THE RELATIONSHIP OF NUTRITION KNOWLEDGE STRUCTURES TO ACCURACY OF FOOD LABEL INTERPRETATION IN ADULTS

Myrtle R. McCulloch

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APPROVED

A.K. Wiswell, Chairperson

M.G. Cline

H.W. Stubblefield

R.L. Mc Keen

M.K. Korslund

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Committee Chairperson: Albert K. Wiswell
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(ABSTRACT)

A new, standardized food label developed by the Food and Drug Administration is appearing on products this year. Extensive research on consumer use suggests that approximately 20 % of the U.S. population, composed mainly of elderly and minorities, cannot correctly interpret the nutrition information on the label. This research explored the specific knowledge required for correct interpretation based on a model in which nutrition knowledge was organized in hierarchical levels: food groups, macronutrients and micronutrients in foods, with each level including dimensions of nutrition terminology, health relationships and related mathematics skills.

An instrument was developed and pilot tested to measure knowledge at each level, as well as to measure accuracy in food label interpretation. Test items were revised based on peer input, correlational data, item analysis, and reliability. The revised instrument was then administered to purposive samples of adults (250 subjects) representing the range of nutrition knowledge measured by the test. Scores were re-analyzed to establish the validity and reliability of the new instrument.

Factor analysis was used to explore the value of the original hierarchical model and to posit an additional model based on conceptual complexity. Hierarchical multiple regression was used to predict accuracy of food label interpretation based on factors depicted by both models.

Findings indicated that the structures outlined in each model are useful predictors of food label interpretation, accounting for over 52 percent of the variance. Suggestions are made for further development of the test instrument and on how to incorporate learner pre-assessment in designing nutrition education interventions.

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CHAPTER ONE

INTRODUCTION

Background of the Problem

Nutritionists face an educational challenge: helping consumers interpret the new food label, as well as helping them to use these acquired skills in making healthy food choices. This must all be done in the context of a complex food market.

The New Food Label. The Food and Drug Administration (FDA) developed a new food label in the Spring of 1993 (Appendix A, p.140). As of May 1994, all products, including some not previously required to be labeled, must carry a standardized format for reporting the nutritional content of a food. The Nutrition Labeling and Education Act of 1990 (Public Law 101-535. 104 Stat.2353) called for activities to educate consumers about the use of nutrition information on the new food labels in order to facilitate making healthier food choices. Both the FDA and the USDA have launched an extensive campaign directed at educating the public on the effective use of these labels.

The National Exchange for Food Labeling Education (NEFLE), has been established by the FDA and USDA to co-ordinate educational activities designed to promote the use of the food label. The campaign's education goals are to stimulate interest in the use of the information on the label, to enable consumers to make nutritious food selections, and to encourage "confidence" and "credibility" in food labeling information (NEFLE, 1992, p.2). As of January of 1993, there were seventy-one education projects designed and developed by private and government groups to facilitate the use of the label (NEFLE Data Base, Agricola, 1992). Two conferences, one in September of 1992 and another in June of 1993 were organized by NEFLE to bring together researchers, education professionals, government agencies, and food manufacturers to address various issues ranging from research and educational materials development to effective communications and partnership formation.

Extensive research has gone into the design, content, and final format of this label. The American Dietetic Association (ADA), representatives from the food industry, consumer interest groups, and other professional organizations have addressed issues regarding how nutritional information should be determined and presented on the labels. An important position taken by the ADA was that an effective nutrition education program should be initiated when the new labels appear on foods, one that aims at educating the consumer to conceptualize household measures and understand the nutritional values represented on the label (Hess, 1991).

The Human Nutrition Information Service (HNIS), a branch of the USDA, conducted two nationwide surveys in 1989, the Diet and Health Knowledge Survey (DHKS) and the Continuing Survey of Food Intakes by Individuals (CSFII). As of June of 1993, the USDA was in the process of combining the data from the two surveys in an attempt to establish relationships between what people eat, their a nutrition label is an educated woman, living with others, who knows about nutrition, is concerned about the quality of the food she buys, and believes that following the Dietary Guidelines for Americans is important to good health. The person least likely to use it is a male, living alone, who is less educated, less knowledgeable about nutrition, less concerned about the quality of the food purchased, and who finds the Dietary Guidelines unimportant (Welsh, 1992; Cleveland, 1992).

In September of 1990, the U.S. Department of Health and Human Services released a set of 298 goals for increasing the span of healthy life for Americans. Twenty-two of these goals were nutrition related, involving reductions in cholesterol, saturated fat, sodium, and kilocaloric intakes, and increases in calcium and iron. These nutrients feature prominently in the new food label. One goal in the above mentioned document, is "to increase, from a baseline of 75% to at "least 85%, the proportion of people aged 18 and older who use food labels to make nutritious food selections (U.S. DHHS, 1990, p.12)."

The development of the new label was based on extensive research by the FDA. The last two large-scale, nationwide experimental studies, one testing label formats (Levy, Fein, and Schucker, 1992), and the other testing format preference and accuracy of interpretation (Levy, Fein, and Schucker, 1992), suggested that, while most people were able to understand the information presented on the label, approximately 20% of adults could not. The people exhibiting difficulty with label use were predominantly of lower educational backgrounds, older Americans, and minorities. The proportion was essentially the same regardless of label format.

Although the inability to make correct interpretations or to exhibit knowledge about nutrition and food labels is not limited to these populations, they represent high risk groups who should be targeted for educational interventions that are designed to increase their knowledge and ability to make nutritious food choices.

Improving Nutrition Education Outcomes. Adult education approaches to nutrition education interventions may increase outcomes and credibility for the profession. The role of nutrition in health care delivery is still a concept not fully accepted. In medicine, nutrition plays a vital role in the control or treatment of certain diseases. The role of the nutritionist as an "intervention specialist" is one that the medical profession is only just beginning to fully recognize (Insull, 1992). Nutrition education is designed to improve eating habits and facilitate food choices through knowledge about foods, the nutrients they contain, and their importance in promoting and maintaining health (Johnson and Johnson, 1985). However, as Smith and Lopez (1991) and several other authors cited in the literature review of this document have indicated, nutrition knowledge does not always bring about desired behavioral changes in the learner. One contributing factor may be the apparent failure to effectively communicate complex, scientific knowledge into content that is comprehensible, acceptable, and easily implemented by adult learners regardless of levels of intelligence, socio-economic or cultural backgrounds (Greene, 1990; Sullivan, Schiller, and Horvaths, 1990). Another factor may involve the profession's approaches to nutrition education interventions.

It is possible that this apparent failure to document change may be one of the reasons for the under use of nutrition services or the slow response by insurance carriers to recognize the value of nutrition education in health care.

<u>The Need for a Paradigm Shift</u>. This study focuses on an approach to nutrition education with the learners' needs as a primary objective. There has been some movement by the profession to accommodate learner needs in nutrition education interventions. The ADA set up a task force to examine the dissemination of nutrition education to the public. In January of 1990, it presented a position paper in which nutrition education was defined as a process by which the public could apply knowledge from the science of nutrition to the improvement of food practices, and recognize these practices to be effective in promoting health. It also stressed the importance of educational methods and evaluations that are designed to accommodate the multiple factors that are involved in how and why people make food choices. These approaches would help the public acquire a knowledge base that would help people make the right choices and "develop decision-making skills". For "the public to achieve optimal nutritional health, nutrition education should be incorporated in all appropriate educational systems, health promotion, disease prevention, and health maintenance programs" (ADA, 1990, p.107). The paper stressed that nutrition education program planning should include a research base for knowledge, audience

identification, settings, program development, and evaluation. Recognizing that people will only make changes in their eating habits if they are committed to change, nutritionists could foster this commitment by encouraging people to set their own goals, respecting and incorporating them and the knowledge base from which they came into a learning situation. The paper also emphasized the need to provide settings conducive to learning where the nutrition educator becomes a learning facilitator rather than merely an information provider (ADA, 1990). This position makes it evident that the ADA is formulating a unique philosophy of nutrition education and is on the verge of a paradigm shift which is ideally suited to the concepts outlined in the model under investigation in this study. Equally important in designing nutrition education programs is the understanding of the epistemology of nutrition knowledge or the ways of knowing about nutrition. Nutrition concepts may be learned from the culture or religion in which a person was raised, or the market and home environment where food habits were learned. They may be learned from practice, observation, advertising, or from the media. Nutrition concepts and subsequent food choice behaviors may be influenced by gender (Auld, 1990; Welsh, 1992; Cleveland, 1992), which in turn may be influenced by rules of a particular culture or society.

Nutrition educators function within boundaries that define objectives, regulations, behaviors, and ways of thinking about the field. Traditionally, this paradigm has encouraged practitioners to interpret nutrition and related scientific research and theory, and translate this information to the public (Guthrie, 1989).

Many of the learning situations in which nutritionists engage are still those of superior knowledge being imparted to those ignorant of this material. This puts the learner in the role of dependence, with concomitant loss of autonomy (Achterberg and Trenker, 1990). The educator thus assumes far more responsibility for learning outcomes than necessary or feasible (Mc Guire, Foley, Gorr, and Richards, 1983). Little attempt is made to evaluate prior knowledge or level of interest of the learner. Rather, the intervention traditionally seeks out a problem area, designs an agenda, and delivers it. Perhaps it is time to empower the learner with greater responsibility in the learning process by using that which s/he already knows or wants to know as a foundation for further educational interventions where necessary (Achterberg, 1988). This knowledge base must be evaluated in an effort to clear up misconceptions, to establish the level of understanding of the learner, and to provide a common ground from which to begin an intervention (Guthrie, 1989).

Building on Prior Learning. The literature review in Chapter Two revealed that research has explored numerous ways to make learning more effective or to trace nutrition information processing. Some of these studies have used concept mapping, that is, identifying methods used by learners to move from general to specific ideas (Guthrie, 1989). Other studies have used marketing models aimed at providing strategies for re-defining the traditional nutrition education paradigm (Parks and Moody, 1986; Dunlap, 1986). There is some indication that people tend to over-simplify nutrition concepts when they are too difficult or confusing to comprehend, usually resulting in categorizing food as "bad" or "good" (Wellman, 1990), or that the degree of difficulty of a nutrition concept and how well it is learned may be motivational in that a nutrition and health-related problem becomes a strong motivator for learning (Cleveland and Tippett, 1991).

Based on research and pilot test interviews therefore, it may be possible to postulate that nutrition learning may follow a hierarchical order, one that involves the processing or acquisition of information in varying levels of complexity. It is also reasonable to expect that an individual cannot, or perhaps will not, satisfy higher levels of complexity unless base level comprehension needs are felt or met first. In other words, it may be necessary to know that meat is a source of fat before one can understand or want to know about the different types of fat in foods and move from there to an understanding or a desire to know about the role of fat in the development of heart disease.

The development and presentation of a model depicting this hierarchy is detailed in Chapter Three. However, it is summarized here in order to introduce the reader to its conceptual framework with reference to the preceding discussion. It proposes that nutrition education interventions may be adapted to varying competency levels and different learner needs. While this type of education has been criticized as being reductionistic (Collins, 1983), it may be appropriate when attempting to identify specific skills or performance-based learning (Torshen, 1977; Knowles, 1984) required, for example, to interpret nutrition information on labels.

In the model, nutrition knowledge is depicted on three levels beginning with the major food groups, followed by the macronutrients, and finally the micronutrients in foods.

At each level, dimensions of knowledge with respect to the terminology used in nutrition, diet and health relationships and relevant, mathematic skills are mapped out. It is assumed that people at different knowledge levels within each dimension would interpret and use the information on a food label differently. Pretesting, using a valid and reliable diagnostic instrument, could allow the educator to establish the level of comprehension and competencies that the learner already has. It also permits one to stop at a point where the skills needed are beyond that which the learner possesses or desires. This latter point is important because confusion and boredom may set in when the learner is no longer capable of, or interested in understanding any more of the information being presented, and to pursue it may be counterproductive.

Statement of the Problem

There is an interesting challenge here for nutrition educators, and it may be time to look for new approaches to teaching nutrition. It is no longer valid to merely seek out a problem area, design an intervention, and deliver the message. Rather, new strategies should attempt to address individual learner needs and competencies, evaluate prior knowledge, address the skills required for the intervention, and design an appropriate intervention based on theory.

A new, standardized label is currently required by federal law to be on all food products. The FDA's study on label interpretation has shown that at least 20% of the U.S. population is unable to correctly interpret information on the label regardless of format (Levy, Fein, and Schucker, 1992). This is attributed to specific deficits in nutrition knowledge and related competencies. In order to identify these deficits, a determination must be made of the specific knowledge and skills or competencies required to correctly interpret nutrition labels. Given that there are different levels of complexity in which the food label can be interpreted, it must be determined what knowledge is required at those different levels in order to design appropriate nutrition interventions.

The model on nutrition knowledge being tested in this study may be an effective way to determine past learning, correct any misconceptions, and direct the intervention to the specific level of competency assessed for or by the individual or group under consideration.

Purpose of the Study

The purpose of the study was to design a model which structures nutrition knowledge in the learner at various levels of complexity corresponding to similar levels identified in the new food label and develop an instrument to measure nutrition knowledge as identified by the model.

This study serves three additional purposes:

1. To assess prior knowledge and skills which may be useful in planning objectives, delivery, and evaluation of future educational interventions.

2. To provide nutrition educators with a useful testing instrument which may enhance the learning of new material and be valuable, among other things, in educating the public on the use of the new food label.

3. To focus on the importance of nutrition education strategies both in the profession and in the public.

Research Questions

The following research questions will be addressed in this study:

1.What is the relationship between performance on label interpretation and nutrition knowledge related to the major food groups?

2.What is the relationship between performance on label interpretation and nutrition knowledge related to macronutrients including protein, carbohydrate, fat, and fiber?

3.What is the relationship between performance on label interpretation and nutrition knowledge related to micronutrients including cholesterol, vitamins, and minerals.

4.To what extent is nutrition knowledge represented by a skills level model an accurate predictor of correct food label interpretation?

Significance of the Study

This is an opportune time for nutritionists to play an active role in public health nutrition education and to increase credibility, confidence, and the use of these professionals. The traditional paradigm of providing nutrition information mostly by translating the scientific literature to make it applicable to food choices and generally saturating the public with nutrition information needs review. The protection of the public is at the heart of the process; however, it is still embedded in the same educational paradigms that have not been as successful as they should have been be. It is therefore timely that new approaches be developed to facilitate a very complex problem.

Nutrition educators need evidence that methods to educate the public have been tested and proven to be effective and that these tests are based on theory and research. This study provides a reliable instrument which may be used to pre-test learners prior to initiating an educational intervention. It also provides evidence that knowledge structures exist in the public at varying complexity levels, and that this knowledge base may be used to enhance learning of new material. Additionally, the pre-test instrument may be valuable for use in the massive campaign being launched by various federal and private sectors to educate the public on the use of the new food label.

Definition of Terms

Nutrition information panel. This panel on the new food label is entitled "Nutrition Facts". The information and format must be in accordance with federal regulations and must list calories, calories from fat, and the amounts of specific nutrients that have been identified as being of greatest public health concern. Serving sizes are standardized and include the above- mentioned nutrients contained in a serving.

Servings. Serving size is defined by the FDA and the Federal Safety and Inspection Service (FSIS) as the amount of a food customarily eaten at one time. The new FDA serving sizes are more realistic than those used by manufacturers in the past.

Ingredient listing. Ingredients are listed in descending order of predominance in a product.

Macronutrients. The major nutrients including protein, carbohydrates, fat, and fiber are listed in gram weights.

Micronutrients. Essential micronutrients are measured in smaller metric measures, usually milligrams, micrograms or nutrient equivalents.

Recommended Dietary Allowances (RDA). Average nutrient and energy standards designed to maintain good nutrition have been defined to meet the needs of most healthy people in the United States. These are established by the National Research Council, Committee on Dietary Allowances.

U.S. Dietary Guidelines. These guidelines are dietary recommendations for healthy Americans and constitute the central statement of federal nutrition policy. They are issued by the USDA and the DHHS.

Daily Values. Reference values developed by the FDA for use on the new food labels represent Reference Daily Intakes (RDI's), or values for protein, vitamins and minerals based on population-adjusted means of the RDA. Daily Reference Values (DRV's) for substances such as fat and fiber which do not have an RDA value nonetheless have important implications for health.

Nutrient Content. Contents will be presented on labels not only by weight, but also as a percent of the Daily Value, allowing the consumer to decide whether a food contributes a lot or a little of a selected nutrient.

Delimitations

1. A purposive sample of adults users of food labels representing a wide range of demographic variables were tested.
2. The effects of instruction on knowledge revealed by subsequent test results were not assessed.
4. Actual food choices were not assessed.

Limitations

1. Because the study will use English as the medium of communication, results should not be used to generalize to non-English speaking populations.
2. Because this is a paper and pencil test it requires a 7th to 8th grade reading ability identifed by a Flesch score of 61 (Grammatik, Word-Perfect 6.1).
3. Because the study is testing knowledge, relationship and probable cause, the results may not be generalized to action outcomes or effect.

CHAPTER TWO

A REVIEW OF THE LITERATURE

This chapter will review the literature on nutrition education with an emphasis on its relationship to food label use, accuracy of use, and comprehension. The material will be organized around the following categories: nutrition education philosophies and approaches; food label research; and the organization and assessment of nutrition knowledge for consumers.

Nutrition Education: Philosophies and Approaches.

This section of the review was undertaken to determine whether or not nutritionists regarded themselves primarily as educators or practitioners. This may reveal the existence of a philosophy of nutrition education and how a study like this one may contribute to its development.

A Brief Historical Perspective

The science of nutrition began with the discovery of vitamins in the early 19th century. Dietary intervention was popularized and then as now, was mainly on body weight and exercise. The education of dietitians was confined to hospitals where the preparation, service and teaching of special diets was complementary to other forms of medical treatment. The role of nutrition began to change when in 1915 to 1920 a nutrition survey in Kentucky, later carried out in other states, revealed "a prevalence" of malnutrition among children (Egan, 1981, p.285). This initiated the Social Security Act of 1935 which was aimed, in part, at preventing malnutrition by the distribution of surplus food. By the 1950's the relationship between diet and disease and the long term ill effects of malnutrition became more obvious and nutrition joined the field of preventive medicine.

The inclusion of normal and clinical nutrition education into a medical health care plan was attempted in the 1960's and by the early 70's the Federal Government's Child and Youth Program, some HMO's, and Family Health Care centers also began incorporating nutrition care into their delivery systems (Caliendo, 1981).

Public education became a major function of nutrition practice mainly providing guidance in following specified diets. Except for a few teachers in universities or other formal educational settings, nutritionists still saw themselves primarily as practitioners rather than educators.

The fact that nutrition education was not reaching the public through qualified professionals became evident when the results of a study conducted in 1980 revealed that 68% of the public seemed to depend on television commercials and magazines instead of health professionals for information (Wellman, 1990). Time and space constraints placed on the media abbreviate and disconnect facts, and they are often presented out of context. Science is reported as a form of entertainment, not education (Burnham, 1987). The public wants useful facts given as briefly as possible, and advertising does that by providing goods that protect people from real or imagined ills like a vitamin pill or a single serving of cereal that will counteract poor food habits (Wellman, 1990).

