	42	56	40
C. 4 items	72	60	58	65	60
D. 4 items	60	40	40	50	20
II. Foods as Nutrient Sources	66	49	54	64	43
A. 7 items	61	46	51	56	38
B. 7 items	73	54	60	73	51
C. 2 items	65	45	50	65	50
D. 4 items	60	48	48	62	32
III. Sociopsychological Aspects of Nutrition	64	51	59	60	50
A. 2 items	80	75	80	80	70
B. 5 items	58	42	52	52	36
C. 3 items	63	50	57	60	60

Subject Groups								
				Other Adults				
Students Beginning FN 301	Elementary Teachers Before Nutrition Education Course	Elementary Teachers After Nutrition Education Course	Teachers After Nutrition Education Workshop	EFNEP Aides	Adults in Extension Groups	4-H Leaders	Mothers	Fathers
64	50	78	64	58	49	46	51	40
57	43	80	63	56	47	46	54	41
64	50	72	56	56	48	44	50	44
80	68	85	78	72	58	60	60	45
60	48	78	62	50	45	32	38	25
78	68	82	74	74	60	63	60	46
68	63	73	63	67	53	58	51	36
86	70	87	86	81	64	66	64	51
75	65	85	60	70	55	60	70	55
85	78	90	82	75	70	68	60	50
74	68	87	82	68	55	60	61	54
95	85	95	90	70	70	85	85	70
64	66	82	72	64	52	52	50	56
77	60	90	93	73	50	57	63	40

Table 20. Nutrition knowledge of various adult groups

Subjects	Number of Respondents	Mean Score	Standard Deviation	Mean Difficulty (%)	Range of Scores
Young Adults					
Standardization Group of Students Completing FN 107	168	32.9	7.8	66	14-48
Students Beginning FN 107	362	23.5	5.9	47	11-49
Student Nurses Beginning Nutrition Course	86	25.4	5.1	51	16-44
Student Nurses at End of Nutrition Course	43	30.7	6.2	61	16-43
Luther College Students	19	21.0	5.1	42	12-29
Students Beginning FN 301	40	35.8	6.4	72	21-48
Other Adult Groups					
Elementary Teachers Before Nutrition Education Course	34	30.7	5.4	61	19-41
Elementary Teachers After Nutrition Education Course	34	41.0	4.4	82	31-49
Teachers After Nutrition Education Workshop	19	35.8	6.0	72	21-46
EFNEP Aides	79	33.1	8.6	66	15-48
Adults in Extension Groups	72	26.8	7.0	54	14-42
4-H Leaders	26	27.6	7.5	55	17-43
Mothers	38	28.0	6.2	56	17-41
Fathers	19	22.5	5.6	45	12-33

SUMMARY

The purpose of this study was to identify nutrition generalizations and supporting facts considered important for young adults and to develop a valid and reliable test to identify the knowledge of nutrition of selected groups of adults.

The three major content areas for classification of generalizations and objectives were:

1. Physiological aspects of nutrition,
2. Food as sources of nutrients, and
3. Sociopsychological and economic aspects of nutrition.

The weighting for the content areas was 40%, 40% and 20% for the first, second and third areas, respectively. Generalizations and supporting facts were identified for each content area. Sixteen judges with expertise in food and nutrition reviewed the generalizations and supporting facts to determine if the information was appropriate and necessary for young adults. Revisions were made according to comments received.

Behavioral objectives were formulated and weightings assigned to each corresponding to a judgment of the relative importance of the understanding to the practice of nutrition. Content and cognitive level of achievement were based largely on that found in a basic nutrition course. The objectives were reviewed by two evaluation specialists and revised.

Multiple-choice items were prepared corresponding to test specifications with 16% representing knowledge, 48% representing comprehension and 36% representing application or higher levels in the cognitive domain. Items were analyzed for quality using the Multiple-Choice Test Analyzer. Repetition of words between the stem and option and the use of negatives and specific determiners were examined with the MCTA.

The revised items were distributed for review with the generalizations and supporting facts to 17 professionals in nutrition and home economics education. Three evaluation specialists reviewed the items and specified cognitive levels for each item.

A representative 75-item pretest was administered to 103 students in FN 107, Nutrition and Man's Food. Fifty items were selected for the final nutrition knowledge questionnaire using test specifications and pretest results. The questionnaire was administered to the standardization group or norm sample of 168 students in FN 107 at the end of the term of basic nutrition instruction. The raw scores ranged from 14 to 48 with a mean score of 32.9, a standard deviation of 7.8 and a standard error of measurement of 3.1. Two items had discrimination indices of less than 0.20. Item difficulty ranged between 29 and 84% with a mean difficulty of 66%. Sixteen items had difficulty indices of 0.71 to 0.80 and four items had difficulty indices of 0.81 to 0.91. Mean difficulty was 72% for the knowledge-level items, 64% for the comprehension-level items and 66% for those items at the application or higher cognitive level. The Kuder-Richardson formula-20 reliability index for the questionnaire was 0.84.

Test groups consisted of students at the beginning of FN 107, student nurses at the beginning of and having completed a nutrition course, students at Luther College, university students at the beginning of an intermediate nutrition course, FN 301, elementary teachers at the beginning of and at the end of a nutrition education course, teacher educators at the end of a nutrition education workshop, Expanded Food and Nutrition Education Program (EFNEP) aides, adults attending extension and weight control meetings, 4-H leaders, and parents of first graders.

Mean scores were highest for groups who had received some nutrition training. The mean score for elementary teachers completing a nutrition education course (41.0 ± 4.4) was significantly higher ($p < 0.001$) than that for the standardization group (32.9 ± 7.8). Other groups which had received some nutrition training (teacher educators completing a nutrition education workshop, students at the beginning of an intermediate nutrition course, FN 301, and EFNEP aides) had mean scores similar to that of the standardization group. Student nurses who had completed a nutrition course had a somewhat lower mean score (30.7 ± 6.2) than did the standardization group ($p < 0.05$).

Those groups with mean scores significantly lower ($p < 0.001$) than that of the standardization group were students at the beginning of FN 107, student nurses at the beginning of a nutrition course, students at Luther College, adults in extension or weight control groups, 4-H leaders, and parents of first graders.

Mean difficulty scores for groups of items testing each of the three content areas and each of the 11 objectives were calculated. Similar results were reported for each of the three subject areas for the standardization group. For the other groups scores were somewhat higher on items testing the latter two subject matter areas in comparison to scores on items related to the physiological aspects of nutrition. It appeared that the nutrition knowledge questionnaire could be used satisfactorily for testing knowledge of nutrition of adult groups. An effort to increase questionnaire reliability to 0.90 could be made by revising items which did not meet the difficulty and discrimination criteria. Further use of the questionnaire for testing knowledge of nutrition of various adult groups is recommended.

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APPENDIX A: NUTRITION AND HEALTH KNOWLEDGE TESTS

NUTRITION AND HEALTH KNOWLEDGE TESTS

Investigators	Subjects	Location	Size of Group (n)	Number of Items
Aboul-Ela (1976)	Female students in residence halls	TX	239	60
	University A		122	
	University B		117	
Adams (1959)	University freshmen in a health course	OR		75
	Males		63	
	Females		63	
Al-Isi, Kanawati and McLaren (1975)	Mothers	Lebanon		50
	No schooling		15	
	1-3 years		15	
	5 years		15	
	7-9 years		15	
Anderson and Standal (1975)	Health food store customers	HI	140	5

[a]R.C. = Reliability coefficient.

[b]Total possible score of 100.

[c]Open-ended.

Type of Items	Mean Score ± S.D.	Range of Scores	Correct Responses (Percent)	R.C.[a]	Content Areas
MC	41.20±8.08	4-57	69		Energy, nutrients, nutrient requirements, deficiency diseases
	40.26±8.77		67		
	42.18±7.21		70		
TF U			61 59		Health misconceptions: food, diet, nutrition (25%); organic function and disorders (21%); prevention of disease and treatment of injury (12%); mental health (10%); eyes, teeth, hair, and skin (21%); first aid (11%).
TF U	30.3 ±6.5[b]		30	.86	Sources of food, food budget, food selection and preparation, infant feeding.
	33.3 ±6.1[b]		33		
	37.9 ±6.0[b]		38		
	50.7 ±5.2[b]		51		
--[c]					Foods considered to be health foods, foods considered hazardous to health.

Investigators	Subjects	Location	Size of Group (n)	Number of Items
Avery (1978)	Community college students in a biology class	CA	17	35
	University students		194	
	Underweight		21	
	Normal weight		125	
	Overweight		31	
	Obese		17	
Axelson and DelCampo (1978)	Ninth graders	FL		10
	Experimental			
	Pretest		205	
	Post-test		179	
	Control			
	Pretest		195	
	Post-test		159	
Baker (1969, 1972)	Fourth and fifth graders	IA		12
	Experimental		127	52
	Pretest			
	Post-test			
	After 5 months			
	Control		140	
	Pretest			
	Post-test			
	After 5 months			
Bell (1975)	Sunday school class members (adults)	IL	156	50
Bell and Lamb (1973)	Fifth graders	KS OK NM TX AR	1,464	

[d]Objective.

Type of Items	Mean Score ± S.D.	Range of Scores	Correct Responses (Percent)	R.C.	Content Areas
MC				.52	Energy balance and weight control (54%); nutrient composition of foods (23%); calorie value of foods (23%).
	19.2		55		
	21.0		60		
	19.1		55		
	19.2		55		
	18.1		52		
				.42	Food sources and functions of vitamin A, iron, vitamin C, calcium; energy needs; food selection.
	3.40±0.12		34		
	4.25±0.13		43		
	4.08±0.13		41		
	4.49±0.13		45		
MC TF					Food and health, food habits and selection, nutrients and calories in food.
	29.7		46	.28	
	36.3		57	.65	
	33.3		52	.54	
	30.2		47		
	30.9		48		
	32.9		51		
TF U	33.2		66		Food and nutrition misconceptions.
--[d]					Nutrients and health, food selection, Basic Four Food Groups.

Investigators	Subjects	Location	Size of Group (n)	Number of Items
Boysen and Ahrens (1972)	Second graders	MD		
	Experimental			
	Pretest		30	16
	Post-test			18
	Control			
	Pretest		29	16
	Post-test			18
Bozdech (1974)	Dental faculty	KY	65	123
Bozdech, Packett, Marlatt, and Bridges (1978)	Dental students		175	
	First year		57	
	Second year		46	
	Third year		36	
	Fourth year		36	
	University students completing introductory nutrition course		87	
	Grade A			
	Grade B			
	Grade C			
	Grade D			
Byrd-Bredbenner (1981)	Nutrition educators	PA	576	50
Campbell and Early (1969)	Freshmen in a health science class	TX	45	100
	Pretest			
	Post-test			
	Parents of students		45	

[e]Percent scores.