An Educational Focus in the Profession and in Practice

Founded in 1917, the American Dietetic Association (ADA) established professional, educational and practice standards. A new position paper on nutrition education for the public (ADA, 1990) focused on the necessity to empower learners with the knowledge they require to use sound nutrition practices to improve food choices and to recognize the importance of good nutrition in promoting health. In order for "the public to achieve optimal health, nutrition education should be incorporated in all appropriate educational systems, health promotion, disease prevention and health maintenance programs" (p.107).

The evolution of a philosophy of nutrition education. Traditionally, nutrition education was directed at women since they were considered to be the ones responsible for the overall health of the family, including nutritional well-being. This approach may be outdated because, according to Lewin's gatekeeper theory, it is based on the concept of "disconnected theory" (Achterberg, 1988, p. 240) in that women are no longer the sole decision makers with regard to family food choices, yet most nutrition education interventions are still directed at women. Achterberg proposes creating links between nutrition education theory (based on research) and practice, suggesting that the more links that are created the stronger the effect of education. For example, research shows that the family is the strongest component of a society, therefore eating to lower heart disease risk is better taught to the whole family.

Defining a code of values. Nutrition educators also need to define a code of values in order to answer some important questions pertaining to practice. For example, "what gives us the right...to intervene in anyone else's eating habits? and, who deserves our limited resources, individuals or groups with the worst problems (Achterberg and Trenkner, 1990, p.189)"? In order to distinguish between right and wrong in practice, a shared set of standards or a paradigm must guide the profession. Nutrition educators have practiced from a philosophy of paternalism (Achterberg et al., 1990), which is mostly a process of "superior knowledge" being imparted to those "ignorant " of this material. This puts the learner in a dependant role and the educator thus assumes too much responsibility for learning outcomes (McGuire, Foley, Gorr, and Richards, 1983).

Evaluating the impact of nutrition education. Some nutrition education interventions have also been based on the assumption that knowledge gains are responsible for positive dietary changes. Programs that evolve from these assumptions are knowledge-based, content-driven, teacher-centered, and cognitive- goal oriented. Some research suggests that affective based nutrition education approaches may be more effective than those with cognitive goals (Rosander and Sims, 1981). Drawing from social psychology, these authors reveal that attitudinal change may precede behavioral and knowledge change. They tested this theory on participants in a WIC program and concluded that they achieved desirable changes in knowledge, attitudes, and behavior with this approach. Using a more elaborate design and data analysis, Brush, Woolcott and Kawash (1986) re-tested this hypothesis examining their data for relationships between nutrition knowledge, attitude toward nutrition and nutrition behavior. While many previous researchers failed to do so, they found correlations between knowledge and behavior. They point out that their sample was self-selected consisting of highly motivated people who were practicing their knowledge before the educational intervention.

Hart, Alford, and Gorman (1990) designed and tested a module evaluating cognitive and affective concepts on nutrition and concluded that a change in knowledge precedes attitudinal change in the knowledge-attitude-behavior sequence.

Johnson et al.'s, meta-analysis (1985) of research findings from over 300 articles led them to conclude that, generally speaking, nutrition education has led to significant increases in knowledge with some positive attitudes toward healthy eating. They found very little evidence of relationships between knowledge, attitudes and behavior.

Achterberg (1988) believes that attitude and behavior studies need to be supported by more qualitative research in order to reveal the variables that fall between pre-and post-tests and accommodate the complexity of food choice behaviors more accurately.

Approaches to nutrition education based on philosophical models. A traditional, philosophical approach used in nutrition education is the "moral model" (Achterberg et al., 1990, p. 190) which puts the onus of decision-making and control on the client. Since neither the paternal nor the moral models appear to be ideal in most situations, the authors propose compensatory and enlightenment models. In the former, clients are held responsible for a solution to a problem but not for the problem itself. In the latter case, clients are responsible for the problem while the solution is left to the health care providers or other organized programs. Alcoholics and Overeaters Anonymous programs are based on enlightenment models. Compensatory models view the client as a victim of society and therefore not responsible for the problem as much as the solution. These approaches provide a way for people to gain some control of their own lives (Achterberg et al., 1990). The compensatory model better reflects the definition of nutrition education which is a process by which an educator seeks to empower learners to act on food and nutrition related issues in a way that will ultimately free them from an intervention (Achterberg, 1988).

Some individuals need a paternalistic or even a Skinnerian approach (Achterberg et al., 1990), although neither may have universal appeal. This is illustrated in the results of a study where one group of subjects was provided with nutrition information in a brochure using "threat appeal" which stressed what deleterious effects would result by not following a recommended regimen. The other group received material presented as "benefit appeal", stressing the positive effects of the dietary regimen. Neither approach resulted in significant differences in nutrition knowledge gains (Looker and Shannon, 1984).

The idea of empowerment through nutrition education has been put into a political context by Kent (1988), who says that malnourished individuals suffer the consequences of people who are more powerful than they and who possibly have other agendas than those of nutrition relief. Nutrition education designed to empower people would create not only a behavioral objective, but one that encompasses an understanding that change is good. Kent also refers to the work of Drummond on nutrition education in developing countries where the emphasis is on promoting critical thinking or awareness as a way of giving back some of the independence that has been taken away from the people.

Knowledge Transmission Methodologies used by Educators

Nutrition education does not always bring about desired behavioral changes. This may be due in part to an apparent failure to effectively communicate complex, scientific knowledge into content that is comprehensible, acceptable, and easily implemented by adult learners regardless of levels of intelligence, socio-economic, or cultural backgrounds (Greene, 1990; Gussow, 1981).

The use of the media. Nutrition professionals now seek out the public through the very sources the public currently relies on--namely, television, radio, newspapers, and books. A few work through the media of television, but the programs are rarely on popular stations nor at a time that ensures a large viewing public. Public television stations sometimes air programs in nutrition education, for example on cholesterol and heart disease (Daniels, 1993). Nutrition educators need to become more familiar with the various formats used by radio and television (Manoff, 1980, 1981). The ADA has outlined guidelines to implement these strategies in order to open the airwaves to nutrition messages (ADA, 1986). The format may be designed by experts in the media field but the content should be the sole responsibility of the nutritionists (Caplan, 1983). There are apparent problems like language, literacy, and viewer or listener bias brought on by cultural, socio-economic, and other factors. However, one cannot attempt to overcome all the difficulties involved in planning nutrition education interventions (Newell, 1985; Probart, Davis, Hibbard, and Kime, 1989).

Nutrition education programs: formal and informal. It is not possible, within the confines of this study, to review and cite the numerous education programs in which nutrition information is being transmitted directly to the public and sometimes through the training of other health professionals. A brief list includes nutrition education in schools of nursing (Morse, Corcoran, and Perry, 1993), medicine (Young, 1988), and dentistry, with courses ranging from approximately 2 - 5 credits. Nutrition education programs are also offered in elementary, junior, and senior high school (Contento, Manning, and Shannon, 1992). Some of these are often specific programs that may be geared, for example, to cholesterol awareness rather than to structured nutrition information (Mullis, et al., 1987).

The Associations of the American Diabetes, Cancer, Heart, Dietetic, Medical, and Dental offer nutrition education through televised programs, brochures, and conferences for professionals or school based programs. Their research is synthesized and the recommendations often become national policy or provide guidelines for healthy eating. The National Dairy Council provides curriculum packages for use in schools and government operated food programs. Federally funded programs like the Women Infants and Children (WIC) program include a nutrition education component that is mandatory for recipients of food coupons. Even folklore using songs, stories, and drama have been used to deliver nutrition messages (Singer, 1982).

The Ways in which People Learn Nutrition Concepts

A Gallup Poll survey conducted for the ADA in 1990 indicated that 68% of the public get their nutrition information from the media (print or television), with 46% finding this information "very useful" (Wellman, 1990, p.1). Other sources of information included doctors, books, and family with a mere 3% seeking help from dietitians. More than two-thirds of the adults chose food based on misconceptions about how "good" or "bad" the foods were and, accordingly, unnecessarily restricted themselves from the use of foods that are important in maintaining health. Most of the self-imposed restrictions stem from misinformation concerning the role of nutrients in health and disease. Many are eliminating meats and dairy products which provide valuable nutrients, while seeking assurance in multivitamins (48%) and oatmeal (52%). The latter appears to be related to overemphasis by the press and advertising, on research linking oatmeal intake to low blood cholesterol levels. Responses also indicate that while most Americans know quite a lot about nutrition, they cannot apply this knowledge when making food choices. They feel that any food that they enjoy is bad for them, and they feel guilty when they make those choices (Wellman, 1990).

Some data suggest that learning nutrition concepts is related to age, income, or need. The USDA conducts nationwide surveys to gather information on the eating patterns of Americans. In 1990, a Diet Health Knowledge Survey was conducted to determine how consumer knowledge and attitudes affect food choice and nutrient intake (Cleveland and Tippet, 1991). Preliminary data suggest that consumers' perceptions about nutrient intakes regarding fat, saturated fat, and cholesterol are influenced by age. Older women (30-50 years of age) are less likely than younger ones (15-29 years old) to perceive their diets as "about right" with respect to fat intakes. Actual intakes based on 3 days were analyzed to see how close they came to the U.S. Dietary Guidelines for fat. Cleveland suggests that this difference in age and perception of nutritional dietary quality may be motivational, in that older people may find it more important to follow cholesterol and fat recommendations than do younger people and thus keep closer track of dietary intake. Their data also suggests that income is another strongly correlated variable in these findings.

When people were asked if they considered themselves overweight, underweight, or just right, 45% said they were overweight whereas national statistics indicate that 25% of American women are overweight (Cleveland et al., 1991). This indicates the possibility that people make judgments about their weight based on sociological stressors rather than medically recognized factors used in determining weight.

Andragogical Approaches to Nutrition Education

The ADA position paper on nutrition education focuses strongly on adult education (andragogical) approaches to nutrition intervention, recognizing that people will only make changes in their eating habits if they are committed to change, permitted to set their own goals, and if their knowledge and views are incorporated into the learning situations. Educational settings must be conducive to learning and nutrition educators must take on the roles of learning facilitators (ADA, 1990). It is known that everyone processes information differently, and there may even be gender differences (Auld 1990; Rudell, 1984). Auld's study reveals that women have a more complex base of nutrition knowledge as compared to the men, although both genders appear to be similar in what they know or do not know, especially about fat and cholesterol. He found that 80% of the women possess a knowledge base that is subjective and epistemological, relying on their own experiences and knowledge for judging nutrition information and making food decisions. Auld suggests designing nutrition interventions built on what is known about gender and other differences, providing the unknown and clearing up misconceptions as they become evident.

Since the focus of this study may be defined as skills or competency-based training, the literature was reviewed to examine the results of these approaches as they apply to adult education. Collins addressed competency-based approaches by taking the position that "the basis of knowledge resides first and foremost within the knowers themselves" (1983, p. 174). Parker (1981) compared scores on exams after a competency-based course in child development with those obtained after a traditional 12 semester course used in the training of child care providers and found no significant differences in scores obtained from the two approaches. Her test instrument was developed and validated using objectives and outlines from four core courses, including one on health, nutrition, and safety, designed to teach basic skills.

Focusing on calculating nutrients in the diet is not interesting to most people and neither is the idea of food plans and nutrient balance (Light, 1981). What the public seems to need is an understanding of nutrients and their relationship to health and help in selecting better diets. They also need to know that moderation, not deprivation, is the key issue in food choice behavior (Wellman, 1990).

Kent (1988) is critical of assumptions made by nutrition educators about addressing competencies based on agendas designed by governments in formulating nutrition programs. He views this approach as problem solving for others on the assumption that they cannot do it on their own. He attributes this approach as the reason for failure in government sponsored nutrition programs, since most people do not like to pursue a plan they had no part in creating.

LIFESTEPS is a weight management program that has incorporated adult education principles in its design (Ross, 1985). The workbook used by participants encourages examination of current behavior, then a reflection on it in the context of their own lives and experiences, and finally, any changes they plan to make. The LIFESTEPS study, and those of others mentioned above regarding the importance of identifying attitude toward nutrition and subsequent behavior need to be preceded by an assessment of what the learner already knows about nutrition in order to make the experience more meaningful.

Food Label Research

This section of the review will not include the extensive research done on food choice behaviors as an outcome of nutrition education on food labels since these include multi-determined phenomenon which are beyond the scope of this study.

Information Processing Techniques used by Consumers in Interpreting Food Labels

The ability to correctly interpret food labels depends, to some degree, on the information processing techniques used. The characteristics of a label affect the strategies a consumer will use to comprehend and apply the information on the label (Bettman, Payne and Staelin, 1985). Consumers appear to use information in the format in which it is presented rather than changing it to meet their needs. In other words, they do not process information on alternatives which are not presented on the same label and in the same way. Information that must be stored or changed from what is seen at a given time tends to be overlooked (Bettman and Kakker, 1977). The current label requires basic math skills. The consumer must know the differences between gram weights and proportions. A more recent study by Levy et al., 1992), including a more sophisticated quantitative analysis of their study data (Levy, 1993), revealed that consumers make systematic errors in decisions involving what to eat more or less of in a day with respect to gram and milligram declarations. This seems to be related to their prior exposure to health messages, for example, about consuming less fat and cholesterol. However, when the values are presented as a percentage of the daily value they are better able to evaluate the food in the context of the total diet, independent of whether or not they are provided with the Daily Value used to calculate the percentages. This finding supports the research done by Bettman and Kakker (1977) which suggests that consumers have difficulty using information that requires changes or modification.

Brucks et al., (1984) conducted an information processing study based on two assumptions about consumers: one, reference knowledge in order to understand the information, and two, motivation in order to process the information if they perceive it as being useful. Volunteer adults (n=102) were randomly assigned to two groups, experimental and treatment. Using print advertising they varied the product, the nutrient to be targeted and the amount and type of nutrition information. Six levels of information were presented. Level 1 consisted of advertising hype; level 2, a strong claim like "loaded with Vitamin C"; level 3, numeric information for the target (chosen for identification) nutrient indicating high levels as containing "100% RDA" for it; level 4 was the same as level 3, but with a lower level for the target nutrient; level 5, a higher level of target nutrient as in 3; and level 6, a lower level as in 4. Nutrition beliefs about brands were graded on a seven point scale from "very nutritious" to "not very nutritious" relative to other brands. Except for the scale measuring RDA beliefs, no differences were noted between nutrition beliefs about the products related to message treatments. Subjects did not use the quantity of nutrition information to simplify making nutritional evaluations. Rather, the increase in amount of information prevented them from using this information.

Bettman et al., (1985) examined mathematics in food label use with respect to human cognition systems. They cited the theories of George Miller on the two kinds of memory, working and long term, the former being limited to five to seven pieces of information at a time. Multiplying or dividing complex numbers requires this type of memory and assumes that the consumer possesses these skills. If the math is too complex to be called upon by short term memory, most consumers won't make the effort. Simplifying strategies for making label information easier may improve a person's chances for making fairly good decisions however the use of heuristics usually disregards important information thus increasing the possibility of making mistakes. Wellman's report (1990) of the results from the Gallup Poll regarding the tendency of consumers to use simplifying strategies by classifying foods as "good" or "bad", confirms this theory.

Using a paradigm proposed by McGuire (1976), Mazis and Staelin (1982) outlined five stages of information processing that describe crossroads in the way consumers process information that is relevant to label use: exposure, attention, comprehension, retention and retrieval, and decision making.

1. Exposure. Information must be available when needed.

2. Attention. People must be motivated to pay attention and they will do this only if it is relevant to them.

3. Comprehension. People must be able to interpret the information and make it meaningful to them. This means that they must understand the information well enough to be able to encode it into memory. While encoding, people assign their own meaning to the information, which means that if it was not presented clearly, it may be encoded incorrectly.

When consumers already possess a memory structure for organizing new material they are able to encode information with greater ease. In the absence of such structures, information retention will be facilitated if presented within a frame of reference (Bettman et al., 1985, and Moorman, 1990).

4. Retention and retrieval. Short memory limits the ability to do math calculations from a label, although cues facilitate information retrieval from long term memory.

5. Decision making. When making decisions, instead of considering all relevant factors, consumers simplify the process by using only that information which is explicitly provided and in the display form (Bettman et al. 1985).

Research studies have identified complex relationships between the amount of information provided (quantity) and the type or content of the information (quality) with respect to the ability of consumers to interpret labels. When excessive information is presented, consumers made poorer decisions but felt they had done better since they had more information available (Jacoby, Speller, and Kohn, 1974; Patton, 1981; Bettman 1985; Muller, 1984). There were benefits from additional information about each brand, but decision-making was poorer when subjects had to consider more than one brand (Wilke, 1974).

The quality of the information appears to be more important than the quantity (Sproles, Geistfeld, and Badenhop, 1980; Keller and Staelin, 1987). The study by Sproles and his associates, using choice on purchase decisions of blankets and cookers rather than food, found that the quantity of information was not as effective as quality when making purchase decisions.

Some studies focused on consumer preference for more information (Asam and Bucklin, 1973; Opinion Research Corporation/National Food Processors Association, 1990; Geiger, Wyse, Parent, and Gaurth, 1991), and some survey responses indicated that consumers want more relevant information (Hackelman, 1980).

Studies on information load based on demographic variables revealed that predominantly blue collar consumers preferred the least amount of information; predominantly white collar preferred more, but not more complex information; and a third group, also predominantly white collar, preferred not only more, but also more complex information (McCullough and Best, 1980). These results were consistent with those of Levy and his associates (Levy et al., 1992).

The American Meat Institute Roper survey data reported by Bender and Derby (1992) revealed that African Americans, Hispanics, and those with less than a high school education are most likely to say that they pay no attention to serving size information. While most other shoppers say that they are aware of serving sizes included on food labels, most neither find it useful nor pay attention to it.

Elderly consumers and those with limited education have the greatest difficulty using labels to select between two products with differing nutrient quality. Often they see differences where there are none (Levy, Fein, and Schucker, 1991, and Bender et al., 1992). However, more highly educated adults over the age of 65 scored higher on nutrition knowledge tests, and these same subjects also reported more frequent reading of food labels (Fanelli and Abernathy, 1990).

Vandeburg (1981) also found that education was a strong demographic predictor of label reading, but that it interacted strongly with concern about health. In other words people who were not as concerned about health were less likely to use the information, even if they were highly educated. His results on less educated consumers confirmed the results of the studies mentioned above.

Cole and Gaeth (1990) conducted a comparison test using boxed cereals and found that the elderly had difficulty extricating information. For example, they had trouble ascertaining sodium content from a list of nutrients on a label if sodium was not always in the same position in the list. Younger subjects performed this task better. However, when the relevant information was boxed and highlighted and subjects were asked to cross out irrelevant information, the older participants did as well as the younger ones.

On a questionnaire administered to 111 people, 65 years and older, mentally and verbally able volunteers (Fanelli et al., 1990), subjects were asked to mark "correct", "incorrect" or "undecided" to 20 nutrition questions. The proportion of correct answers was 11%. Those subjects performing better tended to be Caucasian. They also did their own shopping and had more schooling than subjects who did less well. Forty percent said they never used the nutrition or ingredient information on the label because, among other things, they could not understand the information.

Those consumers who performed better on various label tasks were more apt to be frequent label readers, usually female, younger, white, and better educated. They were also more likely to be trying to control fat, cholesterol, sodium and caloric intake of their own accord rather than on the advice of a physician (Levy et al., 1992).

Consumers' Ability to use Label Information to do Mathematical Calculations in Diet Planning

FDA studies in 1972 and 1992 revealed consumer opinions that conflicted with previous studies on label use. The 1972 study revealed that consumers did, in fact, use label information to choose between different items, for example the most nutritious brand of peas (Stokes and Haddock, 1972). The 1992 study which reported results from the Health and Diet Survey (Derby and Schucker, 1992) also indicated that a significant number of consumers apparently used labels when selecting foods.

About 30% said that they made decisions about using or rejecting a food after having read the label, usually on canned foods, baked products, and cereals.

Prior to this, studies revealed little, if any, use of label information. In a study of adults over 65, 40% did not use food labels to compare products (Fanelli et al., 1990). Although some consumers used the labels to compare brands, they rarely used them to select food groups to achieve balance in their diets (Glanz and Rudd, 1989).

The subjects used in the information processing study (Brucks, 1984) were also tested on their knowledge of nutrition as well as the use of label information. The test was similar to the one used by Jacoby et al., (1977). The questions asked the percentage of recommended nutrients in a serving, the number of servings that would be required to get 100% of a particular nutrient, and the amount of a nutrient that would be obtained from two servings of the food. The percentage accuracy was 55, 50, and 67 respectively. Test scores for general nutrition knowledge indicated that many subjects were unclear or incorrect in their understanding about the food sources of vitamins and minerals, and most admitted to guessing. The results, which were similar to those of Daly (1976) and Jacoby's group (1977), indicated that tests of general nutrition knowledge and nutrition label information measured different aspects of nutrition comprehension.

More recently, Bender and Derby (1992) reported the results of the surveys conducted for the American Meat Institute by the Roper Organization and for the National Food Processors Association by the Opinion Research Corporation. These surveys revealed that consumers find food labels difficult to understand and that the most difficult information to comprehend technical terms, chemical names, and ingredients were unfamiliar. Some people never read food labels because they were uninterested or had seen the information previously, did not understand the information, or had no time to devote to the task.

Levy et al., (1992) found that consumers are more accurate at finding differences in macronutrients like fat and calories than in micronutrients like sodium or vitamins. However, they found it difficult to interpret the percentages of calories obtained from fat and the differences between saturated and unsaturated fat. In fact, consumers made twice as many errors finding differences where none existed in the nutrients that were of most concern, namely sodium, fat, and cholesterol. When subjects were given a brief explanation of Daily Values before trying to interpret the label, they were better able to estimate daily nutrient requirements in a serving. Consumers who were not briefed had difficulty performing this task and incorrectly assumed that Daily Values apply to all or most people. Having to mathematically compute the number of servings required to meet daily recommendations resulted in more errors (only 20% correct). If a food contained little of a "target nutrient", like fat, they did not understand that they could eat more of other fat containing products, as they stayed within the Daily Values.

Prior to the 1974 food labeling regulations, Daly (1976) conducted interviews with adult food shoppers in New York State. She asked subjects what the percent of the RDA for vitamin D would be in one cup of a certain product. Only three quarters of the answers were correct, even though all the shopper had to do was read the number beside the vitamin on the label. When asked how many cups of the products would supply the total recommendation for the day, only one third responded correctly. She also asked about the functions of several vitamins and minerals. Most knew about calcium and iron, but less than 50% knew about carbohydrates, fat and protein. Daly concluded that most people cannot use the nutrition information on a label if mathematical calculations are necessary. The survey by McCullough et al., (1980) described in this review in reference to educational variables, also measured ability to correctly interpret percentages, ratios, and fractions. When shown a half blackened circle, almost all respondents could identify the fact that 50% was darkened, but almost one-third could not answer correctly about other measures, for example the number of servings needed to obtain 100% RDA if one serving provided 25%. Cards were used to display total fat, with half listing saturated and polyunsaturated fats in grams and the other half in percentages. Subjects were asked which had more total fat, more saturated fat, and which had a higher percentage of saturated fat. Less than half correctly identified the food with more total fat or the greater percent of saturated fat. Those who saw the information in grams performed better with respect to answering correctly but had problems when calculating percentages of those gram weights. When they had to identify the food with a high proportion of saturated fat, performance was better. When shown a square divided into 4 with one quarter colored, less than half could correctly answer what percent was colored.

Even when math-related questions on labels were given as a "take-home" test where pressure was not as intense and calculators or other methods could be used to obtain the correct answers, a large number of respondents failed to answer correctly. The researchers concluded that a substantial number of people have trouble working out the math on a label (Klopp and MacDonald, 1981). These results also support the studies by Bettman et al., (1977) on information processing which concluded that consumers have a tendency to use information as it is presented to them, rather than transforming it to meet their needs.

Type of Information Consumers want on a Food Label

Hackelman (1980) surveyed consumer ratings of the usefulness of 38 pieces of information. The top ten nutrients that they found useful were calories, fat, sugar, carbohydrate, and the micronutrients, cholesterol, iron, and sodium. When asked about carbohydrate listings, 40% said it would be useful to express carbohydrate as content of sugar, starch, and fiber. Only 19% didn't want the breakdown into types of carbohydrates, and most wanted sugars further broken down into types. Consumers seem to be more concerned with serving size, calories, protein, fat, and carbohydrate than with the micronutrients, like vitamins and minerals (U.S.DHEW/USDA/FTC, 1978).

In a nationwide FDA survey based on interviews with 1,374 food purchasers, five percent of the respondents said they found the label confusing (Heimbach and Stokes 1981; Hackelman, 1980). When asked which particular parts were confusing, 15% mentioned the metric system, nutrition terminology, and percentages. Almost no respondents knew what several of the words on the label meant, including riboflavin and polyunsaturated. This may be why only 25% said that they paid any attention to vitamin and mineral information.

Practice and Prior Knowledge Effects on Label Use

The survey by Lenahan, Thomas, and Taylor (1972) included an experiment with nutrition labels in which 4,435 shoppers were interviewed at four different time periods. Two months after the labels were introduced into the store, 26% remembered seeing the labels, 16% understood their purpose, and 9 % said that they had used the labels at least once. Understanding the purpose of the labels increased with the length of time the program was in effect, as measured at 2 and 4 month intervals after the initial introduction. They also measured nutrition knowledge about protein, calories, and calcium in multiple choice format. Before the labels were introduced, correct scores ranged from 65-76%. Four months after the labels were introduced, percent correct scores increased to 78-81%, suggesting that exposure to nutrition labels increased knowledge. Twenty years later, this 20% knowledge gap appears to have remain unchanged (Fein et al., 1992). Addressing educational implications based on the abilities of consumers to use labels these researchers concluded that although practice did improve performance on tasks that require little prior knowledge, tasks that most people already perform well, it did not improve performance on more complex tasks, such as the ability to assess a food in the context of a total diet. When comparing two products to identify nutrient differences or to eat more or less of certain nutrients based on what the products contains, consumers were fairly competent at the task (77.9% accuracy), since these skills require minimal prior knowledge.

When faced with excessive information, consumers focus on only one item or one attribute (e.g. sodium content) when comparing products or brands and when this criterion is met they ignore other brands or attributes (Bettman, 1985).

Accuracy in the Use of Advice Concerning Specific Nutrients

Although the label may educate the consumer indirectly, most people use it to plan a diet that is medically prescribed, to compare products, or to match a claim the advertiser makes (Klinger, 1973; Bender et al., 1992). Consumers mainly want to know about the nutritional value of a food and to compare products, which they seem to do accurately. They also use the nutrition information to rate the overall healthfulness of the food and to judge the food with respect to dietary guidelines and nutrient balance (Levy, et al., 1992), however they are less accurate about fat and calories than sources of Vitamin C, and calories (Stokes and Haddock, 1972).

Relationships between Knowledge, Comprehension and Label Interpretation

Several studies have examined consumer comprehension of food labels. One hundred and seventy-two undergraduate students were given a true/false nutrition quiz

(Jacoby, Chestnut, and Silberman, 1977). The percent accuracy for the various items ranged from 8-90%. When they were asked to estimate the amount of each nutrient needed in their own diets, the students overestimated by at least 4 times the RDAs for all nutrients. The exception was calories, where females were somewhat more accurate than males.

Jacoby, Speeler, and Kohn (1974) conducted six studies, some with college students and some with paid, adult volunteers and concluded that consumers neither acquire nutrition information when purchasing food nor comprehend nutrition information when they receive it. They conducted nutrition label comprehension tests using a card displaying nutrition information for a breakfast cereal. About 56% of 242 shoppers claimed that they used this information when shopping, and most were aware that this information was available. Yet when it came to doing some simple math, many mistakes were made. When asked for the quantities of each of four nutrients in the whole box, which meant multiplying the number of servings in the box by the nutrient value, about 50% answered correctly with older subjects more likely to be wrong. Yet 90% said the label was very clear with respect to the nutrition information listed.

Subjects were also asked the meaning of the terms calories, carbohydrates, fat, and protein. Correct answers ranged from 26% for calories to 4 % for fat, again with older respondents more likely to be wrong. When asked how much of each nutrient was needed daily, about 70% answered correctly for calories, but only 5-14% were correct for the other nutrients.

In a point of purchase study (POP) with 2,000 non-randomly selected shoppers in a supermarket, Russo (1986) used a multiple choice nutrition knowledge test requiring respondents to define nutritious foods in terms of low in calories, high in fiber and vitamins, minerals, and protein, as well as those high in harmful ingredients, such as sodium. While this section tested basic knowledge, more sophisticated knowledge was tested with questions about vitamins and, for example, whether a varied diet would generally provide all the vitamins one needs. A third level of knowledge tested was comparative, requiring subjects to select one of two as the more nutritious food. Scoring for the three types of knowledge was done as a proportion of correct answers with 1.00 being correct answers to all questions on the scale. For the basic knowledge test the proportion correct was 0.64, advanced knowledge, 0.61 and comparative knowledge, 0.44. Due to the type of sample, the results may be questionable. However, they could be interpreted to mean that respondents had a moderate level of nutrition knowledge but that exceeded their capability to identify more nutritious foods based on multiple nutrient content. The comparative knowledge scores were much lower than those reported by Stokes et al., (1972) on questions requiring similar comparisons where respondents had to evaluate only one nutrient.

Ernst et al., (1986) extracted a random sample from one of their control and test site POP intervention surveys to measure nutrition knowledge. They used two sets of questions. In the first, respondents had to select foods that were lower in saturated fat and cholesterol from a list of 15 pairs of foods. The second set consisted of three questions regarding the link between food fats and cholesterol. The three responses were, "correct", "incorrect" and "do not know." The latter was added to discourage guessing. Assuming validity in the tests with regard to measuring intended concepts, their results revealed that people knew less about foods that are low in fat and cholesterol than they knew about the relationships between food fats and blood cholesterol.

Heimbach (1982), reported the results of the FDA's 1980 and 1981 national surveys of 1,500 food purchasers which were designed to test comprehension of nutritional terminology on the label. About 80% of those surveyed understood the term cholesterol to some extent and a little over a third understood each term on the label. Although education was positively related to comprehension, no other demographic variable was.

A food labeling questionnaire was given to 2,305 health care workers, university graduate students, members of health clubs, and people from the general public in which they were asked the recommended dietary allowances for selected nutrients (Schapira, 1990). Only 10% were correct for calcium, vitamin A, salt, and fiber; whereas one-fifth answered correctly for fat. When provided with the information required to calculate the percent fat by weight of a food, only 2% could do it correctly. The authors concluded that the public does not have a conceptual framework for making judgments, say on the fat content of a food, even if the necessary information is on the label. Geiger et al., (1991) in their label format study also found that their subjects who did not use food labels failed to do so because they found the information confusing.

Fullmer (1991) concluded that consumers seem to know more about macronutrients than they do about micronutrients. Although they know about the role of fiber in disease prevention, consumers are not able to identify different types of fiber, recommended intakes or sources. Yet in a trends analysis study about consumer knowledge as it relates to macronutrients like dietary fats and oils (Levy, Fein, and Stephenson 1992), where knowledge was measured in 1983, 1986, and 1988, the 1986 results revealed that consumer knowledge about these nutrients was poor. Out of a total of eleven questions, improvement was seen only on 3 of 4 questions that subjects had scored highest on in the first (1983) testing period. The percentage of correct answers ranged from 10-55% in the first test period and from 17-62% in the last (1988). Improvements were only evident in subjects who had been diagnosed with elevated blood cholesterol levels and those on low cholesterol diets. This time demographics did not affect increases in knowledge scores. In the 1988 survey, health-related criteria played a part in higher scores, but so did the following demographics: white, middle age, and higher education.

Simulating shopping tasks in experimental settings, Jacoby et al., (1974, 1977) conducted studies on consumer purchase decisions in relation to nutrition information availability and use. Their results suggest that consumers do not acquire large amounts of nutrition information while shopping.

Liefeld (1983) reviewed American and Canadian research about consumer knowledge and nutrition comprehension and concluded that the literature was consistent in revealing that people don't have a good knowledge of nutrition. When summarizing the research, he found that people think more about trying to eat sensibly and balancing food intake than they do about macro- and micronutrients. He also found little evidence to suggest that there is a relationship between good dietary practices and nutrition knowledge.

The Importance of a New, Standardized Label

The review thus far has identified the problems that people encountered in their use of previous food labels. Congress responded to consumer needs by passing the NLEA which required the FDA to design a new label which would contain specific information. Standardizing the label contents would hopefully facilitate consumer use of the nutrition information in making healthy food choices.

The ADA released a statement in March 1992 (ADA Courier, 1992) supporting the FDA's labeling changes as a move away from lists of the nutrients present in highest quantities based on the U.S. Recommended Allowances. Then president Judy Dodd pointed to the role of special interest groups and the sales of nutrient supplements for the excessively high ranges, adding that today's nutrition problems often involve excesses of certain nutrients rather than deficits.

Misleading health claims have led to a general mistrust of labels by consumers (Lewis and Yetley, 1992). Focus group data revealed that nutrient content descriptors like "lite" were considered helpful by some, but that the information was not credible. Subjects believed that this type of information was designed to sell a product rather than to describe its nutrient content.

Consumers do not believe that the Federal government requires current labels to meet specified guidelines before they can use terms like "low cholesterol" or "light" (AHA/Product Development Services, 1991).

Two separate surveys by the American Heart Association (1991) and the National Food Processors Association (1990) revealed that consumers rate ingredients and nutrition information on food labels as being somewhat or not too understandable although they use food labels to select healthy items.

Most consumers believe that serving sizes on food packages are misleading in that one gets fewer servings than stated on the package and that the size servings are inaccurate (Roper Organization, 1992).

Although most consumers say they need to know more about nutrition, this expressed need does not appear to have increased the search for added knowledge over the course of the last 15 years (Roper Organization, 1990). People whose education is less than a high school diploma, are less likely to get nutrition information from food labels, relying instead on physicians and other health care professionals (FDA, 1990).

Whether the label is used or not, its presence on food products ensures consumer confidence as to the contents of the package, providing the basis for making healthy food choices. As an added benefit, it places a responsibility on the manufacturers to produce nutritious foods (Perez, 1981). A report from the Institute of Medicine (1990) stressed that consumers should be able to understand the nutrition content of a food and make comparisons with other similar products from the information provided by a food label.

Liefield's (1983) review of the research on food labeling and the uses of nutrition information from labels concluded that the benefits obtained by consumers were limited and that nutrition labels were being used primarily to avoid certain nutrients in foods. His review also pointed to diminishing returns, as the number of choices increases, the search for information decreases. The results seem to suggest that consumers are more concerned with the differences between foods than brands, which means that label information may not truly affect healthy food choices.

The Organization and Assessment of Nutrition Knowledge for Consumers

Research Designed to Assess Nutrition Knowledge

The Society for Nutrition Education celebrated its twenty- fifth anniversary in 1992 with the September-October 1992 edition of the Journal of Nutrition Education devoted to nutrition education research from the past and present, assessing future needs. Addressing the trends and the challenges facing nutrition educators, Brun and Gillespie (1992) concluded that research in nutrition education has improved nutrition education practice and that current research is more sophisticated than it was when the Society was first formed. However, they felt that more research is needed that measures behavioral change, the response of such change to genetics, and the relationship of environment and eating behavior. While these findings are optimistic with respect to practice, they still do not address nutrition education outcomes which appear not to have changed in the past decade. Johnson and Johnson's meta-analysis of research in nutrition education (1985) included a review of 670 studies, 303 of which they identified as having usable or significant results. These authors classified the studies into those where nutrition education had no impact and those with some impact to measure statistically significant findings. Their final analysis integrated the effect of nutrition education using all 303 studies from either professional journals or derived from data from Federal nutrition programs with built-in education components. They defined nutrition knowledge as performance on tests that assessed how well skills were mastered and knowledge retained within the programs. They concluded that nutrition education is effective in increasing knowledge. These findings are important since there have been some serious concerns about the effectiveness of nutrition education voiced by numerous authors of studies cited in this review, as well as by others in the field.

Cleveland (1991) suggested that we view behavioral change as a continuum from gaining knowledge to attitude formation, from a decision to adopt or reject an idea to implementing or confirming the decision. If this is the case, then targeting the appropriate step could be effective and the skills level model proposed in this study may be an area to target. Since knowledge gain can be favorable or unfavorable, the model provides an approach to accentuate a favorable response because it incorporates prior knowledge. Kayman (1987) cited numerous studies where the focus on behavioral change has involved physiological and psychological factors that account for why knowledge appears to take a back seat to food choice behaviors. She emphasized the need to define the variables that influence people's commitment to change. Knowledge is only one variable which, on its own, is not an agent of change.

The Diet Health Knowledge Surveys reported in the first part of this review, may be the first nationwide attempt to assess consumer nutrition knowledge. An examination of these data with those obtained from the consumer intake surveys may provide the link between knowledge and food choice. To date, exploratory analysis has revealed that nutrition knowledge deficits exist, at least in relation to fat. Only 12% of the women aged 19-50 had fat intakes below the recommended 30% of total calories in the diet. Yet 50% of the respondents said that their diets were "about right" for fat (Cleveland, 1992). These data suggest that some women are either not knowledgeable or unaware of food sources of fat, saturated fat, and cholesterol.

At the 1987 National Conference on Nutrition Education Research Casey (1987) suggested that research should be done on the assessment of public nutrition knowledge, where it is obtained, its accuracy, and what is missing.