Type of Items	Mean Score ± S.D.	Range of Scores	Correct Responses (Percent)	R.C.	Content Areas
TF					Need for nutrition, Basic Four Food Groups.
MC					
	7.77		49		
	14.89		83		
	7.52		47		
	10.88		60		
TF	65.4± 9.0[e]	41-83[e]			Nutrients, biochemistry, and physiology (39%); disorders (8%); foods (34%); diets (8%); behavioral and social sciences (1%); organisms (5%); programs (5%).
MC	58.7±10.2[e]	21-86[e]	59		
	53.3±11.4[e]	21-75[e]	53		
	61.1± 8.1[e]	40-82[e]	61		
	62.3± 8.4[e]	46-86[e]	62		
	60.9± 8.1[e]	41-72[e]	61		
	87.6[e]		88		
	79.8[e]		80		
	69.7[e]		70		
	59.1[e]		59		
MC	38.4± 6.0		77	.81	Basic nutrition (50%), sources of nutrients (28%), functions of nutrients (22%).
MC					Personal health (36%), nutrition (12%), community health (15%), consumer health (9%), stimulants and depressants (8%), safety education (3%), first aid (5%), family living (7%), mental health (5%).
	65.78±10.72	36-84	66		
	70.64± 9.42	44-88	71		
	75.57±10.93	43-96	76		

Investigators	Subjects	Location	Size of Group (n)	Number of Items
Carruth (1974)	Nutrition education assistants (NEAs) in EFNEP	MO		12 58
	Experimental		9	
	Pretest			
	Post-test			
	Control		18	
	Pretest			
	Post-test			
Carruth and Lamb (1971)	Students beginning introductory nutrition course	TX	360 140 127 151 160	80
Carver (1976)	Preservice elementary school teachers	PA	74	24 15
Carver and Lewis (1979)	Inservice elementary school teachers	PA NY	40	24 15
	Nutrition students and faculty	WI NY	22	24 15
	Total		136	24 15

[f]Total possible score of 86.

Type of Items	Mean Score ± S.D.	Range of Scores	Correct Responses (Percent)	R.C.[a]	Content Areas
MC					Health and body weight, responseability to weight modification, food intake, utilization of resources in weight modification, personal interrelationships and weight modification, nonpersonal influences on weight modification.
TF					
	48.44±10.34[f]		56		
	58.06± 9.59[f]		68		
	50.37± 8.97[f]		59		
	49.63± 8.72[f]		58		
--[d]	62.26±11.33[e]	39-89[e]	62	.83	Food and nutrition
	62.42±11.92[e]	34-84[e]	62	.85	
	64.84±10.75[e]	45-85[e]	65	.82	
	66.85±10.09[e]	45-85[e]	67	.80	
	60.93±11.94[e]	40-80[e]	61	.85	
TF	14.5 ± 2.7	10-20	60	.44	Food fads (12.5%); environmental factors (8%); weight loss and gain (12.5%); sources of nutrients (25%); nutrient functions and requirements (17%); digestion, absorption, metabolism, and excretion (17%); food storage, purchase, and preparation (8%).
MC	4.3 ± 2.5	0-11	29	.52	
TF	15.3 ± 3.2	9-21	64	.60	
MC	3.2 ± 2.5	0-11	21	.58	
TF	21.5 ± 2.1	6-24	90	.57	
MC	9.7 ± 1.9	6-13	65	.22	
TF	15.8 ± 3.7	7-24	66	.72	
MC	4.8 ± 3.1	0-13	32	.73	

Investigators	Subjects	Location	Size of Group (n)	Number of Items
Cerqueira, Casanueva, Ferrer, Fontanot, Chavez, and Flores (1979)	Mothers of preschool children	Mexico		
	Direct education		38	
	Pretest			
	Post-test			
	Mass media		33	
	Pretest			
	Post-test			
	Control		35	
	Pretest			
	Post-test			
Cho (1972)				
Cho and Fryer (1974)	Physical education majors	KS	138	50
	Students completing basic nutrition course		81	
Christopher, Shannon and Sims (1980)	University students in an introductory nutrition course	PA		86
	Multimedia instruction		61	
	Pretest			
	Post-test			
	Traditional instruction		63	
	Pretest			
	Post-test			

[g]Possible range of scores with 5-point degree of certainty -400 to +400.

Type of Items	Mean Score ± S.D.	Range of Scores	Correct Responses (Percent)	R.C.	Content Areas
--[c]					Adequate diet for family, infant feeding and nutritional requirements, dietary needs in pregnancy and lactation, hygiene in food handling and preparation.
	36 ±14[e]		36		
	92 ±13[e]		92		
	40 ±15[e]		40		
	94 ±15[e]		94		
	29 ±13[e]		29		
	47 ±11[e]		47		
TF	93.3[g]	-36-260[g]	40		General knowledge of nutrition, food composition, misconceptions about food.
U	156.6[g]	-20-283[g]	74		
--[d]				.82	Nutrition knowledge.
	36.4		42		
	73.8		86		
	36.1		42		
	68.9		80		

Investigators	Subjects	Location	Size of Group (n)	Number of Items
Coleman, Burkhardt and Highfill (1972)	High school underachievers	TX	42	100
	Parents of students		42	
Cooper and Philp (1974)	Third graders	Ontario		9
	Control		375	
	Test		544	
	Board endorsed		170	
Davis (1971)	Extension advisors	IL	34	50
	EFNEP assistants		34	40
	Low-income homemakers		34	40
Dearborn (1963)	Junior college students in health course	CA		100
	Pretest		5,267	
	Post-test			
Duyff, Sanjur and Nelson (1975)	Spanish-speaking girls (ages 15-19)	IL	75	

[h]Possible range of scores with degree of certainty 50-250.

[i]Possible range of scores with degree of certainty 40-200.

Type of	Mean Score ± S.D.	Range of Scores	Correct Responses (Percent)	R.C.	Content Areas
MC	41.26±10.06		41		Personal health (36%), nutrition (12%), community health (15%), consumer health (9%), stimulants and depressants (8%), safety education (3%), first aid (5%), family living (7%), mental health (5%).
	51.37±13.84		51		
MC			39,14 65,22 81,38		Food groups, food classification, balanced meals.
TF	183.3±12.1[h]	151-207[h]	64	.71	Nutrition as a physiological process (24%), foods as nutrient sources (36%), food handling (14%), nutritional needs through the life cycle (24%), nutrient supplements (2%).
U	159.9±10.4[i]	146-173[i]	70	.41	
	144.7±11.8[i]	116-162[i]	55	.81	
MC		3- 93			Health knowledge.
	46.6	8- 84	47		
	58.8	14- 90	59		
MC				.82	Nutrients.

Investigators	Subjects	Location	Size of Group (n)	Number of Items
Dwyer, Feldman and Mayer (1970)	High school students (grades 9-12)	MA	1,338	100
	Males		616	
	Females		722	
	Dietitians		15	
	Dietetic interns		53	
	Physicians		22	
	Medical students		15	
	Nursing students			
	First year		204	
	Second year		60	
	Third year		33	
Dwyer, Stolurow and Orr (1981)	Dietitians and dietetic interns	MA	88	74
	Practicing physicians		146	
	Public health graduate students		41	
	Medical students		83	
	High school girls		299	
Emmons and Hayes (1973)	Mothers	NY	486	2
	Children in grades 1-4		783	
Eppright, Fox, Fryer, Lamkin, and Vivian (1970)	Mothers of preschool children in:	12 North Central States	2,000	35
	Open country		420	
	Rural places (<2,500)		160	
	Small towns (2,500-9,999)		320	
	Small cities (10,000-50,000)		460	
	Large cities (>50,000)		640	

[j] Possible range of scores with 5-point degree of certainty -280 to +280.

Type of Items	Mean Score ± S.D.	Range of Scores	Correct Responses (Percent)	R.C.	Content Areas
MC	55.9 ±11.59	14-85	56		Nutrition knowledge.
	53.4 ± 0.49		53		
	58.0 ± 0.40		58		
	88.1 ±13.10		88		
	89.7 ± 5.00		90		
	85.4 ±11.40		85		
	85.0 ± 6.00		85		
	78.0 ± 7.80		78		
	77.7 ± 4.90		78		
	77.4 ± 5.20		77		
MC TF	63.0 ± 4.50		85		Nutrients in foods, effects of processing on nutrients, variations in human nutrient needs, substitutions of foods for each other, meeting nutrient needs.
--[c]	53.0 ± 7.80		72		
	52.0 ± 8.50		70		
	51.0 ± 5.80		69		
	38.0 ± 8.50		51	.88	
--[c]					Food selection, nutrient attributes of food.
TF U					General knowledge of nutrition, food composition, misconceptions about food, application of basic nutrition principles.
	100[j]				
	93[j]				
	94[j]				
	108[j]				
	77[j]				

Investigators	Subjects	Location	Size of Group	Number of Items
Fanslow, Brun and Hausafus (1981)	Kindergartners	USA	177	20
	First graders		249	30
	Second graders		313	40
	Third graders		240	30
	Fourth graders		234	40
	Fifth graders		244	50
	Sixth graders		241	50
Franklin (1971)	Elementary student teachers	TX	84	30
	Elementary teachers		80	
Garton and Bass (1974)	Junior and senior high school students	TN		53
	Deaf		73	
	Normal hearing		93	
Gassie and Jones (1972)	Homemakers in EFNEP	LA		1
	Pretest		129	
	Post-test		129	
	Follow-up		240	

[k] 90%, 87%, 97%, 57%.

[l] 98%, 95%, 100%, 84%.

[m] 96%, 94%, 99%, 88%.

Type of Items	Mean Score ± S.D.	Range of Scores	Correct Responses (Percent)	R.C.	Content Areas
MC	12.6 ± 3.3	3–20	60	.71	Physiological facts (10-40%), nutrients (18-44%), food handling (12-40%), life cycle (0-23%), social-psychological aspects of food (0-23%), food technology (0-8%), nutrition and society (0-4%).
	20.4 ± 4.3	6–30	67	.80	
	27.4 ± 6.5	10–39	69	.78	
	16.7 ± 4.5	7–29	55	.75	
	21.9 ± 6.3	6–37	56	.86	
	21.5 ± 6.7	6–50	43	.83	
	25.0 ± 7.8	8–50	50	.87	
MC	18.79 ± 3.30	8–24	63		Nutrition, food choice and preparation.
	20.85 ± 3.15	12–27	70		
TF					Food information: safety storage, energy effect on health, cost, misconceptions about food.
U					
			47		
			67		
--[c]					Basic Four Food Groups.
			--[k]		
			--[l]		
			--[m]		

Investigators	Subjects	Location	Size of Group (n)	Number of Items
Gillespie (1978)	Fathers and mothers of young children	IA		
	Scale A		141	5
	Pretest			
	Post-test			
	Scale B		147	9
	Pretest			
	Post-test			
	Scale C		136	7
	Pretest			
	Post-test			
Grotkowski (1976) Grotkowski and Sims (1978)	Senior citizens	IN	64	20
Haag (1963)	Freshman elementary education majors	New England	1,044	130
	Education majors at beginning of health education course	TX	535	
Hardinger (1974)	Seventh graders	IA	265	32

[n]Total possible score of 1-11.

[o]Multiple answer.

[p]Total possible score of 1.

[q]52.3% to 74.6%.

Type of Items	Mean Score ± S.D.	Range of Scores	Correct Responses (Percent)	R.C.	Content Areas
TF					
U	8.46± 1.84[n]			.58	General nutrition concepts, nutrients in foods, nutrient needs, food selection, consumer aspects of nutrition.
	9.04± 1.86[n]			.67	
--[o]					
	0.68± 0.25[p]		68	.72	
	0.70± 0.27[p]		70	.78	
MC					
	0.38± 0.25[p]		38	.58	
	0.52± 0.27[p]		52	.62	
TF MC	7.2	0-16	36	.80	Nutrition knowledge.
TF				.89	Health misconceptions.
TF	63.4[e]	--[q]	63		
MC				.73	Nutrients, nutrients in foods, serving size, Basic Four Food Groups, food selection, weight maintenance.

Investigators	Subjects	Location	Size of Group (n)	Number of Items
Harrison, Sanchez and Young (1969)	Public health nurses	MI	144	67
Head (1974)	Fifth, seventh, and tenth graders	NC	--[r]	
Hinton (1962)	12-14 year old girls	IA	140	30
	12 year olds			
	13 year olds			
	14 year olds			
Jacklin (1964)	Seventh and eighth grade girls	NY	109	57
	Tenth graders		250	
	Males		88	
	Females		92	
	Females with additional home economics		70	

[r]Four classes at each grade level with average class size of 26.

Type of Items	Mean Score ± S.D.	Range of Scores	Correct Responses (Percent)	R.C.	Content Areas
TF U	62.0± 8.87[e]	23.8-85.0[e]	62		Tools in planning and evaluating diets; physiological factors affecting food intake and nutrient needs; psychological, cultural, social, and economic factors affecting food intake; nutrients in foods-functions sources, digestion, metabolism.
					Nutrition knowledge.
MC TF				.74 .86 .82	Nutritionally adequate meals, substitutions within food groups, fallacies about food practices, reducing or weight-gaining diets, nutrient content of foods, food costs.
MC	23.2		41	.84	Food and nutrition principles: Basic Four Food Groups, nutrients, food sources of nutrients, food ingredients and processing.
	30.6 30.9 31.9		54 54 56		
	28.6		50		

Investigators	Subjects	Location	Size of Group (n)	Number of Items
Jalso, Burns and Rivers (1965)	Members of community organizations	NY	340	30
	Faddists		53	
	Nonfaddists		48	
Jenkins, Stumo and Voichick (1975)	Fourth graders	WI	129	37
	Experimental		92	
	Pretest			
	Post-test			
	Control		37	
	Pretest			
	Post-test			
Kiang (1970)	Nursing students (junior year)	NY	132	60
	Programmed instruction			
	Pretest		15	
	Post-test		15	
	Assigned readings			
	Pretest		17	
	Post-test		19	
	Control			
	Pretest		17	
	Post-test		20	
	Nursing students	NY	10	40
	Pretest			
	Post-test			
	University students in an introductory nutrition course	NY	13	
	Pretest			
	Post-test			

[s] Total possible score 90.

[t] Fill-in.

Type of Items	Mean Score $\pm$ S.D.	Range of Scores	Correct Responses (Percent)	R.C.	Content Areas
TF	67.7 ± 10.3^{s}	$38\text{-}90^{s}$	75	.75	Special health foods; self-prescribed vitamins; diet as related to health; diet adjustments; sources of information; refined and processed foods; chemicals, soil depletion, fertilizers.
	52.9^{s}		59		
	82.0		91		
$\underline{MC_t}$					"Mulligan Stew" film series.
	11.0 ± 0.7		30		
	20.7 ± 0.9		56		
	11.9 ± 0.9		32		
	13.5 ± 1.0		36		
MC					Protein metabolism.
	23.40 ± 6.93		39		
	44.73 ± 8.35		75		
	21.94 ± 5.14		37		
	35.47 ± 9.61		59		
	23.41 ± 5.97		39		
	26.82 ± 4.23		45		
MC	15.30 ± 2.98		38		
	29.50 ± 4.88		74		
	18.92 ± 4.55		47		
	35.31 ± 3.77		88		

Investigators	Subjects	Location	Size of Group (n)	Number of Items
Kirk, Hamrick and McAfee (1975)	Sixth graders Ninth graders Twelfth graders	TN	1,153	
Knudtson (1972)	Fifth and sixth grade teachers	IA	174	20 24
Kolasa, Lackey, Penner, and Mutch (1979)	Teachers (K-12)	MI	153	16 34
	Dairy Council teachers		40	16 34
	Society for Nutrition Education members		234	16 34

[u] Mean score on nutrition section; national norm 59.

[v] Mean score on nutrition section; national norm 74.

[w] Mean score on nutrition section; national norm 54.

[x] Alternative-response.

Type of Items	Mean Score ± S.D.	Range of Scores	Correct Responses (Percent)	R.C.	Content Areas
	44[u] 62[v] 44[w]				Health knowledge.
--[x] MC	26.40±4.42	14-37	60	.62	Nutrients and health, nutritional needs throughout the life-span, nutrients in foods, food habits, food handling, energy and weight control.
TF MC	27		54	.73	Nutrition as a physiological process;
TF MC	28		56	.57	foods as nutrient sources; food handling;
TF MC	47		94	.71	nutritional needs throughout the life cycle; cultural, social, economic and psychological aspects; food and health.

Investigators	Subjects	Location	Size of Group (n)	Number of Items
Krause (1973) Krause and Fox (1977)	Physicians	NE	292	55
Lackey, Kolasa, Penner, and Mutch (1981)	Teachers	MI	208 61	34 16
Linn (1972)	Family food aides	IA	150	50
Lockshin (1978)	Sixth graders	MD		30
	Pretest		25 22	
	Post-test		25 22	
Lohse (1968)	Homemakers	OH	171	35

[y]Possible range of scores with a 5-point degree of certainty -385 to +385.

Type of Items	Mean Score ± S.D.	Range of Scores	Correct Responses (Percent)	R.C.	Content Areas
TF U	134[y]		65		Basic nutrition: nutrients, general information, food composition, pregnancy and lactation, infancy and childhood. Therapeutic nutrition: illness and convalescence, anemia, cardiovascular diseases, diabetes and weight reduction, gastrointestinal diseases, hepatobilliary and renal diseases.
MC TF	25.14± 9.04 14.57±14.63		50 29	.93	
MC	33.33±6.61	14-48	67	.80	Daily Food Guide, nutrients, energy, weight control, enrichment.
TF	16.12±3.11 16.50±3.06 23.32±3.69 22.86±3.32		54 55 78 76		Food and nutrients, label reading, sugar and tooth decay, refined vs. unrefined foods.
TF U	90.5[j]	-42-213[j]	52		General knowledge of nutrition, food composition, misconceptions about food, application of principles of nutrition.

Investigators	Subjects	Location	Size of Group (n)	Number of Items
Lovett, Barker, and Marcus (1970)	Second grade teachers	CA	23	12
	Pretest			
	Post-test			
	Second graders		1,720	
	Experimental		569	
	Pretest			1
	Post-test			
	Pretest			3
	Post-test			
	Semi-control		765	
	Pretest			1
	Post-test			
	Pretest			3
	Post-test			
	Control		386	
	Pretest			1
	Post-test			
	Pretest			3
	Post-test			
Luther (1973)	Sixth graders	IA	122	50
	Pretest		84	42
	Post-test			
	Experimental		40	
	Control		44	

[z]Multiple response, identification, open-ended.

[aa]Identification.

[bb]Scores based on class mean score.

Type of Items	Mean Score ± S.D.	Range of Scores	Correct Responses (Percent)	R.C.	Content Areas
--[z]					Nutrients, Four
	57.8[e]	39-88	58		Food Groups, cul-
	97.5[e]	91-100	97		tural aspects.
--[aa]					Four Food Groups,
					meal selection.
	16[e]		16		
	75[e]		75		
	0.54[bb]				
	1.35[bb]				
	24[e]		24		
	37[e]		37		
	0.59[bb]				
	0.82[bb]				
	18[e]		18		
	31[e]		31		
	0.64[bb]				
	0.78[bb]				
MC	28.40±6.79	9-46	57	.57	Nutrition, nutrient
MC	17.25±5.04	8-29	41		functions, nutrients
					in food, nutritional
	21.70		52	.83	needs through the
	17.02		41	.66	life cycle.

Investigators	Subjects	Location	Size of Group (n)	Number of Items
MacKenzie and Arbor (1979)	High school students in food and nutrition clases	RI		
	Experimental			
	Pretest		28	25
	Post-test		23	66
	Control			
	Pretest		31	25
	Post-test		27	66
McCarthy and Sabry (1973)	University freshmen	Ontario	274	70
	Males		141	
	Females		133	
			40	
Madaras (1977)	Pregnant teenagers	OH		10
	Pretest		22	15
	Post-test			
	Experimental		9	
	Control		9	
Morse, Clayton and Cosgrove (1967)	Mothers of seventh to ninth graders	VT	238	33

[cc]Between 20 and 23.