Models Proposed and/or Used in Organizing Nutrition Knowledge

Models have been proposed that are designed to facilitate the delivery of nutrition education (Gillespie, 1984, 1985; Parks and Moody, 1986; Rody, 1988), based on theories derived from the fields of psychology and sociology (Murphy, 1985; Del Toro, 1988; Lewis and Sims, 1989; Matheson, 1991; Sapp, 1991), or based on communications theory (Gillespie et al., 1984). Some have reflected adult education theories, as have holistic (Rinke, 1986) and wellness models (Engelhardt, 1980). Some authors have emphasized the need for models based on adult education principles even though these principles have not been defined within their recommendations (Rody, 1988; Guthrie, 1989; Gillespie et al., 1984). Some have suggested that nutrition education may be viewed as a commodity to be sold and should be designed as a marketing model (Dunlap, 1986; Parks and Moody, 1986) where nutrition related problems and educational interventions could be left to the professionals to identify. Rody (1988) describes most nutrition interventions as being based on the "machine model". It appears that most Federal Government programs within the United States and abroad use this "top down" rather than "bottom up" approach (p.133). Clients are viewed as dependents who are incapable of taking care of themselves, especially when they come from different cultural, social, or ethnic backgrounds. Programs based on models that deal with assumed needs with little attempt to recognize clients' competencies, resources or views, generally fail after the resources are gone because people do not like using the ideas of others when no account has been taken of their own. Achterberg et al., (1990) refer to these as "paternal models". When the approach is designed to keep the client dependent on the program, it produces passivity rather than empowerment (Kent, 1988; Achterberg, 1990) and encourages the recipient to believe that the knowledge required for a task is too technical to grasp.

Models that have incorporated adult education approaches have emphasized the need to incorporate audience experiences, skills, beliefs, attitudes, and habits (Gillespie et al., 1984; Achterberg, Novak, and Gillespie, 1985; Sims, 1987; Glanz, Hewitt, and Rudd, 1992;). However, they have not emphasized nor incorporated into suggested models the necessity to assess learner knowledge and needs and an organization of nutrition knowledge required for specific interventions. Gillespie et al., (1984) acknowledge that the nutrition communicator decides what concepts to include, and what organization and skills are needed but the methodology involved has not yet been addressed. They perceive their model as one that provides a framework for evaluation and "linking receiver inputs" (p.172), suggesting that data at any given stage of their model will help build a theory of nutrition education.

Nutrition Knowledge Testing Instruments

The literature was also reviewed to examine the nutrition knowledge test instruments in order to see if one could be adapted to this study. No test was found to be satisfactory, so an instrument was developed specifically for this study.

Nutrition knowledge tests have been constructed and tested for reliability and validity in numerous studies cited elsewhere in this review as well as those by Lackey et. al, and Hart, Alford and Gorman (1990). The nationwide, Diet, Health Knowledge Survey (1990) also had an instrument designed to assess nutrition knowledge and another to be used in the 1994-1996 survey. Both were made available for examination by Linda Cleveland of the USDA.

Axelson and Brinberg (1981) examined the results of 25 years of research reported in the Journal of Nutrition Education to find out whether the measurement and conceptualization of the nutrition knowledge construct was valid and concluded that there may be a sufficient number threats to validity that conclusions about theoretical relationships between nutrition knowledge and dietary behavior cannot be made. The authors outline six assumptions that can be used to guide the researcher in developing instruments designed to assess nutrition knowledge which will increase validity. They highlight the importance of defining "knowledge structures" (p. 242) as a way of better understanding the construct's domain. Since the food guides represent nutrition education in its simplest form, they most often form the conceptual framework for knowledge assessment. Most research in which nutrition knowledge is being assessed appears to be organized around food guides. Studies testing nutrition knowledge and what is considered good nutrition indirectly use food guides and recommendations as a framework regardless of the fit this model has with consumer needs or comprehension (Brun and Gillespie, 1992). Often the message is so confusing that it is understandable why consumers tend to oversimplify nutrition information (Wellman, 1990). Often consumers use complex nutrition knowledge structures, for example, including butter with milk products, that make an assessment of this piece of knowledge different for the professional than for the consumer. This makes it important to "assess the level of knowledge structure prior to presenting information (Brun et al., 1992, p. 244)".

Conclusions from the Literature Review

This review was undertaken to examine the literature for evidence as to how nutrition learning in the public has been arranged, organized, and evaluated, and how nutrition education methodologies assessed this learning. It also included an examination of the models and conceptual frameworks used in theory building and the use of these in research studying label use by consumers.

Nutrition education strategies were examined to see whether there was an underlying philosophy of nutrition education that was based on theory, and whether conceptual frameworks were being used in designing nutrition education interventions. These would answer the question as to whether or not nutrition professionals regarded themselves primarily as educators or as practitioners. The reviews suggest that a philosophy of nutrition education is evolving and that teaching strategies are being examined and evaluated with respect to consumer needs. There appears to be some inclusion of adult education principles in these newly emerging paradigms as well as a call for assessing public nutrition knowledge.

In summary, the literature does not contain sufficient information to

1. organize nutrition knowledge of the consumer within a theoretical framework that has been defined by research,

2. assess the learner's prior knowledge and experiences, or

3. identify skills needed for a particular intervention prior to introducing a new set of skills.

This investigation proposes a model where the knowledge and skills required to interpret the new food label are identified and organized in three levels. It also arranges knowledge skills at three dimensions that are assumed to be required to perform this task. By examining the relationships between the test results for knowledge and performance measures for the food label, it is hoped that the results will contribute some validity to the model for the purpose of assessing learner needs.

CHAPTER THREE

METHOD

The material in this chapter is arranged in the following way: research goals; model and instrument development; testing and refinement; data collection and analysis.

Research Goals

A new food label is appearing on products this year. Extensive research by the FDA suggests that approximately 20 % of the U.S. population, composed mainly of elderly and minorities, cannot correctly interpret the nutrition information on the label (Levy, Fein and Schucker, 1992). This research proposes to determine the specific knowledge and/or skills required for correct interpretation based on a model which organizes nutrition knowledge in three hierarchical levels: food groups, macronutrients, and micronutrients. Each level further includes dimensions of nutrition terminology, health consequences, and related mathematics skills. The model proposes that label interpretation is also hierarchical at the same three levels and dependent upon these knowledge dimensions.

The specific research objectives are:

1. To design a model which identifies structures of nutrition knowledge in the learner at various levels of complexity corresponding to similar levels identified in the new food label, and to develop an instrument to measure nutrition knowledge as identified by the model.

2. Test the instrument on a purposive sample of adults representing a wide range of demographics and potential food label users.

3. Evaluate the test results to determine the usefulness of the model in determining nutrition knowledge and related skills.

To accomplish these goals, a sequence of research activities were conducted:

1. Twelve WIC recipients were interviewed regarding nutrition knowledge and food labels. Qualitative analysis of the results led to the development of the model of hierarchical structures.

2. Test items were developed to represent the levels and dimensions of the model.

3. The resultant test instrument was piloted with 83 undergraduate students, reviewed by peers, reduced, and revised.

4. The revised instrument was administered to a sample of 250 people including a new group of undergraduate students.

Model Development and Testing

Development of A Skills Level Model

Competency-based education can be enhanced by the development of models that are designed from data obtained by assessing learner needs. The advantages are that when these models are used as diagnostic tools, the learner becomes central to the instructional methods, thereby personalizing the process. The model reflects the "learner's own perception of--what he wants to be able to achieve" and "the level at which he wants to perform" (Knowles, 1984, p.124).

In order to pursue the FDA study results with a specific population that was identified as having the most difficulty with the interpretation of the new food label, twelve participants of the Women, Infants, and Children (WIC) program were interviewed to qualitatively explore possible reasons for the deficits that were identified. Interviews of four to six subjects a day were conducted over a two-week period. Apparently, the women determined the importance of food labeling based on the importance of nutrition in their lives at the time. The interview results suggested that the need for sustenance and the acquisition of related nutrition knowledge may be hierarchical. The similarity between the basic need for food and the ascent to more sophisticated levels of nutrition knowledge suggested a theory not unlike that of Maslow's hierarchy of needs (1970). Based on these interviews, the literature, and expertise in the field, a conceptual framework was developed postulating that (1) in the general public, nutrition knowledge may be structured and ordered in complexity and (2) this knowledge may be assigned to three levels. Moreover, it is this ordering that is related to a person's ability to correctly use the information on the nutrition panel of a label defined in this study as "interpretation".

The model postulates three levels for nutrition knowledge as depicted in Table 1. Specifically, these are designated as Level One: Food Groups; Level Two: Macronutrients; Level Three: Micronutrients. Within each of the levels of nutrition knowledge, three dimensions are postulated: (1) nutrition terminology, (2) diet/health relationships, and (3) relevant math skills. Label interpretation skills are also hierarchically arranged to correspond with the three levels of nutrition knowledge and included as Dimension 4.

Level One includes the major food groups with dimension 1 including nutrition terminology as it relates to the ability to name and identify food sources of grain: cereals, and other foods made from grains; fruits and vegetables, including juices, partitioned, reconstituted, dried or otherwise processed derivatives; milk and its products that have equivalent nutritional values as milk; meat and meat products including poultry, fish, and vegetable alternates; fats and oils; and sugars. Sources include foods whose main nutritional values are calories derived from these nutrients.

Dimension 2 of level one includes diet/health relationships and consists of knowledge of the number of servings from each food group recommended for good health including the ability to identify foods that belong in the fats/oils/sugars group associated with current health issues.

Dimension 3 of level one describes relevant, nutrition-related math skills and includes the ability to identify the number of recommended servings and size of servings in household measures, as well as the ability to calculate the amounts needed to meet the recommendations.

Table 1
Nutrition Knowledge and Skills-Based Performance Model

	Nutrition Terminology Dimension 1	Diet/Health Relationships Dimension 2	Relevant Math Skills Dimension 3	Label Interpretation Skills Dimension 4
LEVEL ONE Food Groups	Grains, cereals, breads. Fruits Vegetables Milk, milk/ products Meats Fats and oils Sugar	Recommended servings per day according to current health guidelines Judgement of overall health-fulness of food	Number of servings per container Serving size in household measures for selected foods Add and subtract numbers of servings	Order of predominance on ingredient listing Number of servings required per day Other food groups needed or to avoid Judgement of overall healthfulness of food
LEVEL TWO Macro-Nutrients	Protein Carbohydrate Complex Simple Fats Saturated Unsaturated Calories Fiber	Identify healthy food sources of energy yielding nutrients Recommended caloric levels Macro-nutrients and their relationships to: Obesity Diabetes Heart disease and G.I. diseases	Interpret quantities reported in grams Identify grams per serving Calculate caloric contributions Calculate proportions in grams and percent of daily values	Level 1 performance, plus: Additional amounts needed or allowed in grams and percent of Daily Value (DV) Other macro-nutrients needed or to avoid Judgement of relative nutrient and caloric contribution of the food
LEVEL THREE Micro-Nutrients	Cholesterol Calcium Iron Sodium Vitamin A and C (antioxidants)	Cardiovascular disease Bone health and osteoporosis Anemia Hypertension Antioxidants in cancer prevention	Describe/report nutrient requirements in milligrams Calculate proportions in milligrams and percent of daily values	Levels 1 & 2 performance, plus: Additional amounts needed or to avoid in milligrams and percent of DV Judgement of the relative healthfulness of the food with respect to the micro-nutrients

Dimension 4 of level one describes the knowledge and/or skills required for label interpretation. Included in this level is the identification of the number of servings, including additional (or decreased) servings needed to fulfill the recommended servings suggested by diet guidelines. Also included is the ability to evaluate the overall healthfulness of the product. The test items are based on a prototype label which is included with the instrument.

Level Two includes them macronutrients with dimension 1 including nutrition terminology as it relates to the ability to name and identify food sources of macronutrients: carbohydrate, protein, fat (saturated and unsaturated) and fiber. Macronutrients are classified as those measured in grams.

Dimension 2 at level 2 includes diet/health relationships as they relate to the ability to identify food sources of the macronutrients. These include over-consumption of energy-yielding nutrients (protein, carbohydrate, and fat) and their relationship to overweight and obesity, the relationship of saturated fats to the development of cardiovascular disease, and the benefits fiber for gastrointestinal function.

Dimension 3 at level 2 describes the math skills required to interpret quantities reported in grams as approximations of household measures and serving sizes, interpret Daily Values in grams and as percentages of total kilocalories, and calculate kilocaloric contributions of energy-yielding nutrients.

Dimension 4 at level 2 describes the knowledge and/or skills required for label interpretation at level 2, and consists of the ability to calculate additional (or decreased, where necessary) amounts of macronutrients needed in grams and percentage of Daily Values. Also included is the ability to evaluate the overall healthfulness of the whole food product with respect to the macronutrients.

Level Three includes the micronutrients withd dimension 1 including knowledge of nutrition terminology as it relates to the ability to identify food sources of cholesterol, calcium, iron, sodium, vitamins A and C. Micronutrients are classified as those measured in milligrams, micrograms and other small equivalents.

Dimension 2 at level 3 includes diet/health relationships and consists of the ability to identify micronutrients and their relationships to health and disease. Examples include the role of calcium in bone health and in the prevention of osteoporosis, the possible role of sodium to hypertension, the role of iron in iron deficiency anemia, and cholesterol in heart disease.

Dimension 3 at level 3 describes math skills required to interpret quantities reported in milligrams and percentage of Daily Values.

Dimension 4 at level 3 describes the knowledge and/or skills required for label interpretation and consists of the ability to calculate additional amounts of the micronutrients needed or to be avoided, expressed in milligrams or Daily Values. Also included is the ability to evaluate the overall nutritional quality of the product with respect to its micronutrient content.

Instrument Development to Test and Validate the Model

Although nutrition knowledge tests have been used in numerous studies reported in the literature, most do not appear to have met many of the criteria for validity and reliability. Axelson and Brinberg (1992) examined the validity of the nutrition education construct in research articles submitted to the Journal of Nutrition Education over the past 25 years and concluded that there were enough threats to validity to render the results of most of these studies inconclusive. Some of the instruments were examined to establish whether or not they could be adapted to this study (Lackey, Kolasa, Penner, and Mutch 1981; Cleveland, 1992). Also included in this examination were the instruments to be used in the USDA 1994-1996 Diet, Health, Knowledge Survey.

Since none of the tests that were examined met the needs of this investigation or were applicable to the study of the new nutrition label, it was necessary to develop and test a new instrument. This instrument would be based on the assumption that the levels of knowledge outlined in the model exist, and that correct label interpretation is dependent on this knowledge. The nutrition knowledge construct in this study is based on a model designed after a needs assessment was conducted and is specific to label use.

The name given to the instrument, "Nutrition Knowledge Test", should be interpreted with caution since its purpose is not to evaluate the universe of nutrition knowledge, but rather is limited to ascertain baseline knowledge perceived to be needed to correctly use the information on the nutrition panel of the label. Therefore, the definition of nutrition knowledge is confined to that knowledge necessary to accurately perform the tasks related to label interpretation, and the latter is defined as the set of tasks identified in this study needed to apply that knowledge to interpret the nutrition panel of a label.

Construction of the instrument. Although the intent all along has been to have only one instrument in the final analysis, it was decided during the developmental process to create two instruments: the Assessment of Prior Knowledge Nutrition Test and the Food Label Interpretation Test. Only the single instrument that was revised after the pilot tset is included in Appendix A. The first tested nutrition knowledge identified for each of the three levels and four dimensions of the model. The second tested label interpretation at the three levels as they corresponded to the three levels of nutrition knowledge. In order to increase validity the following steps were taken:

1. To assume dimensionality, so that "a single score derived to represent knowledge assesses a single underlying construct" (Axelson and Brinberg, 1992, p.240), the model (Table 1) was used to develop a test blueprint for each section and each cell. Objectives or outcomes designed to meet the constructs identified in the model were outlined, and items were constructed to meet these objectives with respect to knowledge, comprehension, skill, and application. Nutrition knowledge is multifaceted, being influenced, for instance, by cultural, economic, religious, social, physiological, and psychological factors. Although the items were not designed to determine the

effects of these factors on knowledge, it would be shortsighted to ignore their influence.

2. To increase content validity, a total of 138 items were written, 108 to test nutrition knowledge and 30 to test label interpretation. This provided a pool large enough to represent the domain of content identified in the model.

3. Item format. Initially, the items were designed in check list and True/False format. However, based on information from measurement texts, the multiple choice format was selected since it appears to be the form of choice for measuring educational outcomes related to knowledge, understanding, evaluation and problem solving (Crocker and Algina, 1986). Also the stem implies or asks a direct question which is usually realistic and appropriate for testing nutrition knowledge, making it less likely to be biased. In addition, this format lends itself better to an optical scanner that reads answers and transcribes them directly to the SAS statistical format or a DOS file.

4. Item construction. The Nutrition Knowledge Assessment instrument included 108 items to measure Levels 1 2, and 3 skills. To measure the nutrition knowledge hypothesized in the model, 40 items were constructed for Level 1, 36 items for Level 2, and 32 for Level 3. To measure label performance a total of 30 items were written, 10 for each level of the model.

Forty 40 items were written to measure knowledge related to the first level and the main food groups, and the ability to identify the groups into which the foods belong, including the number of servings, and serving sizes recommended for good health. These were numbered 1-40 in the instrument.

Items to test knowledge of level 2 were numbered 41-76 and were related to the macronutrients carbohydrates, protein, fat, and fiber and the ability to identify the healthiest food sources contained in these nutrients within the main food groups. These included the relationship of each nutrient to contemporary health issues and the ability to understand the U.S. Dietary Guidelines percentage of kilocalories recommended from these nutrients (including the use of Daily Values).

Items to test knowledge at level 3 included the micronutrients listed on the food label like cholesterol, Vitamins A and C, iron, calcium, and sodium and the ability to identify the healthiest food sources of these nutrients within the main food groups. These included the relationship of each nutrient to contemporary health issues and maximum or minimum recommended intakes. The latter two sections also tested mathematics skills in interpreting percentages and metric weights. These were numbered 77-108.

To determine whether a relationship existed between the skills required to correctly interpret the nutrition information on labels and these levels of knowledge, 30 items measuring label interpretation were developed. Since these were designed to measure interpretation of the new food label, a prototype around which the items were written was attached to the test.

Level 1 included items testing understanding which food groups are contained in the prototype, including the order of predominance of ingredients. Items also included the number and size of servings of the product and additional (or decreased) servings needed to fulfill health guide recommendations. These were numbered 1-10. In addition, items were written to determine how the overall nutritional quality of the product was being evaluated at all 3 levels.

Level 2 included Level 1 interpretation, as well as understanding how to use gram weights or percentages of the Daily Values, including other macronutrients to include or cut back in the remaining meals that day. These were numbered 11-20.

Level 3 included Level 1 and 2 interpretation, as well as understanding how to use quantities in milli- or micrograms or percentages of Daily Values including other micronutrients to include or cut back on for the remaining day's meals. These were numbered 21-30.