Type of Items	Mean Score ± S.D.	Range of Scores	Correct Responses (Percent)	R.C.	Content Areas
MC				.83	Nutrient functions, food selection, nutrition labeling.
	13.86±2.71		55		
	54.65±4.80		83		
	13.35±2.35		53		
	48.96±8.85		74		
TF	37.8		54	.59	Misconceptions: (equal representation) health foods;
U	37.1 ±7.6		53		
	38.6 ±7.0		55		
				.86	environmental factors; weight loss and gain; sources of nutrients; nutrient requirements and functions; digestion absorption, metabolism, excretion; food handling.
MC TF	13.41±2.57		54	.58	Food habits, nutrient functions, food selection, nutritional needs of the pregnant adolescent, food fads and fallacies.
	15.79		63		
	13.33		53		
MC	--[cc]	2-32			Practical information on nutrition and diet.

Investigators	Subjects	Location	Size of Group (n)	Number of Items
Nece (1979)	10th-12th graders in home economics classes	IA	253	12
				48
			241	12
				48
Nethers (1968)	Ninth graders in health education classes	IL	145	32
Norton (1974)	Third graders	MD		20
	Experimental			
	Pretest		53	
	Post-test		58	
	After 3 months		52	
	Control			
	Pretest		58	
	Post-test		54	
	After 3 months		56	
Ofei (1978)	University students who had studied food and nutrition in high school	IA	45	33
	University students beginning a basic nutrition course		89	
	Community college students		74	
	High school graduates		45	
	All subjects		208	

Type of Items	Mean Score ± S.D.	Range of Scores	Correct Responses (Percent)	R.C.	Content Areas
TF	36.8 ±7.2	17-53	61	.78	Physical, social, cultural, and psychological aspects of food; consumer aspects; food preparation and management.
MC	36.3 ±7.3	17-51	61	.80	
MC	17.13	7-28	54	.57	Social, economic and cultural influences on food choices; influences of nutritional status on physical, social and mental attainments; weight control; deficiency diseases; Basic Four Food Groups, misconceptions.
MC					Nutrient functions and sources, energy, Basic Four Food Groups.
	42.23[b]				
	47.90[b]				
	47.64[b]				
	38.22[b]				
	42.07[b]				
	47.30[b]				
MC	18.20±3.69	9-24	55	.55	Significance of food, nutrient sources and requirements, food habits, food selection, food safety and sanitation, meal planning, marketing, food preservation and storage.
	18.09±3.65	8-24	55		
	16.18±3.65	7-24	49		
	16.93±3.28	9-23	51		
	17.16±3.67	7-24	52		

Investigators	Subjects	Location	Size of Group (n)	Number of Items
Ombwara (1972)	Youth ages 8-11 in EFNEP	IA	145	20
Osman (1967) Osman and Ahrens (1972)	Freshmen beginning a health course	MD	1,331	144
	Males		787	
	Females		544	
Pearson (1969)	Wives of industrial workers	IA	186	12
Petersen (1971) Petersen and Kies (1972)	Elementary teachers (K-3)	NE	910	20
Phillips (1967, 1971)	Student nurses	Boston	111	100
	Second year medical students in four schools	New England	254	
			89	
			60	
			59	
			46	
	Nutritionists and dietitians		13	

[dd]Total possible score of 24.

[ee]Possible range of scores with 5-point degree of certainty -140 to 140.

Type of Items	Mean Score ± S.D.	Range of Scores	Correct Responses (Percent)	R.C.	Content Areas
MC	11.22±3.69	3-19	56	.73	Food sources of nutrients, Basic Four Food Groups, nutrients and health, energy.
TF U	79.26 77.62±20.17 81.57±20.30	19-132	55 54 57	.94	Misconceptions: bread and cereal, milk and milk products, meat and protein food, fruits and vegetables, sweets and fats, vitamins and minerals, weight control and diets, other.
TF	13.65[dd]	3-23[dd]	57	.52	Food and nutrition principles.
TF U	58.3[ee]	0-119[ee]			General knowledge of nutrition, food composition, application of nutrition principles, food misconceptions.
MC				.65	Normal nutrition: recommended allowances of nutrients, food sources of nutrients, food groups.
	40.37± 9.16	15-61	40		
	47.90± 6.70	36-64	48		
	47.11± 8.33	29-68	47		Diet therapy: principles related to disease conditions, foods recommended for specific conditions such as obesity, heart disease, diabetes.
	48.45± 7.65	26-65	48		
	82.62± 5.94	73-92	83		

Investigators	Subjects	Location	Size of Group (n)	Number of Items
Picardi (1976) Picardi and Porter (1976)	11th and 12th graders	MA		20
	Trial 1			
	Experimental		11	
	Pretest			
	Post-test			
	Control		15	
	Pretest			
	Post-test			
	Trial 2			
	Experimental		20	
	Pretest			
	Post-test			
	Control		20	
	Pretest			
	Post-test			
	Trial 3			
	Experimental		23	
	Pretest			
	Post-test			
	Control		19	
	Pretest			
	Post-test			
Pietz (1979) Pietz, Fryer and Fryer (1980)	Dental students	KS	230	50
	First year		97	
	Fourth year		133	
Podell, Gary and Keller (1975)	Physicians	NJ	36	--[gg]
	Medical students	NY		
	Third year		92	
	Fourth year		35	
	All subjects		163	

[ff]Completion

[gg]Test Form A 19 items, Test Form B 20 items.

Type of Items	Mean Score ± S.D.	Range of Scores	Correct Responses (Percent)	R.C.	Content Areas
MC_{ff}					Chemical constituents of foods (25%), dietary habits and health (20%), nutrition labeling (35%), fad diets (20%).
	40.73±14.35[e]		41	.71	
	59.18±16.57[e]		59	.75	
	35.40±10.67[e]		35	.53	
	36.20± 6.45[e]		36	-.48	
	33.30± 7.71[e]		33	.23	
	52.70±14.49[e]		53	.71	
	35.75±13.27[e]		36	.71	
	41.95±11.42[e]		42	.58	
	39.65± 8.84[e]		40	.33	
	64.04± 9.98[e]		64	.38	
	36.11± 9.87[e]		36	.38	
	37.74± 8.65[e]		38	.21	
TF	155.1[g]	59-298[g]	69	.61	Normal and therapeutic nutrition, foods, nutrients, diets, nutrition and dental health, nutritional assessment.
U	183.1		72		
	148.1		67		
MC			44		Lipids and heart disease, sodium-restricted diets, obesity and calorie values, food additives, nutrients, politics and personalities.
			51		
			51		
			50		

Investigators	Subjects	Location	Size of Group (n)	Number of Items
Préfontaine (1975)	Home economics teachers	Quebec	169	25
	University health science students	Montreal	668	
	Mothers of infants		127	
	Immigrants		208	
	All subjects		1,172	
Rosander and Sims (1981)	Women	PA		17
	Instructed		23	
	Uninstructed		22	
Rountree (1975) Rountree and Tinklin (1975)	Senior citizens	KS		20
	High-rise residents		50	
	Nonresidents		54	
Schwartz (1973, 1975)	Female high school graduates	OH	313	30
	Attended college		134	
	Did not attend college		179	
Schwartz (1976)	Public health nurses	British Columbia	352	40

[hh]Total possible score with 4-point degree of certainty of 210.

Type of Items	Mean Score ± S.D.	Range of Scores	Correct Responses (Percent)	R.C.	Content Areas
MC	19.6		78	.68	Nutrition, nutrient sources and functions,
	15.7		63	.64	nutritional needs throughout the life
	12.5		50	.67	cycle, food handling.
	10.2		41	.69	
			64		
MC				.78	Relationship of nutrient intake to health.
TF	9.91		58		
	14.52		85		
MC					Nutrient functions (35%), food sources of nutrients (35%), balanced diets (5%), energy and weight control (25%).
TF U	147[hh] --[hh]				General knowledge of nutrition, food composition, misconceptions about food, application of basic nutrition principles.
	153[hh] --[hh]				
	142[hh] --[hh]				
TF U	74.9[e]	47-89[e]	75		Tools in planning and evaluating diets; physiological factors affecting food intake and nutrient needs; psychological, cultural, social, and economic factors affecting food intake; nutrient in foods--functions, sources, digestion, metabolism.

Investigators	Subjects	Location	Size of Group (n)	Number of Items
Seffrin and Veenker (1972)	High school students who had completed health science courses	IN	632 632 1,082	60 70
Shannon (1976)	University students completing nutrition courses	PA	154 149 191	70
Sims (1976)	Mothers of preschool children	IN	163	23 1
Sims (1978)	Lactating women	PA	61	20
Skinner (1978)	High school nutrition teachers	OR	61	40
	High school students			
	Pretest		1,193	28
	Post-test		1,073	28

[ii]Multiple choice, true-false and matching.

[jj]Between 15 and 19.

[kk]Between 65 and 83.

[ll]25% to 100%.

Type of Items	Mean Score ± S.D.	Range of Scores	Correct Responses (Percent)	R.C.	Content Areas
MC				.81	Health knowledge.
				.76	
MC	33.42±10.47	9-63	48	.87	
--[ii]	63.2 ±4.4		90		Identity sources and functions of nutrients, nutrient needs, food quality and safety.
	63.4 ±5.4		91		
	63.4 ±5.7		91		
TF[c] --	--[jj]		--[kk]		General knowledge of nutrition, food composition, misconceptions about food, application of basic principles of nutrition, basic food groups.
TF MC	74.5[e]	--[ll]	74	.77	General nutrition information.
MC	19.3 ±5.4	9-34	48	.66	Basic, advanced, applied, and recent nutrition knowledge.
MC	11.02±3.26	2-22	39	.37	
	11.85±3.36	1-27	42	.39	

Investigators	Subjects	Location	Size of Group (n)	Number of Items
Smith (1977) Smith and Justice (1979)	Third graders	IN		20
	Student education			
	Pretest			
	Post-test			
	Parent education			
	Pretest			
	Post-test			
	Parent and student education			
	Pretest			
	Post-test			
	Control			
	Pretest			
	Post-test			
Smith and James (1980)	Fourth graders	WI	57	66
	Pretest			
	Post-test			
Sondgeroth (1968)	High school girls	IA		78
	Ninth graders		64	
	Twelfth graders		54	
Spitze (1976)	High school students in home economics and health occupations classes	IL	50	311
	Post-test			
Spollen (1974)	Elementary teachers	NY	102	36

Type of Items	Mean Score ± S.D.	Range of Scores	Correct Responses (Percent)	R.C.	Content Areas
MC				.81	Food and health, food habits, vegetables.
	13.29±3.98		66		
	14.15±3.95		71		
	12.51±3.50		63		
	14.02±3.21		70		
	14.09±3.25		70		
	14.25±3.51		71		
	13.81±3.13		69		
	14.82±2.75		74		
MC[aa]					
--	37.8 ±7.8		57		Four Food Groups, nutrient sources, food selection.
	49.5 ±6.2		75		
TF					Misconceptions: nutritive value foods (46%), calorie value of foods (14%), weight control practices (18%), nutrient sources and functions (22%).
	42.5		54		
	49.8		64		
TF				.88	Body functions and nutrient intake, food sources of eight common nutrients, diet quality, nutrition myths.
	251		81		
MC	18.4 ±5.47	8-32	51	.81	Factors influencing food intakes (17%); nutrients (72%); energy needs and diet (11%).

Investigators	Subjects	Location	Size of Group (n)	Number of Items
Stansfield and Fox (1977)	Independent grocers	NE	194	36
	Chain store managers		23	
Stephens (1970, 1971)	12th graders	CO	240	100
	Small schools (1-175 students)		80	
	Medium-sized schools (176-550 students)		80	
	Large schools (>551 students)		80	
Studdiford and Guthrie (1972)	University students in an introductory nutrition course	PA		
	Experimental group			
	Pretest		35	25
	Post-test		24	
	Control group			
	Pretest		35	25
	Post-test		24	
Sullivan, Gere, Nowlin, and Kloehn (1976)	Homemakers	CA	25	
	Taught by nutritionists			
	Pretest			12
	Post-test			35
	Taught by paraprofessionals		19	
	Pretest			12
	Post-test			35

[mm]Total possible score with degree of certainty 180.

[nn]Short answer.

[oo]Total possible score of 35.

Type of Items	Mean Score ± S.D.	Range of Scores	Correct Responses (Percent)	R.C.	Content Areas
TF U	124 --[mm] 123 --[mm]	67-151[mm] 100-148[mm]			Nutrients, diet foods, consumer issues, fats.
TF U	67.81	9-97	68		Health misconceptions: personal health (6%), nutrition (9%), rest and exercise (4%), care and prevention of diseases (13%), habit-forming substances (11%), first aid and safety (11%), consumer health (9%), family living (10%), mental health (12%), camouflage items (15%).
	65.45		66		
	66.39		66		
	71.08		71		
--[d]					Basic principles of nutrition.
	14.3 47.84±6.29		57		
	13.9 42.10±7.00		56		
--[nn]					Four Food Groups: classification of foods, serving sizes, servings recommended for different age groups, cost comparison per serving within groups.
	12.2 --[oo] 30.2 --[oo]		35 86		
	10.1 --[oo] 28.3 --[oo]		29 81		

Investigators	Subjects	Location	Size of Group (n)	Number of Items
Territo (1978)	Elementary teachers (K-6)	LA	191	21
Thompson and Schwartz (1977)	Eighth graders	British Columbia	366	20
Tifft and Stanton (1972)	High school students	MD	912	144
Tinsley, Houtkooper, Engle, and Gibbs (1981)	Fifth and sixth graders	AZ		30
	Instructed		330	
	Uninstructed		178	
U.S. Department of Health, Education and Welfare (1975)	Food shoppers	United States	100	14
	University students in an introductory nutrition course		85	
	Food shoppers		1,664	

[pp]Total possible score of 134.

Type of Items	Mean Score ± S.D.	Range of Scores	Correct Responses (Percent)	R.C.	Content Areas
TF U	65 ±14[e]	28-92[e]	65		General nutrition knowledge (33%), food composition (19%), application of basic nutrition principles (19%), food misconceptions (29%).
TF U	66.67± 8.91[e]		67		General knowledge of basic nutrition principles and concepts.
TF U	65.84±22.32		46	.94	Misconceptions: bread and cereal, milk and milk products, meat and protein food, fruits and vegetables, sweets and fats, vitamins and minerals, weight control and diets, other misconceptions.
MC				.81	Basic nutrition knowledge.
--[o]	--[pp]			.77	Nutrient content of foods, nutrient functions, food substitutions.
	--[pp]			.80	
	69.28±22.83[pp]	8-115	52		

Investigators	Subjects	Location	Size of Group (n)	Number of Items
Vickstrom and Fox (1976)	Hospital nurses	NE	500	30
Wakefield and Vaden (1973)	Elementary school teachers Pretest Post-test	KS	104	27
Walker (1975)	Homemakers	48 States	2,545	18 5
Wang (1971)	Homemakers in organized clubs	MD	1,050	40
	Low-income homemakers		97	
	4-H members (ages 13-15)		259	

[qq]Total possible score with 5-point degree of certainty of 210.

[rr]Three percent responded correctly to all 18 statements.

[ss]Food plans to evaluate for nutritional desirability.

Type of Items	Mean Score ± S.D.	Range of Scores	Correct Responses (Percent)	R.C.	Content Areas
TF U	112 --[qq]		77		Normal nutrition: food composition, basic nutrtion, functions of nutrients. Therapeutic nutrition: rationale and prescription of therapeutic diets, foods allowed or restricted on therapeutic diets.
MC	12.97±3.40 18.69±3.45	5-27 9-24	48 69	.53 .70	Food habits; psychological and physiological needs for food; digestion, absorption, and utilization of nutrients; food facts and fallacies; food selection.
TF --[ss]	14.5 66[e] 47[e] 71[e] 16[e] 69[e]	--[rr]	81 66 47 71 16 69		General nutrition facts; selection, handling and preparation of food; Basic Four Food Groups.
TF U	67[e] 54[e] 56[e]		67 54 56		Misconceptions about foods: bread and cereal, milk and milk products, meat and protein foods, fruits and vegetables, sweets and fats, vitamins and minerals, weight control, other misconceptions.

Investigators	Subjects	Location	Size of Group (n)	Number of Items
Washnik (1957)	12th graders	NJ	1,171	
Watson (1975)	Youth (ages 8-11) in EFNEP	IA	148	25
Weber (1965)	Seventh graders	NY		45
	Experimental group		119	
	Pretest			
	Post-test			
	Control group		81	
	Pretest			
	Post-test			

[tt]Mean fell in 50th percentile based on national norms for the Shaw-Troyer Health Knowledge and Application test used. Range extended from 35th to 75th percentile.

Type of Items	Mean Score ± S.D.	Range of Scores	Correct Responses (Percent)	R.C.	Content Areas
TF	67.45[tt]			.92	Health knowledge: Safety and first aid; nutrition; health in the home, school and community; mental health.
MC				.64	Nutrient functions, food sources of nutrients, Basic Four Food Groups, energy use in activities, energy value of foods.
MC					Nutrient functions, energy, food selection.
	17.0±4.9		38		
	24.5±5.8		55		
	15.2±3.7		34		
	15.6±4.5		35		

Investigator	Subject	Location	Size of Group (n)	Number of Items
Werblow, Fox and Henneman (1978)	University women athletes	NE	94	31
Williams (1956)	High school students	NC	255	171
Wodarski (1976)	10th, 11th and 12th graders	TN	185	56
Wodarski, Adelson, Tood, and Wodarski (1980)	10th-12th graders in home economics courses	MO		
	Pretest			30
	Class 1		12	
	Class 2		24	
	Post-test			30
	Class 1		12	
	Class 2		24	

[uu]Total possible score with 5-point degree of certainty of 155.

Type of Items	Mean Score ± S.D.	Range of Scores	Correct Responses (Percent)	R.C.	Content Areas
TF	105 --[uu]				General nutrition knowledge, nutrition for athletes.
TF	51[e]	25-80[e]	51		Health misconceptions: nutrition, personal and environmental health, dental health, venereal diseases, mental health and other communicable diseases.
TF	17.0±7.1	2-38	30		Nutrition misconceptions: diet and weight watching, organic and health foods and vegetarian diets, diet in relation to disease, foods my body needs, food safety, nutrition and pregnancy, other.
TF					
				.84	Foods and nutrients, sugar and tooth decay, label reading, refined versus unrefined foods, diet in relation to health, physical appearance, food preparation and service.
	19.42±5.18		65		
	20.73±4.26		69		
				.76	
	24.17±3.78		80		
	25.33±2.53		84		

Investigators	Subjects	Location	Size of Group (n)	Number of Items
Yetley (1974)	Young parents	IA		11
	Husbands		116	
	Wives		116	
Yetley and Roderuck (1980)				
Young, Waldner Berresford (1956)	Homemakers	NY	646	96

Type of Items	Mean Score ± S.D.	Range of Scores	Correct Responses (Percent)	R.C.	Content Areas
MC					General nutrition,
	5.4±2.5	0-11	49	.64	food composition,
	5.9±2.3	1-11	54	.61	application of basic nutrition principles, misconceptions about nutrition, consumer aspects of nutrition.
--[c]					Basic Food Groups, food substitutions based on nutrient content, balanced diet.