Pilot Testing and Instrument Revision

Sample Description used in the Pilot Study

These pilot instruments were administered to 83 undergraduate students enrolled in two, 3-credit nutrition courses prior to the start of lectures in the fall semester, 1993. Forty-seven of the students were sophomores enrolled in a nursing program, and thirty-six non-nursing students, ranging from freshmen to seniors, representing various disciplines and enrolled in an elective course entitled "Nutrition and Health".

The sophomore nursing students had little exposure to health-related courses at this point in the curriculum, and it was assumed that the non-nursing students had not received formal nutrition training at the undergraduate level. It was also assumed that they had an equivalent knowledge base at the time of testing, although the groups were different in other respects.

Data Collection

The "Assessment of Prior Knowledge Nutrition Test" was administered to the 37 students who were not in the nursing program at 11.40 a.m. the first day of class prior to any instruction, on September 2, 1993. They were asked to fill in the bubbles of a scantron sheet, providing their names, gender, class, I.D. numbers and the disciplines they were enrolled in. They were informed of the study and how the test scores would be used to refine a nutrition knowledge instrument. They were also told that the scores would be used to assess the level of knowledge they already possessed, but that it would not influence their course grades. In addition, they were informed of the confidentiality that would be afforded them and their responses. They were given a little over an hour to answer 108 questions. The instrument was similarly administered to 47 nursing students on the same afternoon, during scheduled class time at 2.40 p.m.

On September 7th, the "Label Interpretation Test" was administered to the same 2 groups during class time, with the same instructions. This time the testing time was about 40 minutes. Students were told that five bonus points would be added to their final exam grade as an incentive to take this part of the test.

Analysis of Pilot Test Results

The scores on the pilot test were examined to see if they revealed real differences in the way subjects performed on each item, as well as on the whole test. These data informed initial validity and the discriminatory power of the instrument.

For every subject the number of correct responses divided by 108 provided a score for test 1, and the number of correct responses divided by 30 provided a score for test 2. Therefore the unit of analysis was the subject and the three measures were percent score correct on Test 1, percent score correct on Test 2, and correct or incorrect responses on each item.

Descriptive statistics. These were used to examine distributions, means, and variances of scores to ascertain whether or not there was variability in the groups and whether the instrument, as a whole, was discriminating. Visual examination of graphical data revealed a negatively skewed distribution but with enough variance on the two tests to establish initial reliability and the discriminatory power of the instrument. The mean score for the nutrition knowledge was 59%, and the standard deviation, 11.4. The mean score for the label interpretation test was 69% and the standard deviation was 16.47.

Item analysis and item difficulty . This procedure was used to determine how well each item provided data about the domain of content and the characteristics that determined its content validity. It included an analysis of response patterns for correct and incorrect answers. Item difficulty was established by using the percent of the total sample who answered correctly. For example, a low difficulty item would be one where 90% answered it correctly or high difficulty if 30% answered correctly. The wording and structure of each incorrect option that was selected was examined and re-written in order to improve the item, or discarded where necessary.

Tests for reliability and internal consistency. Pearson's Product Moment (r) was selected to determine the strength of the relationships between nutrition knowledge scores and scores on label interpretation. It was used to examine the internal consistency of the sub-scales of the cells of the model. In addition, each of two items testing one construct were examined. If the items were highly correlated R=0.6 or higher) it was assumed that they were both testing the same construct and the best were selected for the revised, final instrument. Subjective analysis included examination of these items to determine whether or not (1) the two items were eliciting the same knowledge and (2) knowledge of one could predict knowledge of the second. If the correlations from the two items were not significantly different from zero, it was concluded that the two items were not predictive of one another and therefore tapping different knowledge areas. These items were included in the final selection.

Kuder Richardson-20. KR-20 was also used to examine the internal consistency of the instrument. In the SAS program the selection of KR-20 or Cronbach's Alpha is auto-selected based the type of data being analyzed. It selected KR-20 because the data are dichotomous. Cell alphas were moderate (about 0.70), suggesting that items were measuring the intended constructs and reflected homogeneity of items within each sub-scale.

Expert review. To further validate the instruments, they were sent to nutrition professors at Virginia Polytechnic Institute and State University for review. Four reviews were received and the corrections and additions were considered for incorporation into the revised instrument.

Instrument revision.

Having taken all the necessary steps to construct a reliable and valid instrument the items were revised and re-written as necessary. Items with high (< 40% correct) or low (> 95% correct) difficulty levels were examined, along with the options selected instead of the correct answer. Misleading wording or items that did not discriminate were eliminated or re-worded to achieve clarity. Items that elicited the same knowledge or were duplicated in some other way were also eliminated. A final, single instrument was designed with nutrition knowledge items reduced from 108 to 87, and label items from 30 to 21 (Appendix 1).

Readability index. The language of this instrument is at a seventh grade reading level. The index was established by running the test through "Grammatik" in Word-perfect for Windows which uses the Flesch index to establish grade readability indices.

Data Collection and Analysis Procedures Subsequent to Pilot Testing

Sample Description

A purposive sample was selected from the Washington-Metropolitan area, consisting of 250 male and female adults, representing a range of educational and socio-economic backgrounds are listed in Table 2. They were assumed to be food shoppers and they were drawn from different populations whose scores would provide as wide as possible a range of nutrition knowledge. The choice of the population was to develop test reliability, and not to generalize to populations.

They were selected from larger convenience samples: students, faculty and staff of 2 area universities, church groups, seniors in retirement settings, or adults in training conferences. Individuals from minority and elderly populations, who functioned poorly in the label performance studies conducted by the FDA (Levy, Fein and Schucker, 1992) were also included. These groups were acquired through personal and professional contacts. The undergraduate students were enrolled in classes taught by this investigator.

As an incentive to take the test, token gifts or free instructions and advice by a licensed nutritionist were offered on the use of the Food Guide Pyramid, and the new food label. There were approximately equal requests for instructions and gifts.

Table 2
Sample Breakdown

Sample	Number	%
University students	101	40
Women in WIC centers	9	4
Faculty & Staff from 2 area Universities	18	7
AARP members	17	7
Elementary school teachers and staff	13	5
Church group	11	4
CCNV homeless shelter (males)	11	4
Senior citizen center	7	3
Fire fighters attending a conference	15	6
Junior high school teachers and staff	32	13
Naval intelligence trainees	6	2
Vienna Chamber of Commerce employees	4	1.6
Center for Food and Nutrition Policy	6	2
Total	250	

Data Collection

As with the pilot test, the instrument was administered to a new group of students enrolled in two nutrition courses at Georgetown University on the first day of class, and before the start of lectures. These were not the same students who participated in the pilot study. The students made up 41% (n=99) of the sample. Other subjects were tested, mostly in groups. Ten subjects were dropped for having strings of data missing, for leaving and not returning to the testing site to complete the test, or for evidence pointing to irresponsible test-taking. This provided a total of 240 subjects. The testing period took 45 minutes to one hour. The instrument was also designed to collect demographic data about the participants, including age, ethnic origin, income, gender, and educational levels (Appendix A, p. 139). To ensure confidentiality, subjects were identified only by a number. The answers that were selected were circled on the instrument, except in the case of the two student groups who used scantron sheets. In the case of the former, responses were transferred onto scantron sheets by the investigator. An optical scanner provided total scores for each subject, item difficulty, and the response selected from the four available options. These data were stored on a DOS file for analysis using SAS mainframe and SPSS-PC.

Analysis Procedures

Descriptive statistics were once again used to examine distributions, means, and variances of scores to ascertain whether or not there was variability in the groups and whether the instrument, as a whole, was discriminating. Visual examination of graphically displayed data again revealed a negatively skewed distribution but with enough variance on the two tests to establish reliability and the discriminatory power of the revised instrument. The mean score for the whole test was 74%, and the standard deviation, 14.22. The mean score for nutrition was 67%, standard deviation, 10.89, and for the label test, mean score was 15% and the standard deviation, 5.12.

Re-testing for reliability and internal consistency. Pearson's r was again selected to determine the strength of the relationships between nutrition knowledge scores and scores on label interpretation as well as to examine the internal consistency of the sub-scales of the model. KR-20 was used to examine the internal consistency of the instrument.

To determine whether or not the test was discriminating, responses were examined to see whether low scorers answered easy items incorrectly. Of the six easiest items (those with the highest % correct responses), 15 of the 32 subjects scoring below 60% missed at least one. Of the 17 subjects scoring below 50%, 15 missed at least one and 7 missed 2 or more.

Factor analysis was used to explore the value of the original hierarchical model and to posit an additional model based on conceptual complexity. It was also used to examine the structures among the variables in order to determine the extent to which they reflected the hypothetical constructs of the model.

Hierarchical multiple regression was used to predict accuracy of food label interpretation based on factors depicted by both models.

Significance of differences between groups was determined using a T-Test. Student and non-student mean scores were compared and no significant differences in the overall scores of the two groups were observed ($F [140,98]= 1.76$, $p=0.2288$); therefore they were combined for subsequent analysis. The results of this analysis is summarized in Table 3.

Table 3

Comparison of Student and Non-Student Responses

	n	Mean	SD
Total	240	81.57	14.94
Students	99 (41%)	82.89	12.40
Non-Students	141 (86%)	80.64	16.48

CHAPTER FOUR

RESULTS

The results are organized as follows: analysis of demographic data; examination of reliability of the instrument; hierarchical multiple regression to address the research questions; re-organization of knowledge structures including reliability measures; and final hierarchical regression analysis.

Analysis of Demographic Data

The median age of the subjects studied was 34; 88% had at least some college education, and 71% of household earnings were more than $50,000 per year. Sixty-seven percent of the sample were males. Whites made up 81%, blacks, 12%, and the remaining 7% were distributed across other races. A demographic description of the sample is summarized in Table 4.

T-tests revealed differences between male and female, and white and non-white total test scores. Tukey and Sidak tests were used to control for type 1 and type 2 errors. These revealed that male scores were significantly higher in nutrition knowledge (p=.0037) and total test scores (p=.0023). Total scores of white respondents were also significantly higher than those of others (p=0.0001). These results are included in Tables 3 and 10.

Analysis of variance revealed that total nutrition scores for people earning $20,000 per year were significantly higher (F [4,233]=17.58, p= 0.0001) than people earning less.

Table 4. Demographic Profiles and Means on Total Test Scores

AGE	N=238	%	Mean Score	SD
Under 18	1			
18 - 25	102	43	82.48 (NS)	13.02
26 - 34	19	8	73.00 (NS)	20.04
35 - 50	71	30	81.77 (NS)	16.90
51 +	45	19	83.38 (NS)	12.01
GENDER	N=240	%	Mean	SD
Male	160	67	84.93*	12.6
Female	80	33	74.82	16.9
EDUCATION	N=238	%	Mean Score	SD
< & Grade School (1)	3	1		
High School (2)	23	10	61.21	20.22
Some College (3)	132	55	81.92	12.92
4-Year Degree (4)	34	14	85.00	8.25
Graduate Degree (5)	46	19	89.28	11.08
1 vs 2,3 and 4 p=0.0001; t-tests : * p=<.005; ** p=<.0005.				
INCOME	N=218	%	Mean	SD
< 20,000 (2)	25	11	62.28	21.92
20-50,000 (3)	39	18	79.13	12.50
50-100,000 (4)	82	38	85.29	10.67
> 100,000 (5)	72	33	85.13	12.23
2vs5, 3vs5, 2vs3, 2vs4, p=0.0001.				
ETHNIC ORIGIN 1	N=236	%	Mean Score	SD
White	191	81	84.72	11.71
Black	28	12	65.67	21.28
Other	17	7	74.76	14.44
ETHNIC ORIGIN 2	N	%	Mean	SD
White	191	81	84.72**	11.71
Other	47	19	69.17	19.34

Comparisons of math, label, and total test scores were made with respect to educational background. People with a high school education or less had significantly lower scores than those with a higher education. However, there were no significant differences between graduate degree holders and people with 4-year degrees.

Examination of Reliability of Instrument

KR-20 analysis was used to establish the internal consistency of the instrument modified from the pilot study. Level 1 nutrition, diet health relationships, and math alphas were between 0.48-0.59. Level 2 dimensions were slightly higher (0.63-0.69); Level 3 (0.60-0.70); and label items at all three levels were 0.77, 0.63, and 0.88 respectively. These results suggest that the items were measuring intended constructs at levels lower than the pilot test. However, there were fewer items in this instrument which could account for the drop in cell reliabilities. Cell alphas, cell correlations and the number of items in the cells being examined are in Table 5.

Pearson's r. Cell correlations between nutrition, diet health relationships, and math scales at level 1 range from .29 to .43; level 2 between .29 to .45; and Level 3 between .28 to .48. Sub-scale correlations between nutrition dimensions and label scores, except at label level 1 (around 0.50) were not highly correlated either. Correlations among the sub-scales of label interpretation ranged from .23 to .69.

Table 5.
Cell Correlation and Alpha Measures of Original Model

#	∝	VAR	NT1	DHR1	MT1	NT2	DHR 2	MT2	NT3	DHR3	MT3	LAB.1	LAB.2	LAB. 3
11	.56	NT1	1.000	0.379	0.429	0.426	0.376	0.333	0.396	0.395	0.330	0.360	0.264	0.347
8	.48	DHR1	0.379	1.000	0.384	0.291	0.315	0.244	0.321	0.284	0.320	0.360	0.225	0.304
11	.59	MAT1	0.429	0.384	1.000	0.407	0.480	0.343	0.526	0.519	0.473	0.514	0.309	0.424
13	.63	NT2	0.426	0.291	0.407	1.000	0.495	0.454	0.431	0.418	0.388	0.529	0.398	0.430
9	.69	DHR2	0.376	0.315	0.480	0.495	1.000	0.401	0.491	0.632	0.485	0.496	0.432	0.481
8	.67	MAT2	0.333	0.244	0.342	0.454	0.401	1.000	0.381	0.396	0.471	0.435	0.333	0.370
10	.60	NT3	0.396	0.321	0.526	0.431	0.491	0.381	1.000	0.492	0.354	0.501	0.342	0.467
10	.69	DHR3	0.395	0.283	0.519	0.418	0.632	0.396	0.491	1.000	0.528	0.519	0.301	0.400
7	.71	MAT3	0.330	0.320	0.472	0.388	0.485	0.471	0.354	0.528	1.000	0.590	0.455	0.507
10	.77	LAB1	0.360	0.360	0.514	0.529	0.496	0.435	0.501	0.519	0.590	1.000	0.556	0.669
4	.63	LAB2	0.264	0.225	0.310	0.398	0.432	0.333	0.342	0.301	0.455	0.555	1.000	0.689
7	.83	LAB3	0.347	0.304	0.424	0.430	0.481	0.370	0.467	0.400	0.507	0.669	0.689	1.000

= number of items in each cell; NT1 = Nutrition Terminology Level 1; DHR = diet-health relationships; MT or MAT = math, LAB = label; Cell values = Pearson's R; alphas = Kr-20s for each cell.

Examination of Relationships between Knowledge and Label Interpretation Skills

The goal of this analysis was to determine whether a relationship exists between the knowledge and skills required to interpret nutrition information on labels and the three levels hypothesized in the model.

Hierarchical multiple regression analysis was used to address the following research questions:

1. What is the relationship between performance on label interpretation and nutrition knowledge related to the major food groups?

2. What is the relationship between performance on label interpretation and nutrition knowledge related to the macronutrients--protein, carbohydrate, fat and fiber?

3. What is the relationship between performance on label interpretation and nutrition knowledge related to the micronutrients--cholesterol, calcium, iron, sodium, and vitamins A and C.

4. To what extent is nutrition knowledge represented by a skills level model an accurate predictor of correct food label interpretation?

Variables

The dependent variable in this study was the score for interpreting the new food label.

The independent variables were the sub-scores on the test designed to identify the levels of knowledge and skills outlined in the model, as well as demographic variables including age, gender, ethnicity, educational background and income level.

Hierarchical multiple regression analysis was used to examine the extent to which each level of the model contributed to correct interpretation of the label. The variables were entered in the same order proposed in the model, after which first and second order interactions were entered. A separate regression model was developed and tested for each level without first residualizing the other 2 levels. Therefore the unique contributions of each level is not shown. The results are depicted in Table 6.

Analysis Addressing Research Questions

Research question 1: What is the relationship between performance on label interpretation and nutrition knowledge related to the major food groups.

Regression Model for Level 1. The main effect of nutrition terminology (NT) explained 13% of the variance in label interpretation. Diet health relationships (DHR) explained an additional and significant 6%, and math explained an additional 12%, which was also significant. The interaction between NT and MATH explained an additional, significant 12% with a small but significant addition due to DHRMATH (3%). The whole regression model for Level 1 contributed 46%.

Table 6
Hierarchical Multiple Regression Analysis Using Original Structures

STEP	VARIABLES	R^2	Change in R^2	F Change in R^2	Beta
Model 1. Step 1	Level 1 NT	.13	.13	35.55***	.36
2	DHR	.18	.06	16.96***	.26
3	MATH	.31	.12	40.99***	.40
4	NTDHR	.31	.00	.01 NS	.03
5	NTMATH	.43	.12	47.54***	.40
6	DHRMATH	.46	.03	13.75**	.25
7	NTDHRMATH	.46	.00	1.11 NS	.39
Model 2. Step 1	Level 2 NT	.16	.16	44.87***	.40
2	DHR	.23	.07	22.65***	.31
3	MATH	.25	.01	3.88 NS	.13
4	NTDHR	.25	.00	1.69 NS	.39
5	NTMATH	.30	.05	17.94***	.30
6	DHRMATH	.30	.00	.09 NS	.02
7	NTDHRMATH	.30	.00	1.83 NS	-.25
Model 3. Step 1	Level 3 NT	.22	.22	66.46***	.47
2	DHR	.35	.04	12.31**	.22
3	MATH	.35	.10	35.44***	.37
4	NTDHR	.26	.00	.16NS	.10
5	NTMATH	.37	.02	5.91*	.16
6	DHRMATH	.40	.03	9.86*	.20
7	NTDHRMATH	.40	.00	.09 NS	-.09
Whole Model 1	NTTOT	.38	.38	146.23***	.62
2	DHRTOT	.44	.06	25.74***	.33
3	MATHTOT	.50	.06	27.30***	.36
4	NTDHR	.51	.01	4.48 NS	.65
5	NTMATH	.51	.00	1.85 NS	.69
6	DHRMATH	.52	.01	4.12 NS	1.01
7	NTDHRMATH	.52	.01	1.51 NS	-1.78

N1 = Nutrition Terminology Level 1, 2, 3; TOT = total, DHR = diet health relationships.
* p< 01; ** p< 001; *** p<.0001.

Research question 2: What is the relationship between performance on label interpretation and nutrition knowledge related the macronutrients--protein, carbohydrate, fat, and fiber.

Regression Model for Level 2. The main effect of NT2 explained 16% of the variance in label interpretation. DHR2 explained an additional and significant 7%, and math explained 1%, which was not significant. The first order interaction between NT2 and DHR2 added nothing but NTMATH was once again significant in explaining an additional 5%. The whole model for Level 2 contributed 30% as did the second order interactions although the latter were not significant.

Research question 3: What is the relationship between performance on label interpretation and nutrition knowledge related to the micronutrients--cholesterol, calcium, iron, sodium, and vitamins A and C.

Regression Model 3. After accounting for the main effects of NT3, 4% of the remaining variance was significant in explaining the contribution of DHR3, and math an additional 10% which was also significant. The interaction between NT3 and MATH3 explained 2% over and above MATH, DHR, and NT which was also significant. Once again, the second order interaction was not significant.
The whole model for Level 3 explained 40% of the variance in the label interpretation scores.

Research question 4: To what extent does nutrition knowledge represented by a skills level model be an accurate predictor of correct food label interpretation.

Whole Model Regression. The main effect, nutrition terminology, at all three levels (NTTOT) explained 38%, DHRTOT explained an additional 6% and MATHTOT an additional 6% above and beyond NT and DHR, both of which were highly significant. None of the interactions contributed significantly to the model's predictive value. The whole model explained 52% of the variance in label interpretation which was greater than any of the 3 levels considered alone. This is less than the sum of the individual, non-residualized contributions, indicating that the levels are not independent of each other.

Re-organization of Proposed Knowledge Structures

Item difficulty using percent correct responses suggested that the knowledge hierarchy may be different than the one originally postulated. Therefore the results of factor analysis were examined (principal component analysis with prior commonality estimates set to squared multiple correlations and varimax rotation) to identify between 2 and 3 coherent dimensions within each of the 3 conceptual areas. The decision concerning the number of factors to be examined was made by successively examining 12, 9, 6, 4, 3, and 2-factor solutions within each content area, selecting the solution with the least number of factors, the most conceptual coherence, and loadings greater than .30. Of these, only the three-factor and two-factor solutions appeared to reflect the item difficulty structures. The three-factor solution was tested first, and the items were arranged in three dimensions based on the loadings. The results are presented in Appendix B. This analysis identified a third variable, one each in nutrition and math, however, hierarchical multiple regression analysis indicated that the latter variables were not adding or contributing sufficient information to be included as separate variables. These items were therefore eliminated.

Item difficulty was used to further examine the possibility of latent structures. Nutrition terminology items were first arranged in descending order of difficulty, separate from items related to diet/health relationships. Examination of the difficulty levels revealed that there possibly was only one rather than two different dimensions of nutrition knowledge. This was because difficulty levels included both nutrition and diet-health related items with a fairly equal distribution and could be combined as one variable. In order to determine whether or not a different hierarchy existed, the combined items were re-arranged in descending order of difficulty, examined, and defined in several ways to determine what the structures might be. Item difficulty scores of 85 and above were separated from lower scores.

The two-factor solution corresponding best to the two levels proposed by item difficulty cut-off points are presented in Appendix C. Items that did not fall into these two factors were eliminated. With this information, the dimensions and levels of the model were re-structured. Item difficulty and two-factor analysis data were used to create new structures with two nutrition and two math levels categorizing items with low difficulty on level 1 and high difficulty on level 2.

These data are summarized in Table 7. Nutrition knowledge on Level 1 had 18 items, and Level 2 had 6. Math Level one had 10 and Level 2 had 8 items.

Label scores were not re-structured into levels for 2 reasons:

1. With the exception of one item with a percent difficulty of 85, all other items were below 84%.

2. Factor analysis did not present factor loadings corresponding to item difficulty cut-off points being used for nutrition knowledge items. As such, all label items were included as one variable.

These were the variables used to address the final research question: to what extent can nutrition knowledge represented by a skills level model be an accurate predictor of food label use?

Table 7
Summary of Revised Structures of Nutrition and Related Math Knowledge

LEVELS	#	%	Fact.Load 1	Fact.Load 2	NUTRITION CONTENT (VAR.1)	#	%	Fact. Load 1	Fact. Load 2	MATH CONTENT (VAR.3)
1	6	95	.45	-.01	Identifying food groups	25	91	.45	.21	Calculating servings
Low	11	90	.52	.15	Healthy low fat foods	26	94	.35	.35	using multiplication
Diff.	14	99	.57	-.12	Calcium: food sources/	29	90	.56	.22	Calorie calculations
(>85%)	19	96	.50	.05	health relationships	54	90	.70	.07	given a formula
loads	23	87	.36	.21	Overweight and health	55	80	.57	.05	using
high on	44	89	.59	.20	Sucrose: food sources/	56	84	.54	-.01	multiplications
factor	45	92	.56	.01	health relationships	57	91	.68	.06	Calculating fat
1	47	89	.59	.20	Sodium: food sources/	81	93	.60	.19	using subtractions
	49	95	.55	.08	health relationships	83	85	.56	.36	Interpreting
	50	94	.73	.13	Iron: health/relationships	85	90	.56	.19	percentages
	52	89	.46	.08	Cholesterol/					
	63	94	.50	.07	health/relationships.					
	67	88	.42	.27						
	73	96	.67	.04						
	74	94	.59	.10						
	75	93	.54	.19						
	79	90	.54	.26						
	80	94	.47	.11						
STRUCTURE SUMMARIES: Application of nutrient health relationships to food categories.						Multiplication/subtraction/percentages				
					(VAR.2)					**(VAR.4)**
2	31	73	.11	.51	Protein functions	12	82	.37	.21	Serving size:
High	33	38	-.08	.54	Food sources of: simple	20	70	.14	.49	vegetables, grain,
Diff.	35	23	-.13	.55	carbohydrates,	21	71	.08	.25	milk
(<85%)	48	73	.12	.38	fat/cholesterol	24	71	.07	.46	Knowledge of
loads	61	83	-.01	.36	fiber sources	28	73	.24	.53	household
high on	69	48	-.05	.51	Vitamin A sources	58	75	.51	.01	measures:
factor						82	82	.44	.14	cups,lbs.,ozs.
2						84	61	.51	.21	Calculate %
										using division
										Conceptualizing
										percentages from
										given daily values
										Determining
										excesses over D.V
STRUCTURE SUMMARIES: Food sources of specific nutrients						Servings, household/metric measures/proportions, and label math.				

#= item number from original test. %= percent correct response

Re-examination of Reliability of Revised Structures

KR-20 and Pearson's r for reliability and internal consistency measures were once again examined for the new structures. Cell alphas constructed from factor analysis would be expected to have higher reliabilities than those obtained from the original instrument. Nutrition Level 1 cell alphas averaged 0.85 (18 items) and math level 1 averaged 0.78 (10 items). Lower alphas were observed for nutrition level 2 (6 items) averaging 0.55 and for math, 0.54 (8 items) (Table 8).

Math levels 1 and 2 correlated moderately with each other (.55) and with nutrition at level 1 (.52 and .70) and these variables correlated at a lower level with nutrition at level 2 (.31 and .37).

Final Analysis Re-addressing Research Questions

Hierarchical multiple regression analysis examining the new structures. Seven multiple regression models were examined and are presented in Table 9. Nutrition Level 1 (N1), math level 1 (M1), nutrition level 2 (N2), and math level 2 (M2) interactions were reversed in entry in models 6 and 7 to examine change effects. There were no significant differences due to the order of entry.

Table 8
Cell Correlation and Alpha Measures of Revised Structures

#	∝	Cells	N1	N2	M1	M2	LTOT
18	.86	N1	1.000				
6	.57	N2	.219	1.000			
10	.81	M1	.713	.311	1.000		
8	.57	M2	.516	.370	.552	1.000	
21	.89	LTOT	.543	.449	.576	.510	1.000

N1=Nutrition Level 1; M =Math; L=Label; Tot=Total Scores;
#= No. of items in the cell.

The main effect of nutrition terminology level 1 explained a highly significant 29% and level 2, an additional and significant 12%. Level 1 math explained 4% over and above both nutrition levels which was highly significant. Level 2 math explained an additional and significant 1%. The whole model contributed 52% which was also highly significant.

In conclusion, the original model explained about half of the variance in label scores using a total of 88 nutrition, diet health, and math items. These results were significant. The revised structures, with a total of 42 items explained 52% of the variance and was also highly significant (p.0001).

Sub-group hierarchical regression using revised structures. Gender, income, and race explained about 16-17% of the variance in label scores. Residualizing demographics reduced total nutrition (NTOT), almost by a third. The change in R^2 ($p < .0001$) is .23 whereas it was about .38 in the original model regression equations. Math total scores (MTOT) accounted for 40% of the variance in label scores. Residualizing demographics reduced the contribution of total math by 24%. These data are summarized in Table 10.

Table 9
Hierarchical Multiple Regression Analysis Using Revised Structures

STEP	VARIABLES	R^2	Change in R^2	F Change in R^2	Beta
Model 1. Step 1	NTOT	.36	.36	135.44***	.60
2	MTOT	.46	.09	40.72***	.39
3	NxM INTER	.46	.00	1.69 NS	.39
Model 2 Step 1	MTOT	.38	.38	143.13***	.61
2	NTOT	.46	.08	35.12***	.36
3	MxNINTER	.46	.00	1.69 NS	.39
Model 3 Step 1	N 1	.29	.29	99.50***	.54
2	N 2	.41	.12	45.78***	.35
3	M 1	.45	.04	16.68**	.29
4	M 2	.46	.20	7.09 NS	.16
Model 5 Step 1	N2	.20	.20	60.01***	.45
2	N1	.41	.21	83.27***	.46
3	M2	.44	.03	12.63**	.21
4	M1	.46	.02	11.03*	.24
Model 6 Step 1	N1	.29	.29	99.50***	.54
2	N2	.41	.12	45.78***	.35
3	M1	.45	.04	16.68***	.29
4	M2	.46	.02	7.09*	.16
5	N2M2	.46	.00	.00 NS	.00
6	N1M1	.52	.05	26.95***	1.45
Model 7 Step 1	N1	.29	.29	99.50***	.54
2	N2	.41	.12	45.78***	.35
3	M1	.45	.04	16.68***	.29
4	M2	.46	.01	7.09*	.16
5	N1M1	.52	.06	27.00***	1.45
6	N2M2	.52	.00	.06 NS	.06

N1 = Nutrition Level 1 etc. M1 = Math. TOT = total. * p< 01; ** p< 001; *** p<.0001.

Table 10
Sub-Group Hierarchical Regression Analysis Using Revised Structures

MODEL 1 STEP 1	R^2	Change in R^2	F Change in R^2	BETA	VARIABLE
1				.25	GENDER
2				.21	INCOME
3	.17	.17	15.89***	.25	WHITE
4	.40	.23	87.01***	.53	NTOT
5	.47	.08	34.77***	.38	MTOT
6	.48	.01	4.16 NS	.61	NMINTER
MODEL 2 STEP 3	.17	.17	15.89***	.25	WHITE
4	.41	.24	93.98***	.56	MTOT
5	.47	.07	29.08***	.33	NTOT
6	.48	.01	4.16 NS	.61	NMINTER

Model 2: steps 1 and 2 are similar to those used in Model 1.
* P<.01; ** P< .001; *** P< .0001.

CHAPTER FIVE

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

The FDA has developed a new food label which is appearing on most packaged and canned foods this year. Extensive research on consumer use suggests that approximately 20% of the U.S. population, composed mainly of elderly and minorities, cannot correctly interpret the nutrition information on the food label (Levy et al., 1992). This group represents a population at high risk of not making nutritious food choices.

There are numerous label education programs underway which make the results of this study timely since it provides valuable information on the importance of pre-assessment, in addition to providing an instrument with which to do this.

The literature on food label use revealed that consumers adopt a variety techniques in interpreting food labels including using formats or information as they are presented rather than changing them to meet their needs often ignoring information when it gets too complex (Bettman, 1977; Bettman, 1985; Levy, 1992; Levy 1993); selecting on the basis of usefulness of information (Brucks, 1984); or oversimplifying when faced with difficult concepts (Bettman, 1985; Wellman, 1990).

Although consumers say they want more information on labels (Asam, 1973; Opinion Research Corporation Surveys, 1990; Geiger, 1991), their decisions are less accurate when more is provided (Jacoby, 1974; Patton, 1981; Muller, 1984, Bettman, 1985), and their interpretation is not as accurate as when the quality of the information is better (Sproles, 1980; Keller, 1987). Income, race, age, and gender are also determinant variables in accurate of food label use (Mc Cullough, 1980; Vandeburg, 1981; Fanelli, 1990; Cole, 1990; Levy, 1991, 1992, Bender, 1992).

Mathematical skills required for correct interpretation present special problems. If the skills are too complex, most consumers won't make the effort (Bettman,1985). Using percentages, daily values, and computing servings and serving sizes presents the most difficulty (Daly, 1976; Bettman, 1977; Mc Cullough, 1980; Klopp, 1981; Levy, 1992).

Studies examining the relationships between nutrition knowledge and label interpretation reveal that except for calories, which are underestimated with respect to dietary recommendations by women more often than men, other nutrients are overestimated by as much as four times the RDA (Jacoby 1977). People make errors with respect to specific nutrients like fat, cholesterol, or the fiber content in foods (Stokes, 1972; Jacoby, 1974; Russo, 1986; Ernst, 1986; Levy, 1992). Although consumers say they need to know more about nutrition, over the course of 15 years this expressed need does not appear to have changed in that people show about the same deficits in nutrition knowledge (Liefeld, 1983; Roper Organization, 1992).

Summary

The objective of this study was to explore an approach to nutrition education with the learner's needs as a primary focus. This was done by examining the specific knowledge required for correct label interpretation based on a model in which nutrition knowledge was arranged in three hierarchical levels: food groups, macronutrients, and micronutrients in foods each with dimensions of nutrition terminology, health relationships, and related mathematic skills. The assumption was that people at different knowledge levels within each dimension would interpret and use label information differently and that pre-testing, using a reliable diagnostic instrument could allow the educator to establish the consumer's or groups' comprehension and competency levels prior to an intervention.

The research questions that the study was designed to address were:

1. What is the relationship between performance on label interpretation and nutrition knowledge related to the major food groups?

2. What is the relationship between performance on label interpretation and nutrition knowledge related to macronutrients including protein, carbohydrate, fat, and fiber?

3. What is the relationship between performance on label interpretation and nutrition knowledge related to micronutrients including cholesterol, vitamins, and minerals.

4. To what extent is nutrition knowledge represented by a skills level model an accurate predictor of correct food label interpretation?

The model served as a useful heuristic in the development of an instrument which was subsequently piloted to test this knowledge. Test items were revised based on correlational data, item analysis, reliability, and peer review. This instrument was then administered to a purposive sample of adults representing the range of nutrition knowledge measured in the test. The median age of the sample was 34, with whites comprising 81%, and males, 67%. Seventy-one percent came from households with incomes above $50,000. Analysis of variance revealed that scores of people with incomes above $20,000 were significantly higher than those earning less, and mean scores for males were significantly higher than females. Income and education may account for the results of the former but those of the latter were an unexpected finding and may reflect a more competitive approach to testing. However, because of the type of sample it is not possible to generalize from these results and they should be interpreted with caution.

Tests for internal consistency and cell correlations supported the intended constructs measured by the instrument. Because nutrition terminology, diet health relationships and math skills are not independent, hierarchical multiple regression was used to examine the unique association of each construct of the model with food label interpretation. Separate regression models were developed for each level. Each of the three models tested the first three research questions respectively, and explained a significant portion of the variance in label interpretation scores. Nutrition knowledge related to the major food groups (level 1) by itself explained a significant 46% of the variance in label scores. Nutrition knowledge related to the macronutrients (level 2) explained a significant 30% although math skills at this level did not contribute significantly to the model. Nutrition knowledge related to the micronutrients (level 3) explained a significant 40%. The whole model at all three levels explained 52 % of the variance.

An examination of item difficulty and factor analysis was not consistent with the dimensions or levels posited by the model; instead, it appeared that other structures may exist. To explore this finding the items were re-arranged in increasing order of difficulty. Item difficulty using percent correct responses were used to explore alternate structures. Total percent correct scores greater than 85% were included in level 1, and the remaining items (less than 85% correct) in level 2. The results of exploratory factor analysis were examined for the whole model, six, four, three, and two factors using a varimax rotation. Of these, the two-factor solution appeared to best reflect the revised proposed levels based on item difficulty. Items that did not load on either factor of the two-factor analysis were eliminated. Label interpretation test scores were not re-structured because they did not meet the criteria used for re-structuring the combined nutrition, diet health relationships, and related math skills. Instead, all label items were combined as a single variable.

Reliability and internal consistency measures were higher than the original model even though there were fewer items.

Multiple hierarchical regression analysis at level 1 explained a significant 29% and level 2 an additional and significant 12%. Level 1 math explained more than level 2 math and was highly significant. Whereas the original model explained 52% of the variance in label scores with 88 items, the revised structures explained the same amount of variance with only 42 items.

Math and nutrition scores were highly correlated suggesting that these specific math skills are, to some extent, necessary for utilizing certain nutrition knowledge. Using the revised structures, the model is useful in predicting accuracy of food label interpretation based on nutrition knowledge and related math skills.

Conclusions

The model that was developed for this study was conceptualized under the assumption that nutrition knowledge structures exist at levels of complexity based on most acceptable learning theories: that learning proceeds from the simple to the complex. Results indicate that this may not always be the case, and in the absence of empirical data describing a theoretical framework for nutrition knowledge structures, this study may provide information about nutrition knowledge in the public.

Two models were created and examined (Table 1 and 7). In one the conceptual base is similar to the nutrition education interventions conventionally provided to people, and designed around food groups and the nutrients that are in the foods. The second model emerged as a result of the scores on the test instrument and was based on factor analysis and item difficulty arranged in 2 levels.

An examination of these levels revealed:

1. Level 1 appeared to be related to general nutrition knowledge and health relationships. Subjects had least difficulty applying some general nutrition health

relationships to food sources. For example, given a choice of cooked food items they were able to pick the healthiest choice based on the method of preparation.

2. Level 2. Subjects exhibited difficulty in relation to the specific nutrient contributions of different foods. For example, out of a selection of four vegetables, they experienced difficulty identifying a food high in vitamin A.

In general, subjects knew more about macro- and micronutrients, as defined in Levels 2 and 3 of the originally hypothesized model, and their relationships to health than they did about the food sources of these nutrients. For example, they understood the role of fiber, fat, cholesterol, and calcium in disease prevention but experienced difficulty identifying food sources of these nutrients, as well as differences in fat types. These results are similar to those reported by Fullmer (1991) and Levy (1992).

There are several possible explanations for these findings:

1. The number of pieces of information required to master knowledge about nutrient health relationships are fewer than those required to identify nutrient contributions of specific foods. This task is becoming increasingly difficult as the food market becomes more complex due to an increasing supply of processed and prepared foods whose origin is not easily discernable. This may explain the differences between nutrition level 1 and the levels required to identify macro- and micronutrients.

2. Media and advertising are focused more on the relationships between nutrients and health in a push to sell vitamin supplements and prepared products than

on educating the public about the nutritional value of minimally processed foods. The trend for better knowledge about specific nutrients like calcium and cholesterol maybe because they are concentrated in relatively few foods and are more prominently displayed on labels.