APPENDIX B. EXPERT JUDGES FOR REVIEW OF NUTRITION GENERALIZATIONS AND SUPPORTING FACTS, BEHAVIORAL OBJECTIVES, AND QUESTIONNAIRE ITEMS

Nutrition Generalization and Supporting Facts:

Dr. Wilma Brewer, Nutrition Professor, Iowa State University

Dr. Lotte Arnrich, Nutrition Professor, Iowa State University

Dr. Charlotte Roderuck, Director, World Food Institute, Iowa State University

Dr. Jacqueline Dupont, Nutrition Professor, Iowa State University (follow-up reviewer)

Dr. Madge Miller, Food Science Professor, Iowa State University

Mrs. Margaret Tait, Nutrition Assistant Professor, Iowa State University

Dr. Jackie Runyan, Nutrition Associate Professor, Iowa State University

Miss Phyllis Olson, Nutrition Associate Professor, Iowa State University

Mrs. Pauline Mairs, Nutrition Assistant Professor, Iowa State University

Mrs. Katherine Munsen, Nutrition Assistant Professor, Iowa State University

Mrs. Jacque Coulson, Nutrition Instructor, Iowa Methodist Medical Center Nursing School, Des Moines

Mrs. Patricia Dillon, County Home Economist, Fayette County

Mrs. Dorothy Eyberg, County Home Economist, Union County

Mrs. Carolyn Blankenship, Expanded Food and Nutrition Program Extensionist, Black Hawk County (initial reviewer)

Mrs. Janet Joens, Expanded Food and Nutrition Program Extensionist, Black Hawk County (follow-up reviewer)

Mrs. Sue Palmore, Iowa Dairy Council Director

Mrs. Jane Baty, former Nutrition Assistant Professor, Iowa State University

Dr. Margaret Osborn, Nutrition Professor, University of Iowa

Behavioral Objectives:

Dr. Francis Smith, Home Economics Education, Associate Professor, Iowa State University

Dr. Alyce Fanslow, Home Economics Education Professor, Iowa State University

Questionnaire Items for Cognitive Level:

Dr. Ruth Hughes, Home Economics Education Professor, Iowa State University

Dr. Alyce Fanslow, Home Economics Education Professor, Iowa State University

Dr. Rosalie Amos, Home Economics Education Assistant Professor, Iowa State University

Questionnaire Items for Reading Level:

Dr. Diane Hunter, Elementary Education Assistant Professor, Iowa State University

Questionnaire Item Key:

Dr. Shirley Chen, Nutrition Assistant Professor, Iowa State University

Mrs. Susan Benson, Nutrition Instructor, Iowa State University

Miss Sharon Case, Senior Dietetic Student, Iowa State University

APPENDIX C. LETTERS TO EXPERT JUDGES FOR REVIEW OF GENERALIZATIONS, SUPPORTING FACTS AND QUESTIONNAIRE ITEMS

Iowa State University
Ames, Iowa 50011
October 5, 1977

To the Expert Judges:

I would appreciate your participation in validation of a compilation of generalizations and supporting facts in nutrition for young adults. In my study the validated generalizations and supporting facts will be used in preparation of a standardized test of nutrition knowledge which will be administered to several young adult groups. The generalizations and supporting facts (Generalizations are statements of fact or belief which are true in a variety of situations.) which have been prepared should be indicative of the nutrition knowledge which the general public needs to have.

I hope you will be able to give an opinion on the value and accuracy of the enclosed generalizations and supporting facts. An attempt has been made to include those generalizations and facts of interest and concern to young adults.

Your responsibility will be to read each statement and evaluate it. The time involved has been estimated to be slightly more than one hour.

In evaluating the generalization and supporting facts please do the following:

1. Indicate your approval or disapproval of each statement in the right hand column.

2. If you disapprove a generalization or supporting fact either rewrite it in the space beneath, or indicate your objection to it by some descriptive phrase such as:

    a. poorly stated idea.
    b. not important.
    c. error in fact.

3. If you wish to add generalizations or supporting facts, write them in the spaces between items or on a separate sheet of paper. If you do not have time to write a complete statement please indicate your idea for it.

.../2

4. If you do not agree with the classifications suggested, or do not agree on the classification under which a generalization or supporting fact has been placed, please indicate an alternative classification scheme or indicate what your objection is. Make marginal notations opposite statements that have been incorrectly placed.

Thank you for the time and cooperation you have given in evaluating this material. If you are unable to complete the evaluation before October 31, return the materials with as much completed as you had time to do. I would very much appreciate receiving materials by November 1. Thank you again.

Respectfully yours,

Marie Corey

Iowa State University
Ames, Iowa 50011
December 1, 1978

To the Expert Judges:

This letter is to request your assistance in one phase of the research which I am undertaking for my doctoral thesis.

I have prepared generalizations and supporting facts in nutrition important for young adults in the general population to know. They have been validated by nutrition experts and revised.

I have now prepared a series of multiple choice questions which test these generalizations. Some of them will be eliminated and some revised based on your comments and pretest results. I would appreciate it if you would:

1. Indicate test items that do not test the generalizations.

2. Indicate your approval or disapproval of any test items.

3. Make any other comments you would like.

Thank you for your time and cooperation in evaluating this material. I would very much appreciate receiving the completed materials by December 18. Thank you again.

Respectfully yours,

Marie Corey

Iowa State University
Ames, Iowa 50011
December 1, 1978

To the Evaluation Specialists:

This letter is to request your assistance in one phase of the research which I am undertaking for my doctoral thesis.

I have prepared generalizations and supporting facts in nutrition important for young adults in the general population to know. They have been reviewed by nutrition experts and revised.

I have also prepared a series of multiple choice questions which test these generalizations. I would appreciate it if you would:

1. Classify each of the test items using Bloom's taxonomy for the cognitive domain.

2. Make any comments you would like about the test items.

Thank you for the time and cooperation in evaluating this material. I would very much appreciate receiving the completed materials by December 18. Thank you again.

Respectfully yours,

Marie Corey

Iowa State University
Ames, Iowa 50010
May 3, 1979

To the Expert Judges:

This letter is to request your assistance in one phase of the research which I am undertaking for my doctoral thesis.

I have prepared generalizations and supporting facts in nutrition important for young adults in the general population to know. For validation, they have been reviewed by nutrition experts and revised.

I have also prepared a series of multiple choice questions which test these generalizations. Revisions have been made based on your comments. Since some questions have been changed and some will still be eliminated based on further comments and pretest results, I would appreciate it if you would again:

1. Indicate test items that do not test the generalizations.

2. Indicate your approval or disapproval of any test items.

3. Make any other comments you would like.

Thank you again for your time and cooperation in evaluating this material. I would very much appreciate receiving the completed materials by May 18. Thank you again.

Respectfully yours,

Marie Corey

Iowa State University
Ames, Iowa 50011
May 3, 1979

To the Evaluation Specialists:

This letter is to request your assistance in one phase of the research which I am undertaking for my doctoral thesis.

I have prepared generalizations and supporting facts in nutrition important for young adults in the general population to know. They have been reviewed by nutrition experts and revised.

I have also prepared a series of multiple choice questions which test these generalizations. Revisions were made based on your comments. Since some questions have been changed, I would appreciate it if you would:

1. Classify each of the test items using Bloom's taxonomy for the cognitive domain.

2. Make any comments you would like about the test items.

Thank you for your time and cooperation in evaluating this material. I would very much appreciate receiving the completed materials by May 18. Thank you again.

Respectfully yours,

Marie Corey

APPENDIX D. CONSENT FORM FOR HUMAN SUBJECTS IN RESEARCH

NUTRITION KNOWLEDGE QUESTIONNAIRE

Food and Nutrition Department
Iowa State University
Ames, Iowa

This questionnaire is designed to assess nutrition knowledge of young adults. Answering the questions in this questionnaire will take about 25-30 minutes of your time. The computer-scored answer sheet should be filled out with a No. 2 lead pencil which will be provided. The circle on the answer sheet corresponding to the best answer to each question should be darkened.

The results will be an indication of the nutrition knowledge of this group. Results from questionnaires of this kind can be reported and used in formulating plans for programs designed to improve nutrition knowledge of young adults.

No risk nor discomfort will be involved.

Any questions that you have will be answered by the person administering the questionnaire.

You do not need to participate in completion of this questionnaire if you would rather not and you may withdraw consent and discontinue participation at any time.

All of the information obtained will be held strictly confidential and will not be released to unauthorized persons.

PARTICIPANT INFORMED CONSENT

I freely agree to participate in the completion of this nutrition knowledge questionnaire designed by a staff member at Iowa State University.

I understand fully what I am being asked to do from reading carefully the materials given to me and from listening to the verbal explanation by the investigator.

I understand that I may withdraw at any time.

Participant

Date ____________________ Signature ____________________________

APPENDIX E. QUESTIONNAIRE ORAL DIRECTIONS

1. Please do not make any marks on the test copy. Answers are to be placed on a computer-scored answer sheet.
2. Use only a No. 2 pencil which is provided to mark your answer.
3. On your answer sheet there are five spaces available for answers. The test you will take is multiple-choice with each item having three possible choices. You will mark "A, B, or C" as your answer.
4. After carefully reading over the test item, select the response that you consider <u>best</u> and darken in its corresponding letter on the answer sheet.
5. You are to answer all test items. You will not be penalized for guessing.
6. If you decide to change an answer after you have marked it on your answer sheet, erase the mark completely and darken your next choice.
7. Do not mark more than one choice to a number.

APPENDIX F. HOME ECONOMISTS ADMINISTERING QUESTIONNAIRE

Mary Chernesky, Cerro Gordo County

Ester Mae Cox, Taylor County

Dorothy Eyberg, Union County

Peggy Haafke, Woodbury County

Susan Harris, Polk County

Sherrie Ilg, Scott County

Paula Keefe, Black Hawk County

Lorine Matters, Tama County

Pam Millang, Decatur County

Marilyn J. Olson, Dubuque

Harriet Smith, Jasper County

Patricia Steiner, Des Moines County

Susie Utoff, Benton, Jones and Linn Counties

Carol Van Waardhuizen, Webster County

APPENDIX G. NUTRITION KNOWLEDGE QUESTIONNAIRE BOOKLET FOR PARENTS

IOWA STATE
UNIVERSITY

Food and Nutrition Department
107 MacKay Hall
Ames, Iowa 50011

Telephone 515-294-4432

February, 1980

for Fathers only

Congress has made funds available for nutrition education programs for children and parents. Your assistance is being requested in helping us to determine what parents of Iowa school children currently know about nutrition. Results from this questionnaire can be used to improve programs in nutrition education and evaluate programs which currently exist.

The questionnaire has been developed at Iowa State University and is being used to assess nutrition knowledge in partial fulfillment of requirements for a Ph.D. in Nutrition under the direction of Wilma Brewer, Ph.D., R.D.

This letter is a request for your assistance. Your responses will be confidential. We would appreciate it if you would circle the best answer to each question. We recognize that some of the questions are difficult. Therefore, do not be discouraged if you are unsure of a number of them. Just circle the answer you consider the best one. I would appreciate your help.

Sincerely,

Marie Corey

Marie Corey, M.S., R.D.

parents
and children
good nutrition
partners

Select the answer you consider the best one for each item.

Q-1 Snacks can be planned nutritionally along with meals. Good snack items to go with the following meals for Martie (age 7) would be:

Tomato Juice	Tuna Salad Sandwich	Chicken, Lettuce, Tomato
French Toast	(1 slice bread)	Sandwich (2 slices bread)
Butter/Syrup	Celery Sticks	Grapes
	Strawberries	Iced Tea
	Milk	

A. BLUEBERRY MUFFINS, BANANA
B. PEANUTS, APPLESAUCE
C. APRICOTS, CHOCOLATE MILK

Q-2 The best way for Americans to assure themselves that they are attaining good nutrition is to:

A. EAT THREE REGULAR MEALS A DAY.
B. EAT A WIDE VARIETY OF DIFFERENT KINDS OF FOOD.
C. INCLUDE VITAMIN-MINERAL SUPPLEMENTS IN THEIR DIETS.