3. A health-related individual or family problem like diabetes or heart disease may exist requiring dietary intervention and more extensive education on the specific nutrients that may have to be included or avoided.

The nutrition related mathematics skills reveal that people know how to do subtraction, multiplication, and percentages better than they know the recommended serving sizes of foods within various groups and the household measures used for these computations. This may be due to the fact that serving sizes are not realistic with respect to actual measures used in the home. For example, a standard 12-ounce glass is more easily equated with a serving of milk than is the recommended 8-ounce measure.

Subjects experienced difficulty calculating percentages of daily values and determining excesses over DV's. Computational skills required for label interpretation presented difficulties similar to those reported from the CSFII and DHKS (Cleveland, 1992) as well as results reported by Daly (1977) and Levy et al.(1992). People do not have a frame of reference for interpreting gram and milligram measures as being high or low and they appear to judge by the size of the number presented (e.g. 1500-2000 mg. sodium). Although percent declarations would be more accurate to use, proportions are not well understood either.

Implications for Practice

Nutrition education interventions have been launched from numerous sectors, both private and government. However, there have been none to date that begin by pre-assessing the learner's nutrition knowledge and creating interventions based on specific needs. This can be done by personalizing nutrition education interventions, and critically examining what the public needs to know, which is in their best interest and is in accordance with their perceptions, values, and beliefs.

Pre-testing using a reliable instrument like the one developed in this study, can be used to evaluate the consumer's knowledge base and to identify and assess needs. People are likely to learn more when an intervention is based on their pre-existing knowledge, which may not always be congruent with a professional's food classification approach to nutrition knowledge.

If this study is repeated with the recommendations included in this chapter and the results confirm that these levels of knowledge exist, interventions can be designed for specific levels, either low or complex depending on pre-assessment outcomes. This would be an improvement on the uni-level approach used in most nutrition education interventions.

The new food label and the Food Guide Pyramid developed by the FDA and the USDA respectively, present nutrition educators with a challenge to test their educational intervention skills. The public and, in particular some high risk groups identified as the elderly and minorities, need help in the proper use of these tools in making nutritious food choices.

Nutritionists can respond to this challenge by designing and conducting effective interventions based on research and nutrition education theory in order to increase exposure and confidence in the profession. This study emphasizes the need for pre-assessment as a way of identifying an existing knowledge base that people possess. This puts the learner in an active role and acknowledges his or her unique contributions to the learning process. A commitment to change can occur only when goal setting and learning processes are agreed on mutually, where the learner is encouraged to eventually become independent of an intervention, and when there is an atmosphere of mutual respect in the acknowledgement of each individual's contribution to learning.

Recommendations for research

This results of this study suggests areas for future research. Some of the questions that may be asked are:

Is there an additive index of nutrition knowledge? In other words, are there different ingredients that add up to what we call nutrition knowledge? If we construct different items that tap nutrition knowledge and analyze the scores, we are assuming an additive index rather than one that is subsumed by two or more factors.

Is nutrition knowledge measurable only by its latent structures (i.e structures that cannot be measured directly but instead must be indirectly inferred from actual behavior)? Can nutrition knowledge therefore be more accurately measured by including food choice, food safety, food preparation, or other dimensions along with test scores based on single dimensions?

This study revealed that nutrition knowledge accounts for 52% of the variance in label interpretation scores. Presumably, additional factors added to the model would explain even more. Are there therefore, other dimensions of knowledge or behavior that are relevant for predicting the ability to accurately interpret a food label?

Research could be directed at identifying dimensions of knowledge other than those identified in this study. This could be done by revising and updating the instruments used in this study. Confirmation of the structures reported here may be improved by generating a different pool of items by a variety of writers in order to control for author influence. Culture or regionally-sensitive items need to be examined and revised. For example, in this study, corn was classified either as a vegetable or a grain probably because of cultural or regional differences. Both 05-responses could be considered correct. There is a need to have a standardized instrument with predictive value.

A readability index should be established as it pertains to the population in question. The test may be converted to an interactive video format to accommodate low literacy levels or to entice people to take the test with less anxiety.

Even without a formal education, food preparers generally use some math skills that they are not consciously aware that they have; for example, recipes require the use of proportions and measuring skills. In order to test pure math skills separate from nutrition or food related mathematics skills, a test for the former could be administered followed by a test similar to the one in this study in order to identify these special skills. This will permit an examination of the possibility that these skills are more a part of nutrition knowledge than mathematics.

This investigation may lend strength and purpose to the further development of a philosophy of nutrition education in that it is based on engaging the adult learner in the education process. Knowledge of the skills and competencies required for a task are quantitatively defined, and may provide an understanding of nutrition knowledge structures in the consumer. These in turn, will be of value in designing effective nutrition education interventions of public health significance. The instruments designed and validated in this research may be further refined and used or adapted for use and provide practitioners with empirical data that pre-assessment can work to facilitate the acquisition and possible outcomes of nutrition education.

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APPENDICES

APPENDIX A

REVISED NUTRITION KNOWLEDGE TEST

Please circle only one of the four options, a,b,c, or d.

1. Which one of the following has a food value similar to bread or cereal?

   a. rice
   b. white potatoes
   c. corn-on-the-cob
   d. sweet potato

2. Which one of the following has the same food value as milk?

   a. eggs
   b. margarine
   c. butter
   d. cheese

3. Which of one of the following is classified as a vegetable?

   a. corn chips
   b. potatoes
   c. peanuts
   d. popped corn

4. Which one of the following has the same nutritional value as milk?

   a. mayonnaise
   b. yogurt
   c. dessert topping (like Cool Whip)
   d. salad dressing

5. Which one of the following has a food (nutritional) value similar to meat?

   a. potatoes
   b. oatmeal
   c. fish
   d. rice

6. Pasta and rice are

   a. vegetable foods
   b. grain foods
   c. milk foods
   d. fruit foods

7. Which one of the following has the same food value as pure fruit juice?

   a. beverage (like Kool Aid)
   b. grape jelly
   c. apple
   d. jello gelatin

8. Select one food that has the same food value as meat

a. french fries
b. tuna fish
c. milk
d. oatmeal

9. Select the food that is classified as a vegetable

a. corn oil
b. grapes
c. sweet potato (yams)
d. salad dressing

10. Which one of the following provides mostly fat and few other nutrients?

a. roast pork
b. butter
c. plain yogurt
d. peanuts

11. Which one of the following provides mostly sugar and few other nutrients?

a. orange juice
b. apple jelly
c. pears
d. strawberries

12. It is recommended that we eat 3-5 servings of vegetables a day. According to the guidelines, one serving would be about

a. 3 cups
b. 2 cups
c. half cup
d. two tablespoons

13. One medium ear of corn is about

a. 3 servings
b. 1 serving
c. 2 servings
d. half a serving

14. Which one of the following would be the healthiest low-fat vegetable?

a. creamed corn
b. salad with regular french dressing
c. steamed broccoli
d. french fries

15. It is recommended that we eat 3-4 servings of fruit daily. A half a grapefruit is about

a. 3 servings of fruit
b. 2 serving
c. 1 serving
d. less than half a serving

16. If you ate one banana and a half a cup of orange juice, how many more servings would you need to get 4 servings a day?

a. 1
b. 2
c. 0
d. 3

17. It is recommended that we need 2-3 servings of meat, poultry, fish or eggs a day. Which one of the following is about one serving of meat?

a. 6 ounces of lean hamburger meat
b. 2 slices of sandwich-sliced ham
c. half a chicken
d. an 8-ounce steak

18. Which lunch contains a serving of meat or its alternative?

a. bacon, lettuce and tomato sandwich
b. tuna sandwich
c. macaroni salad
d. cucumber and tomato sandwich

19. Which one of the following meats or alternatives is the healthiest low-fat choice?

a. a quarter pound hamburger
b. fried leg and thigh of chicken
c. two hot dogs
d. three ounces of baked fish

20. It is recommended that we eat 6-11 servings of grain foods like bread and cereals daily. Which of the following would equal 1 serving from this group?

a. 3 slices of bread
b. half a bagel
c. 2 cups of oatmeal
d. 2 cups of cooked rice

21. It is recommended that adults consume at least 2-3 servings of milk or a milk product a day. Which one of the following would equal one serving of milk?

a. 4 cups
b. 3 cups
c. 1 cup
d. half a cup

22. One serving of milk or its equivalent is

a. half a sandwich-style slice of cheese
b. 1 cup yogurt
c. 1 ounce sour cream
d. 2 tablespoons butter

23. Which of the following is a healthy low-fat choice of milk or milk products?

a. cheddar cheese
b. skim milk ricotta cheese
c. custard-style yogurt
d. whole milk

24. How many ounces are there in a quarter of a pound?

a. 2
b. 3
c. 4
d. 8

25. A can of carrots contains four servings. How many cans would be required to provide one serving each for 8 people?

a. 1
b. 2
c. 3
d. 4

26. A small can of tuna contains 3 ounces (about 1 serving). How many cans are needed to provide 4 people with one serving each?

a. 1
b. 3
c. 2
d. 4

27. Half a cup of margarine or butter is equal to

a. 3 sticks
b. 2 sticks
c. 1 stick
d. a quarter stick

28. In the diet guides, one serving of milk equals 1 cup. In ounces, this is

a. 2
b. 4
c. 6
d. 8

29. In the diet guides, one serving of cooked pasta is a half a cup. If an adult consumes 3 cups, how many servings is this?

a. 2
b. 3
c. 4
d. 6

30. How many teaspoons of sugar are there in 1 tablespoon?

a. 1
b. 3
c. 4
d. 5

31. The main function of protein is to

a. provide calories for energy
b. build muscle and other tissues
c. build strong bones
d. provide all the vitamins

32. Given 2 ounces of each of the following foods, which one provides the most protein?

a. bacon
b. wholewheat bread
c. cream cheese
d. fish

33. Which one of the following is a source of simple carbohydrate?

a. sugar
b. starch
c. fiber
d. protein

34. Which one of the following is classified as a source of complex carbohydrate?

a. applesauce.
b. rice.
c. milk.
d. cheese.

35. Which one of the following foods is classified as a source of simple carbohydrate?

a. grape juice
b. rice
c. plain corn flakes
d. potatoes

36. A complex carbohydrate is generally proportionately higher in

a. sugars
b. starch
c. protein
d. fats

37. Which of the following statements is true?

a. butter is an unsaturated fat
b. margarine is an unsaturated fat
c. butter has no cholesterol
d. butter is a saturated fat

38. Which one of the following is an unsaturated fat?

a. bacon fat
b. peanut oil
c. butter
d. shortening, (like CRISCO)

39. Which one of the following foods would be highest in calories?

a. 2 ounces of hard candy
b. 2 ounces of strawberry jam
c. 2 ounces of butter
d. 2 ounces of plain, mashed potatoes

40. Which one of the following fats and oils (one tablespoon each), are lowest in calories?

a. regular corn oil margarine
b. butter
c. oil and vinegar dressing
d. olive oil

41. Which one of the following fruits or juices are highest in fiber?

a. orange juice
b. applesauce
c. whole apple
d. cranberry jelly

42. The nutrient that provides the most calories per gram is

a. protein
b. sugar
c. fat
d. starch

43. If your diet is high in fresh fruits, vegetables, and grain products and lower in meats and milk foods it will be

a. high in fiber
b. high in sugars
c. low in vitamins
d. low in carbohydrates

44. To follow a low fat diet, the foods to use sparingly are

a. vegetables
b. grain foods like bread and cereals
c. meats, milk and milk products
d. fruits and fruit juices

45. Which one nutrient do you think is most important to use sparingly to lower the risk for heart disease?

a. sugar
b. fat
c. carbohydrate
d. protein

46. Carbohydrates, fat and protein provide calories. Which statement about these nutrients is true? Of the three

a. carbohydrates provide the most calories.
b. fat provides more than double the calories of protein and carbohydrate
c. fat and carbohydrates provide the same number of calories
d. protein and fat provide the same number of calories

47. Which nutrient is most important to cut down on in weight reduction diets?

a. fiber
b. protein
c. fat
d. carbohydrate

48. High fiber diets are important because they may prevent

a. cancer of the intestines
b. bone problems in adults
c. iron deficiency anemia
d. high blood pressure

49. Being obese puts a person at risk for developing which one of the following diseases?

a. lung disease
b. heart disease
c. anemia (iron poor blood)
d. bone cancer

50. An excess of saturated fat in the diet may lead to

a. high blood sugar
b. kidney disease
c. clogged arteries
d. digestive problems

51. Most diet guides suggest that at least 55% of our total calories come from carbohydrates, most of which should be complex and high in fiber. Which one of the following foods best meet this recommendation?

a. white bread
b. oatmeal
c. applesauce
d. bananas

52. People with diabetes would be better off avoiding

a. meat and chicken
b. milk and cheese
c. jams and jellies
d. fruits and vegetables

53. Which one of the following nutrients raises blood sugar levels the most in a person with diabetes?

a. saturated fat
b. simple carbohydrate
c. protein
d. complex carbohydrate

The following can be used for calculating calorie values in the next 2 questions:
1 gram of fat=9 calories, 1 gram of protein=4 calories and 1 gram of carbohydrate=4 calories.

54. If a steak contained 30 grams of protein and 5 grams of fat the total number of calories would be

a. 240
b. 290
c. 165
d. 190

55. How many calories are there in 5 grams or 1 teaspoon of sugar?

a. 50
b. 100
c. 20
d. 5

56. Diet guides suggest that 55% of one's calories should come from carbohydrates. This is

a. under half the total calories
b. over half the total calories
c. almost all the total calories
d. a quarter of the total calories

57. If a diet contains a total of 86 grams of fat (saturated and unsaturated), and 40 grams of it was saturated, how many grams were unsaturated?

a. 33
b. 46
c. 52
d. 27

58. If a 2000 calorie diet provides 720 fat calories, what percent of the calories come from fat?

a. 25%
b. 50%
c. 36%
d. 75%

59. About how many grams of salt are there are in 1 teaspoon ?

a. 1
b. 5
c. 15
d. 30

60. 2 pieces of pizza has about 30 grams of fat. About how many teaspoons of fat is this?

a. 2
b. 6
c. 3
d. 10

61. Given 1 ounce of each of the following, which one do you think is highest in cholesterol?

a. butter
b. margarine
c. olive oil
d. corn oil

62. Which one of the following foods is a good source of calcium?

a. potato
b. rice
c. skim milk
d. egg

63. Which one of the following is a poor source of calcium?

a. milk
b. cottage cheese
c. dessert topping (like Cool Whip)
d. yogurt

64. Which food, (each weighing 1 ounce) has the most iron?

a. potatoes
b. chicken
c. yogurt
d. cooked peas.

65. Which of the following statements is true? The foods highest in iron are

a. meats
b. milk products
c. yellow vegetables
d. fresh fruits

66. Which one of the following foods (one ounce each) is highest in sodium?

a. fresh fish
b. bread
c. applesauce
d. hot dogs

67. People who wish to cut down on sodium should limit their use of

a. lemon juice
b. soy sauce
c. black pepper
d. fresh garlic

68. Which groups of foods are highest in vitamin C?

a. bread/grain
b. meats
c. milk
d. fruits

69. Assuming equal serving sizes, which of the following is highest in vitamin A?

a. pears
b. sweet potatoes (yams)
c. white potato
d. cauliflower

70. Which of the following statements is true?

a. green peppers are good sources of vitamin C.
b. meats are good sources of calcium
c. milk and cheese are good sources of iron
d. bread and pasta are good sources of vitamin A

71. Which one of the following foods contains no cholesterol?

a. chicken
b. pork
c. egg whites
d. ice cream

72. People on low cholesterol diets should lower their intakes of

a. fish
b. beef
c. peanut butter
d. skim milk

73. A lack of sufficient calcium throughout life may, in old age, lead to

a. cancer
b. brittle bones
c. diabetes
d. kidney failure

74. In children and adolescents, calcium is most important for

a. healthy blood
b. good muscle tone
c. bone and tooth formation
d. good eyesight

75. People with hypertension (high blood pressure) may need to reduce their intake of

a. sodium
b. iron
c. potassium
d. calcium

76. Which one of the following vitamins is thought to be protective against cancer?

a. Vitamin D
b. Vitamin E
c. Vitamin K
d. Vitamin B-1 (Thiamin)

77. The vitamins that are thought to be protective against cancers are called antioxidants and include vitamins A and C. Which one of these pairs of foods would provide the most antioxidants?

a. meat and chicken
b. carrots and oranges
c. lettuce and onions
d. tuna fish and shrimp

78. People lacking iron in their diets should increase their consumption of

a. fruit
b. cheese
c. red meat
d. potatoes

79. A lack of iron in the diet may lead to

a. diabetes
b. anemia
c. heart disease
d. dental decay

80. Too much cholesterol in the diet may put a person at risk for

a. anemia
b. kidney disease
c. heart disease
d. stomach ulcers

81. Diet guides recommend that we consume no more than 300 milligrams of cholesterol a day. A whole egg has 212 mg of cholesterol. If a person ate an egg for breakfast, how many more milligrams would s/he be allowed that day?

a. 70
b. 88
c. 90
d. 100

82. Approximately what percent of the recommendation for cholesterol is there in an egg?

a. 100%
b. 75%
c. 200%
d. 150%

The daily recommendation for Vitamin C is 60 milligrams. Use this guideline to answer the next 2 questions.

83. An orange provides 70 milligrams of vitamin C. Approximately what percent of the daily recommendation of vitamin C is this?

a. a little over 100 %
b. 50%
c. 150%
d. more than 200%

84. A supplemental tablet of vitamin C has 1000 milligrams. About how much in excess of the recommendation is this?

a. 6 times
b. 10 times
c. 100 times
d. 15 times

85. Individuals 11 to 25 years of age should consume 1200 milligrams of calcium a day. 1 cup of skim milk provides 300 milligrams. How many cups of milk will meet the daily requirements?

a. 2
b. 3
c. 4
d. 5

86. One Mac Donald's Big Mac has about 900 milligrams of sodium. About what percent of the daily safe limit of 2400 mg.is this?

a. 10 %
b. 5 %
c. 30 %
d. 50%

87. An adult female requires about 15 milligrams of iron a day. Half a cup of fresh, cooked spinach provides about 4 milligrams. Approximately what percent of the recommendation for iron is this?

a. 25 %
b. 50 %
c. 60 %
d. 75 %

FOOD LABEL INTERPRETATION

The following questions are all based on the attached food label. Use it to answer questions 88-108. For the purposes of this test consider beans a vegetable. You may detach the label, it does not have to be returned with the test.