Q-3 The energy value of carbohydrates is:

A. ABOUT EQUAL TO THAT OF PROTEINS.
B. MORE THAN TWICE THAT OF FATS.
C. LESS THAN THAT OF PROTEINS AND FATS.

Q-4 Complete the analogy: calcium is to strong bones as vitamin A is to healthy:

A. NERVES.
B. SKIN.
C. CONNECTIVE TISSUE.

Q-5 Calcium is essential in small amounts in the body for:

A. CONTRACTION OF MUSCLES.
B. RESISTANCE TO INFECTION.
C. MAINTENANCE OF CONNECTIVE TISSUE.

Q-6 Three of the B-complex vitamins, thiamin, riboflavin and niacin, are needed primarily:

A. FOR RELEASING ENERGY FROM ENERGY-YIELDING NUTRIENTS.
B. AS CARRIERS FOR IRON AND CALCIUM IN THE BODY.
C. TO FORM THYROXINE FOR METABOLISM OF NUTRIENTS.

Q-7 Vitamin C intake is necessary for:

A. PREVENTING COLDS.
B. MAINTAINING CONNECTIVE TISSUE.
C. ABSORBING POLYUNSATURATED FATS.

Q-8 Vitamin D is important because the body changes it to a substance that:

A. HELPS MAINTAIN HEALTHY SKIN.
B. IMPROVES CALCIUM ABSORPTION.
C. COMBINES WITH MINERALS IN BONES AND TEETH.

Q-9 Iodine is used by the body to form a hormone which regulates:

A. ENERGY METABOLISM.
B. MUSCLE CONTRACTION.
C. BODY TEMPERATURE.

Use the following information to answer questions 10-14.

Angela	Sue	
Just starting to walk	Chemist	
Age: 11 months	Age: 28	
Height: 2'4"	Height: 5'7"	
Weight: 20 lbs.	Weight: 132 lbs.	
Bob	**Dave**	**Carl**
High school wrestler	Gymnastics coach	Construction foreman
Age: 15	Age: 26	Age: 54
Height: 5'7"	Height: 5'9"	Height: 5'9"
Weight: 134 lbs.	Weight: 154 lbs.	Weight: 154 lbs.

Q-10 In comparing the nutrient needs of Angela and Sue, Angela needs:

A. CERTAIN NUTRIENTS THAT SUE DOES NOT.
B. LARGER QUANTITIES OF SOME NUTRIENTS.
C. MORE OF MOST NUTRIENTS PER POUND OF BODY WEIGHT.

Q-11 Bob's nutrient needs differ somewhat from the nutrient needs of Dave and Carl. The most marked difference for people Bob's age generally is their higher need for:

A. CALCIUM AND VITAMIN A.
B. VITAMIN A AND IRON.
C. IRON AND CALCIUM.

Q-12 Dave needs more protein than Sue. The primary reason is that:

A. DAVE IS LARGER THAN SUE.
B. DAVE IS YOUNGER THAN SUE.
C. DAVE IS MORE ACTIVE THAN SUE.

Q-13 In comparison with the nutrient needs of Dave, Carl probably needs:

A. MORE PROTEIN.
B. LESS VITAMIN E.
C. SIMILAR AMOUNTS OF VITAMIN A.

Q-14 If Dave had major abdominal surgery, which nutrient would he need in increased amounts to form new tissue?

A. MAGNESIUM
B. VITAMIN C
C. VITAMIN D

Q-15 Tom needs 50 grams of protein per day. His regular diet supplies adequate sources of energy from carbohydrate and fat as well as 90 grams of protein per day. Most of the extra protein will be:

A. CHANGED TO FAT AND STORED.
B. USED TO FORM MORE MUSCLE.
C. LOST FROM THE BODY.

The next two questions refer to differences in body storage of different nutrients.

Q-16 In comparison with symptoms of vitamin D deficiency, symptoms of a deficiency of vitamin C would probably be seen in:

A. A MUCH SHORTER TIME.
B. ABOUT THE SAME AMOUNT OF TIME.
C. A MUCH LONGER TIME.

Q-17 If Jean's intake of some nutrients from supplements she is taking greatly exceeds her need for them, which nutrient would most likely be harmful to her health?

A. RIBOFLAVIN
B. VITAMIN A
C. CALCIUM

Q-18 Tim (age 48) has had a heart attack. His blood pressure is above normal, his serum cholesterol is elevated and he is 15 lbs. overweight. In order to help correct some of the problems, his physician may ask him to consume more foods containing polyunsaturated fat and to limit his intake of sodium, saturated fat, cholesterol and:

A. VITAMIN E.
B. KILOCALORIES.
C. CALCIUM.

Q-19 If Nancy's average daily intake of energy is 2000 kilocalories and her average expenditure is 1800 kilocalories per day, in two months her body fat tissue content will increase:

A. BY 3-4 POUNDS NO MATTER WHAT NUTRIENTS THE EXTRA ENERGY IS FROM.
B. By 8-9 POUNDS WHETHER THE EXTRA ENERGY IS FROM CARBOHYDRATE, PROTEIN OR FAT.
C. MORE IF THE ENERGY IS FROM CARBOHYDRATE THAN IF IT IS FROM PROTEIN.

Q-20 Kathy, age 19, could lose 3 pounds of excess fat tissue in:

A. ABOUT THREE DAYS IF SHE EATS HALF AS MUCH FOOD AS HER USUAL 2000 KILOCALORIE INTAKE.
B. LESS THAN A WEEK IF SHE BEGINS TO SWIM AN HOUR EACH DAY (400 KILOCALORIES PER HOUR).
C. ABOUT THREE WEEKS BY EATING THREE-FOURTHS AS MUCH FOOD AS HER USUAL 2000 KILOCALORIE INTAKE.

Q-21 John is trying to lose weight. He plans to begin bicycling 8 hours per week (250 kilocalories/hour). For an average loss of two pounds of fat tissue per week he will also need to reduce the daily energy value of his usual diet by about:

A. 500 KILOCALORIES.
B. 750 KILOCALORIES.
C. 1000 KILOCALORIES.

Q-22 Don (age 71) uses approximately 300 kilocalories less energy each day now than when he was 21 years old. His energy intake from food has stayed about the same. Approximately how many pounds of fat tissue would he gain in six months?

A. 5 POUNDS
B. 10 POUNDS
C. 15 POUNDS

Use the following three daily intakes of food to answer questions 23 and 24.

The same breakfast was eaten each day:

1/2 c. Orange Juice
3 Pancakes
2 tsp, Margarine
2 tbsp, Syrup
1 c, 2% Milk

Day 1	Day 2	Day 3
1/4 of 16" Hamburger Pizza	3 oz. Roast Chicken	3 oz. Roast Beef
1 c. Tossed Salad	1/2 c. Rice	1/2 c. Mashed Potatoes
2 tbsp. Vinegar and Oil	1/2 c. Carrots	1/2 c. Lima Beans
Salad Dressing	1/2 c. Green Beans	1/2 c. Corn
1 serving Apple Pie	1 large Apple	1 c. 2% Milk
1/2 c. Ice Cream	1 c, 2% Milk	1 c. Spaghetti with
1 c. Whole Milk	1 c, Beef Noodle Soup	2 Meat Balls
1 Breaded Pork Chop	8 small Saltine Crackers	1 piece French Bread
1/2 c. Scalloped Potatoes	2 tsp. Margarine	1 tsp. Margarine
1/2 c. Asparagus with Cheese	1/2 c. Coleslaw	1 c. Tossed Salad
1/2 c. Butterscotch pudding	1 c. 2% Milk	2 tbsp. French Dressing
12 oz. Pepsi	12 oz. Coke	1 c. Chocolate Milk

Q-23 How do the above intakes compare in energy value?

A. DAY 1 CONTAINS MORE ENERGY THAN THE OTHER TWO DAYS.
B. DAY 2 CONTAINS LESS ENERGY THAN DAY 3 BUT MORE THAN DAY 1.
C. DAY 3 CONTAINS LESS ENERGY THAN THE OTHER TWO DAYS.

Q-24 Jim (age 32) ate the foods listed above for Day 3. When looking at the nutrient contributions from the day's intake, beef is a poor source of:

A. IRON, BUT THERE IS AN ADEQUATE AMOUNT AVAILABLE FROM THE PANCAKES, LIMA BEANS, CORN AND FRENCH BREAD.
B. CALCIUM, BUT THERE IS AN ADEQUATE AMOUNT AVAILABLE FROM THE 2% AND CHOCOLATE MILKS.
C. NIACIN, BUT THERE IS AN ADEQUATE AMOUNT AVAILABLE FROM THE ORANGE JUICE, PANCAKES, AND MASHED POTATOES.

Q-25 Two months ago Gerald was asked to reduce the total number of kilocalories from fat, and to decrease the saturated fat and increase the polyunsaturated fat coming from foods in his diet. Which of the following sets of changes would best accomplish this?

A. SUBSTITUTE A HAM SANDWICH FOR CHEESE PIZZA, CUSTARD PIE (CONTAINS EGGS AND MILK) FOR CHOCOLATE PUDDING, ROAST BEEF FOR A PORK CHOP, AND SOFT MARGARINE FOR BUTTER ON A BAKED POTATO.
B. SUBSTITUTE TOMATO SLICES FOR A BAKED POTATO, CHEDDAR CHEESE FOR ICE CREAM, WHOLE MILK FOR COKE, AND 1 1/2 TBSP. FOR 2 TBSP. OF SALAD DRESSING.
C. SUBSTITUTE ANGEL FOOD CAKE AND STRAWBERRIES FOR APPLE CRISP AND ICE CREAM, TURKEY AND MAYONNAISE SANDWICHES FOR HAMBURGER PIZZA, SKIM MILK FOR WHOLE MILK, AND LEMON JUICE FOR CHEESE ON BROCCOLI.

Q-26 Which of the following combinations of foods would provide the most calcium if average size servings are eaten?

A. CREAM CHEESE, ENRICHED SWEET ROLLS, SWEET POTATOES
B. CHEDDAR CHEESE, WHITE BREAD, BROCCOLI
C. BUTTER, WHOLE WHEAT BREAD, CAULIFLOWER

Q-27 Which of the following foods could Barb (age 30) eat less than her husband John since it contains little iron?

A. ENRICHED SWEET ROLL
B. COTTAGE CHEESE
C. BROCCOLI

Q-28 The combination of fresh fruits highest in content of vitamin C per serving is:

A. APRICOTS AND BANANAS.
B. WATERMELON AND GRAPEFRUIT.
C. CHERRIES AND PEACHES.

Q-29 The food highest in energy value per serving is:

A. BREAD (1 SLICE).
B. POTATO (1 MEDIUM).
C. PORK CHOP (1 MEDIUM).

Q-30 In order for Peggy to lose weight, which of the following changes would decrease the energy value with the least change in the nutritive value of her diet.

A. SUBSTITUTING SKIM MILK FOR COCOA.
B. SUBSTITUTING MORE MEAT FOR BREAD AND POTATOES.
C. OMITTING THE BREAD AND POTATOES.

Use the following information to answer question 31.

Breakfast	Lunch	Dinner	Snacks
1/2 c. Apricot Nectar	Roast Beef Sandwich	1 Pork Chop	1 c. Chocolate Milk
1 c. Oatmeal with	(2 1/2 oz. beef,	1/2 c. Green Beans	1 Apple
1/2 c. Milk	2 slices bread)	1 piece Apple Cake	
	1/2 c. Broccoli	1 glass Iced Tea	
	1 Oatmeal Cookie		

Q-31 John, age 7, to meet recommendations for his nutrient intake would alter the above meals by substituting

A. ORANGE JUICE FOR APRICOT NECTAR AT BREAKFAST.
B. MILK FOR ICED TEA FOR DINNER.
C. A PEANUT BUTTER SANDWICH FOR THE CHOCOLATE MILK.

Q-32 Joan wants to select doughnuts with the best nutritional value. She will select those which are:

A. MADE WITH ENRICHED FLOUR.
B. FORTIFIED WITH VITAMINS C, D, AND E.
C. MADE WITH YEAST WHICH SUPPLIES B-COMPLEX VITAMINS.

Q-33 Mark has a broken leg. He needs lots of calcium and other nutrients found in milk but does not like to drink it. Which of the following foods could he best substitute for milk nutritionally?

A. CREAM CHEESE
B. BUTTER
C. YOGURT

Q-34 Sally (age 7) is eating at a fast food restaurant in the evening with a friend. She has already eaten 1 serving of each of the following foods during the day--orange juice, cinnamon roll, milk, chicken salad sandwich (1 slice bread), carrot sticks, green beans, jello with bananas, iced tea, apple, salted popcorn. Which group of foods could she order to complement nutritionally the other foods she has eaten?

A.	B.	C.
REGULAR FISH SANDWICH	REGULAR CHEESEBURGER WITH LETTUCE AND TOMATO	SMALL CHEF'S SALAD (LETTUCE, 3 STRIPS HAM, 3 STRIPS CHEESE)
FRENCH FRIES	SMALL MILKSHAKE	CHERRY PIE
COLESLAW		TEA
SMALL COKE		

Q-35 How much ice cream would supply the same amount of calcium as 1 cup of milk?

A. LESS THAN 1 CUP
B. 1 CUP
C. MORE THAN 1 CUP

Q-36 Whole wheat and white enriched bread are very:

A. SIMILAR IN NUTRITIONAL VALUE.
B. DIFFERENT IN PROTEIN CONTENT.
C. DIFFERENT IN ENERGY VALUE.

Use the following information to answer questions 37 and 38.

Product 1 - Turkey, turkey broth, peas, carrots, water, starch, flour, salt, chicken fat, colors and flavors.
Product 2 - Turkey broth, peas, turkey, carrots, flour, shortening, water, potatoes, colors and flavors.
Product 3 - Turkey broth, carrots, peas, turkey, starch, potatoes, water, colors and flavors.

Q-37 The ingredients as they are listed on three packages of turkey pies are printed above. Which product is probably highest in vitamin A per serving?

A. PRODUCT 1
B. PRODUCT 2
C. PRODUCT 3

Q-38 Which one of the above products is probably highest in protein per serving?

A. PRODUCT 1
B. PRODUCT 2
C. PRODUCT 3

Q-39 Losses of vitamins A and C can occur during storage and preparation of broccoli. Which statement best describes the relative nutrient losses? If fresh broccoli is:

A. REFRIGERATED UNCOVERED FOR A WEEK, THERE WILL BE A GREATER LOSS OF VITAMIN A THAN VITAMIN C.
B. COOKED IN BOILING WATER, THERE WILL BE A GREATER LOSS OF VITAMIN C THAN VITAMIN A.
C. KEPT AT SERVING TEMPERATURE FOR AN HOUR, THERE WILL BE A GREATER LOSS OF VITAMIN A THAN VITAMIN C.

Q-40 A nutrient which is added in enriching bread is:

A. CALCIUM.
B. PROTEIN.
C. IRON.

Q-41 Roast beef should be cooled quickly after a meal because:

A. SUBSTANTIAL LOSSES OF IRON CAN RESULT FROM HOLDING THE MEAT AT WARM TEMPERATURES.
B. FOOD POISONING IS POSSIBLE EVEN IF THE MEAT IS HEATED BEFORE IT IS EATEN AGAIN.
C. MEAT PIGMENTS CAN CHANGE CAUSING SIGNIFICANT NUTRITIVE CHANGES IN THE MEAT.

Q-42 In which of the following situations is the food most likely to be unsafe to eat?

A. BANANA CREAM PIE--BAKED AND STORED COVERED ON THE KITCHEN COUNTER OVERNIGHT.
B. TUNA, MAYONNAISE AND PICKLE RELISH SANDWICH FILLING--PREPARED AND STORED COVERED IN THE REFRIGERATOR FOR ONE DAY.
C. CANNED GREEN BEANS--OPENED AND STORED COVERED IN THE CAN IN THE REFRIGERATOR FOR TWO DAYS.

Q-43 The ability of a meal to supply psychological satisfaction is least dependent upon:

A. THE CHOICE OF FOODS SELECTED FOR THE MEAL.
B. THE WAYS IN WHICH THE FOODS ARE PREPARED.
C. THE CONTENT OF ESSENTIAL NUTRIENTS.

Q-44 Children who accept a wide variety of fruits and vegetables have been influenced primarily by the:

A. MARKET AVAILABILITY OF MANY FRUITS AND VEGETABLES.
B. KINDS OF FRUITS AND VEGETABLES PREFERRED BY THEIR PARENTS.
C. KNOWLEDGE THAT FRUITS AND VEGETABLES ARE A GOOD SOURCE OF NUTRIENTS.

Q-45 When compared with foods grown with the use of commercial fertilizers and pesticides, those foods grown with natural fertilizers and no pesticides generally:

A. ARE MORE NUTRITIOUS.
B. HAVE HIGHER CROP YIELDS.
C. ARE MORE EXPENSIVE.

The food costs for some dairy products are listed below:

Cheddar Cheese	$2.65/lb. chunk
Cheddar Cheese Spread	2.79/2 lb. (e.g., Velveeta)
Skim Milk	.93/half gallon carton
Cottage Cheese	.75/12 oz. carton (uncreamed)
Ice Cream	1.69/half gallon carton
Low-fat Milk	.96/half gallon carton

Q-46 Which of the following combinations of foods contains the most calcium for the least cost?

A. CHEDDAR CHEESE SPREAD, SKIM MILK.
B. COTTAGE CHEESE, ICE CREAM.
C. CHEDDAR CHEESE, LOW-FAT MILK.

Q-47 Which of the following meals contains the most nutritional value for the usual amount of money spent?

A.	B.	C.
HAMBURGER SANDWICH TOMATO AND ONION	CHICKEN AND NOODLES	SPAGHETTI AND MEAT BALLS
ASPARAGUS WITH CHEESE SAUCE	PEAS AND CARROTS	TOSSED SALAD, DRESSING
PEACH PIE	ENRICHED BREAD, MARGARINE	FRENCH BREAD, GARLIC BUTTER
ICE CREAM	CHOCOLATE CHIP COOKIES	CHOCOLATE CAKE
	SKIM MILK	ICE CREAM

Q-48 Which of the following meals contains the most nutritional value for the usual amount of money spent?

A.	B.	C.
BUFFET HAM SLICE	T-BONE STEAK	RUMP ROAST
SPICED APPLE RING	BAKED POTATO, SOUR CREAM	SCALLOPED POTATOES
SPINACH AND SESAME SALAD, DRESSING	LETTUCE SALAD, DRESSING	BROCCOLI
CHERRY PIE	COFFEE	PUMPKIN PIE
		ICED TEA

Q-49 An example of a convenience product which is less expensive than its home-prepared counterpart is:

A. FROZEN CONCENTRATED ORANGE JUICE COMPARED WITH FRESH ORANGE JUICE.
B. PURCHASED YOGURT COMPARED WITH HOME-PREPARED YOGURT.
C. FROZEN CHOCOLATE CHIP COOKIES COMPARED WITH HOME-PREPARED CHOCOLATE CHIP COOKIES.

Q-50 When Carol is dieting she finds that the best of the following ways to lose weight is to:

A. SUBSTITUTE FOODS THAT HAVE A HIGHER WATER AND FIBER CONTENT THAN THOSE NOW CONSUMED.
B. DIVIDE HER CURRENT FOOD INTAKE INTO SIX OR SEVEN MEALS RATHER THAN FEWER.
C. TAKE LONGER TO EAT THE MEALS AND SNACKS THAT SHE CURRENTLY CONSUMES.

What is your age? (Check the correct category)

_____ Under 25
_____ 25-35
_____ Over 35

The last four digits of your social security number are: _____
This number will be used for scoring.

Is there anything that you would like to comment on or ask us? If so, please use this space for that purpose.

Your contribution to this effort is greatly appreciated. Please print your name and address on the back of the return envelope. We will send you your score and any specific information you have requested at a later date.

APPENDIX H. ANSWER KEY TO NUTRITION KNOWLEDGE QUESTIONNAIRE

1. C
2. B
3. A
4. B
5. A
6. A
7. B
8. B
9. A
10. C
11. C
12. A
13. C
14. B
15. A
16. A
17. B
18. B
19. A
20. C
21. B
22. C
23. A
24. B
25. C
26. B
27. B
28. B
29. C
30. A
31. B
32. A
33. C
34. B
35. C
36. A
37. C
38. A
39. B
40. C
41. B
42. A
43. C
44. B
45. C
46. A
47. B
48. C
49. A
50. A