88. From the ingredient list you conclude that

a. there are more onions than tomato paste in this product
b. there is meat in this product
c. mixture of beans are used
d. in quantity, water is the second highest ingredient

89. The label tells you that

a. there is more food color than sodium nitrate
b. there is less salt than red peppers
c. red food color is used
d. there is more water and tomato paste than beans

90. The list also tells you that

a. there are equal quantities of meat and beans
b. there are two sources of sodium in the product
c. fresh, whole tomatoes were used in the sauce
d. there are more red peppers than onions

91. How many servings are there in this container?

a. 3
b. 1
c. 4
d. 5

92. What is the quantity of one serving of this product?

a. 4 cups
b. 1 cup
c. 3 cups
d. 2 cups

93. 3-5 servings of vegetables is the recommended daily intake. If you ate 3 servings of this food in a day, how many more would you require to get the maximum 5 servings?

a. 4
b. 2
c. 1
d. 0

94. One serving of this food fulfills the requirement for

a. fruit
b. vegetable
c. milk
d. grain, bread, or cereal

95. How many cans are needed to provide 4 people with one serving each?

a. 1
b. 3
c. 2
d. 4

The percent daily values (D.V.) on the label are based on a 2000 calorie diet.

96. Using percentage allowances, one serving of this food is

a. a fairly good source of protein
b. very low in fiber
c. very high in carbohydrates
d. very low in fat

97. 3 servings of this food provide

a. a poor source of fiber
b. 100% daily fiber recommendations
c. 100% daily carbohydrate requirements
d. a poor source of protein

98. If you ate 1 serving of this food in a day about how much more fiber would fulfill your recommended daily values?

a. 5 grams
b. 16 grams
c. 9 grams
d. 30 grams

99. 1 serving of this food would provide

a. 20 grams of fiber
b. 3 grams of total fat
c. 36 grams of fiber
d. 36% of the daily value for fiber

100. What percent of the Daily Value for total fat is in 2 cups of this chili with beans?

a. 17
b. 26
c. 13
d. 34

101. Which ingredient do you think contributes the most fiber in this food?

a. onions
b. beans
c. tomatoes
d. red peppers

102. One serving of this food is

a. a low source of cholesterol
b. low in sodium
c. relatively high in cholesterol
d. a good source of calcium

103. Two servings provide

a. a good source of iron
b. a high source of Vitamin C
c. 42% sodium
d. 100% of the daily value for A

104. If you ate 3 servings of this of this food in a day which one of the following nutrients should you try to get <u>more</u> of to fulfill your recommended daily values?

a. vitamin A
b. vitamin C
c. iron
d. sodium

105. If you ate 3 servings of this food in a day which one of the following nutrients should you <u>limit</u> in the foods you eat the rest of the day?

a. calcium
b. vitamin C
c. sodium
d. carbohydrate

106. 1 serving of this food would provide

a. 35 grams of vitamin A
b. 44 milligrams of cholesterol
c. 30 milligrams of iron
d. 6% of one's daily calcium needs

107. What percent of the daily value for vitamin C is in 3 servings?

a. 6
b. 2
c. 8
d. 4

108. Persons with heart disease should limit their intake of this food because it is relatively high in

a. fiber
b. carbohydrate
c. cholesterol
d. iron

The following information is needed for the study but cannot be traced to you since your name is not being asked for. Please circle the number or letter that applies to you.

ETHNIC ORIGIN

1. White
2. Black
3. Asian/Pacific Islander
4. American Indian/Alaskan native
5. Hispanic (Mexico/South, Central America)

FAMILY INCOME

1. less than $20,000
2. $20,000 - 50,000
3. $50,000 - 100,000
4. 100,000 and over

AGE

1. 18-25 years
2. 26-34
3. 35-50
4. 51 +

GENDER

1. Male
2. Female

EDUCATION

Select highest level completed

1. Grade school
2. High school
3. Some College
4. 4-year degree
5. Graduate degree +

Chili with Beans

Nutrition Facts

Serving Size 1 cup (253 g)
Servings Per Container 4

Amount Per Serving

Calories 260 Calories from Fat 70

	% Daily Value*
Total Fat 8g	13%
Saturated Fat 3g	17%
Cholesterol 130mb	44%
Sodium 1010mg	42%
Total Carbohydrate 22g	7%
Dietary Fiber 9g	36%
Sugars 4g	
Protein 25g	

Vitamin A 35% • Vitamin c 2%

Calcium 6% • Iron 30%

* Percent Daily Values are based on a 2,000 calorie diet. Your daily values may be higher or lower depending on your calorie needs:

	Calories:	2,000	2,500
Total Fat	Less than	65g	80g
Sat Fat	Less than	20g	25g
Cholesterol	Less than	300mg	300mg
Sodium	Less than	2,400mg	2,400mg
Total Carbohydrate		300g	375g
Dietary Fiber		25g	30g

Calories per gram:
Fat 9 • Carbohydrate 4 • Protein 4

Ingredients: kidney beans, water, tomato paste, butter, onions, salt, peppers, sugar, U.S. certified food color, and sodium nitrate

APPENDIX B

Nutrition Knowledge, 3-factor solution

Orthogonal Transformation Matrix

	1	2	3
1	0.83752	0.46822	0.28165
2	-0.52767	0.82688	0.19451
3	-0.14181	-0.31153	0.93959

Rotation Method: Varimax

Rotated Factor Pattern

	FACTOR1	FACTOR2	FACTOR3
RW1	-0.00090	-0.06561	0.30581
RW2	0.14972	0.11554	0.04766
RW3	0.11333	0.27614	-0.02694
RW4	0.28541	0.11504	0.09624
RW5	-0.01076	0.08270	0.64026
RW6	0.46616	0.01530	-0.05718
RW7	0.18714	0.11515	0.23023
RW8	0.08529	0.07951	0.57595
RW9	0.25449	0.08800	0.05128
RW10	0.29108	0.32396	0.26877
RW11	0.49032	0.09088	0.25183
RW12	0.31926	0.17166	0.16489
RW13	0.02254	0.13345	0.12358
RW14	0.54921	-0.15894	0.15667
RW15	0.19162	0.24803	0.10405
RW16	0.02543	-0.03565	0.21745
RW17	0.00605	0.07231	0.37499
RW18	0.21938	0.12356	0.29446
RW19	0.46636	-0.02056	0.26468
RW31	0.10043	0.49848	0.11846
RW32	0.27930	0.16342	0.40308
RW33	-0.09742	0.51273	0.16690
RW34	0.17319	0.20813	0.34171
RW35	-0.15152	0.50033	0.24202
RW36	0.07385	0.06469	0.30614
RW37	0.31328	0.14605	0.07840
RW38	0.06342	0.36435	0.12135
RW39	0.01706	0.31653	0.16897
RW40	0.12565	0.30062	0.04232
RW41	0.24087	0.26205	-0.12095
RW42	0.10159	0.28143	-0.00365
RW43	0.26839	0.29788	0.05640
RW44	0.57389	0.17354	0.16983
RW45	0.53513	-0.05407	0.23679
RW46	0.18914	0.28076	-0.13780
RW47	0.59603	0.05123	-0.04663
RW48	0.18474	0.50475	-0.29819
RW49	0.57737	0.14830	-0.16338
RW50	0.72229	0.12624	0.09996
RW51	0.11177	0.38107	0.12042
RW52	0.47558	0.11174	-0.03178
RW61	-0.01089	0.36908	0.04458
RW62	0.20065	0.15476	0.42225
RW63	0.48177	0.03313	0.17282

RW64	0.06872	0.31720	0.24150
RW65	0.11228	0.25927	0.12964
RW66	0.45456	0.46146	-0.12122
RW67	0.43893	0.31146	-0.04229
RW68	0.32135	-0.01119	0.24976
RW69	-0.03981	0.53234	-0.00196
RW70	0.02469	0.35009	0.00193
RW71	0.25381	0.29597	0.08078
RW72	0.09038	0.21360	-0.09934
RW73	0.66028	0.01636	0.11877
RW74	0.57806	0.08490	0.10909
RW75	0.57414	0.26072	-0.12758
RW76	0.10424	0.30301	0.08041
RW77	0.36964	0.32816	-0.04031
RW78	0.27940	0.16434	0.01431
RW79	0.51807	0.21242	0.22000
RW80	0.45761	0.07894	0.15373

Variance explained by each factor

FACTOR1	FACTOR2	FACTOR3
6.692914	3.924707	2.757285

Math items, 3-factor solution

Rotation Method: Varimax

Orthogonal Transformation Matrix

	1	2	3
1	0.89354	0.44719	0.04003
2	-0.16338	0.40690	-0.89874
3	-0.41820	0.79652	0.43665

Rotated Factor Pattern

	FACTOR1	FACTOR2	FACTOR3
RW20	0.07216	0.56627	-0.20934
RW21	-0.06645	0.46283	0.03563
RW22	0.05221	0.28440	-0.11239
RW23	0.39717	0.14831	-0.09063
RW24	0.20439	0.13815	-0.42401
RW25	0.50641	0.10537	-0.08519
RW26	0.44857	0.14040	-0.24185
RW27	0.21145	0.08700	-0.09338
RW28	0.27168	0.39812	-0.33384
RW29	0.63244	0.09244	-0.08667
RW30	0.10513	0.24573	0.08862
RW53	0.03197	0.34576	-0.08744
RW54	0.75341	0.00706	0.06428
RW55	0.54684	0.11770	0.12532
RW56	0.57849	-0.04119	0.09705
RW57	0.69000	0.08530	0.10737
RW58	0.58064	-0.08261	0.04669
RW59	0.14759	0.10680	0.79983
RW60	0.14759	0.08901	0.72670
RW81	0.51132	0.37507	0.11026
RW82	0.29293	0.41944	0.16185
RW83	0.50827	0.43367	-0.05275
RW84	0.48260	0.26720	0.00996
RW85	0.53470	0.25163	0.04298
RW86	0.15227	0.37421	0.14052
RW87	0.07861	0.62857	0.06880

APPENDIX C

LEVEL ONE COMBINED NUTRITION KNOWLEDGE ITEMS ARRANGED IN DESCENDING ORDER 0F DIFFICULTY WITH 2-FACTOR LOADINGS USING ONLY ITEMS INCLUDED IN THE REVISED STRUCTURES

(Directions for answering items on original test, Appendix 1)

(#=item; % = difficulty; 1&2 = loadings on each of 2 factors.)

#	%	FACTORS 1	FACTORS 2	
14.	99	.57	-.12	Which one of the following would be the healthiest low-fat vegetable? a. creamed corn b. salad with regular french dressing c. steamed broccoli d. french fries
19.	96	.50	.05	Which one of the following meats or alternatives is the healthiest low-fat choice? a. a quarter pound hamburger b. fried leg and thigh of chicken c. two hot dogs d. three ounces of baked fish
73.	96	.67	.04	A lack of sufficient calcium throughout life may, in old age, lead to a. cancer b. brittle bones c. diabetes d. kidney failure
6.	95	.45	-.01	Pasta and rice are a. vegetable foods b. grain foods c. milk foods d. fruit foods
49.	95	.55	.08	Being obese puts a person at risk for developing which one of the following diseases? a. lung disease b. heart disease c. anemia (iron poor blood) d. bone cancer
63.	94	.50	.07	Which one of the following is a poor source of calcium? a. milk b. cottage cheese c. dessert topping (like Cool Whip) d. yogurt

#	%		

74. 94 .59 .10 In children and adolescents, calcium is most important for

a. healthy blood
b. good muscle tone
c. bone and tooth formation
d. good eyesight

80. 94 .47 .11 Too much cholesterol in the diet may put a person at risk for

a. anemia
b. kidney disease
c. heart disease
d. stomach ulcers

50. 94 .73 .13 An excess of saturated fat in the diet may lead to

a. high blood sugar
b. kidney disease
c. clogged arteries
d. digestive problems

75. 93 .54 .19 People with hypertension (high blood pressure) may need to reduce their intake of

a. sodium
b. iron
c. potassium
d. calcium

45. 92 .56 .01 Which one nutrient do you think is most important to use sparingly to lower the risk for heart disease?

a. sugar
b. fat
c. carbohydrate
d. protein

79. 90 .54 .26 A lack of iron in the diet may lead to

a. diabetes
b. anemia
c. heart disease
d. dental decay

11. 90 .52 .15 Which one of the following provides mostly sugar and few other nutrients?

a. orange juice
b. apple jelly
c. pears
d. strawberries

%

44. 89 .59 .20 To follow a low fat diet, the foods to use sparingly are
   a. vegetables
   b. grain foods like bread and cereals
   c. meats, milk and milk products
   d. fruits and fruit juices

47. 89 .58 .02 Which nutrient is most important to cut down on in weight reduction diets?
   a. fiber
   b. protein
   c. fat
   d. carbohydrate

52. 89 .46 .08 People with diabetes would be better off avoiding
   a. meat and chicken
   b. milk and cheese
   c. jams and jellies
   d. fruits and vegetables

67. 88 .42 .27 People who wish to cut down on sodium should limit their use of
   a. lemon juice
   b. soy sauce
   c. black pepper
   d. fresh garlic

23. 87 .36 .21 Which of the following is a healthy low-fat choice of milk or milk products?
   a. cheddar cheese
   b. skim milk ricotta cheese
   c. custard-style yogurt
   d. whole milk

LEVEL TWO

61. 83 -.01 .36 Given 1 ounce of each of the following, which one do you think is highest in cholesterol?
   a. butter
   b. margarine
   c. olive oil
   d. corn oil

31. 73 .11 .51 The main function of protein is to
   a. provide calories for energy
   b. build muscle and other tissues
   c. build strong bones
   d. provide all the vitamins

%

48. 73 .12 .38 High fiber diets are important because they may prevent
   a. cancer of the intestines
   b. bone problems in adults
   c. iron deficiency anemia
   d. high blood pressure

69. 48 -.05 .51 Assuming equal serving sizes, which of the following is highest in vitamin A?
   a. pears
   b. sweet potatoes (yams)
   c. white potato
   d. cauliflower

33. 38 -.08 .54 Which one of the following is a source of simple carbohydrate?
   a. sugar
   b. starch
   c. fiber
   d. protein

35. 23 -.13 .55 Which one of the following foods is classified as a source of simple carbohydrate?
   a. grape juice
   b. rice
   c. plain corn flakes
   d. potatoes

COMBINED MATH KNOWLEDGE ITEMS ARRANGED IN DESCENDING ORDER OF DIFFICULTY

LEVEL 1
FACTOR
% 1 2

26. 94 .35 .35 A small can of tuna contains 3 ounces (about 1 serving). How many cans are needed to provide 4 people with one serving each?
   a. 1
   b. 3
   c. 2
   d. 4

#	%			
81.	93	.60	.19	Diet guides recommend that we consume no more than 300 milligrams of cholesterol a day. A whole egg has 212 mg of cholesterol. If a person ate an egg for breakfast, how many more milligrams would s/he be allowed that day? a. 70 b. 88 c. 90 d. 100
25.	91	.45	.21	A can of carrots contains four servings. How many cans would be required to provide one serving each for 8 people? a. 1 b. 2 c. 3 d. 4
57.	91	.68	.06	If a diet contains a total of 86 grams of fat (saturated and unsaturated), and 40 grams of it was saturated, how many grams were unsaturated? a. 33 b. 46 c. 52 d. 27
29.	90	.56	.22	In the diet guides, one serving of cooked pasta is a half a cup. If an adult consumes 3 cups, how many servings is this? a. 2 b. 3 c. 4 d. 6
54.	90	.70	.07	If a steak contained 30 grams of protein and 5 grams of fat the total number of calories would be a. 240 b. 290 c. 165 d. 190
85.	90	.56	.19	Individuals 11 to 25 years of age should consume 1200 milligrams of calcium a day. 1 cup of skim milk provides 300 milligrams. How many cups of milk will meet the daily requirements? a. 2 b. 3 c. 4 d. 5

%

44. 89 .59 .20   To follow a low fat diet, the foods to use sparingly are
- a. vegetables
- b. grain foods like bread and cereals
- c. meats, milk and milk products
- d. fruits and fruit juices

47. 89 .58 .02   Which nutrient is most important to cut down on in weight reduction diets?
- a. fiber
- b. protein
- c. fat
- d. carbohydrate

52. 89 .46 .08   People with diabetes would be better off avoiding
- a. meat and chicken
- b. milk and cheese
- c. jams and jellies
- d. fruits and vegetables

67. 88 .42 .27   People who wish to cut down on sodium should limit their use of
- a. lemon juice
- b. soy sauce
- c. black pepper
- d. fresh garlic

23. 87 .36 .21   Which of the following is a healthy low-fat choice of milk or milk products?
- a. cheddar cheese
- b. skim milk ricotta cheese
- c. custard-style yogurt
- d. whole milk

LEVEL TWO

61. 83 -.01 .36   Given 1 ounce of each of the following, which one do you think is highest in cholesterol?
- a. butter
- b. margarine
- c. olive oil
- d. corn oil

31. 73 .11 .51   The <u>main</u> function of protein is to
- a. provide calories for energy
- b. build muscle and other tissues
- c. build strong bones
- d. provide all the vitamins

%

48. 73 .12 .38 High fiber diets are important because they may prevent
- a. cancer of the intestines
- b. bone problems in adults
- c. iron deficiency anemia
- d. high blood pressure

69. 48 -.05 .51 Assuming equal serving sizes, which of the following is highest in vitamin A?
- a. pears
- b. sweet potatoes (yams)
- c. white potato
- d. cauliflower

33. 38 -.08 .54 Which one of the following is a source of simple carbohydrate?
- a. sugar
- b. starch
- c. fiber
- d. protein

35. 23 -.13 .55 Which one of the following foods is classified as a source of simple carbohydrate?
- a. grape juice
- b. rice
- c. plain corn flakes
- d. potatoes

COMBINED MATH KNOWLEDGE ITEMS ARRANGED IN DESCENDING ORDER OF DIFFICULTY

LEVEL 1

FACTOR

% 1 2

26. 94 .35 .35 A small can of tuna contains 3 ounces (about 1 serving). How many cans are needed to provide 4 people with one serving each?
- a. 1
- b. 3
- c. 2
- d. 4

%

81. 93 .60 .19 Diet guides recommend that we consume no more than 300 milligrams of cholesterol a day. A whole egg has 212 mg of cholesterol. If a person ate an egg for breakfast, how many more milligrams would s/he be allowed that day?
   - a. 70
   - b. 88
   - c. 90
   - d. 100

25. 91 .45 .21 A can of carrots contains four servings. How many cans would be required to provide one serving each for 8 people?
   - a. 1
   - b. 2
   - c. 3
   - d. 4

57. 91 .68 .06 If a diet contains a total of 86 grams of fat (saturated and unsaturated), and 40 grams of it was saturated, how many grams were unsaturated?
   - a. 33
   - b. 46
   - c. 52
   - d. 27

29. 90 .56 .22 In the diet guides, one serving of cooked pasta is a half a cup. If an adult consumes 3 cups, how many servings is this?
   - a. 2
   - b. 3
   - c. 4
   - d. 6

54. 90 .70 .07 If a steak contained 30 grams of protein and 5 grams of fat the total number of calories would be
   - a. 240
   - b. 290
   - c. 165
   - d. 190

85. 90 .56 .19 Individuals 11 to 25 years of age should consume 1200 milligrams of calcium a day. 1 cup of skim milk provides 300 milligrams. How many cups of milk will meet the daily requirements?
   - a. 2
   - b. 3
   - c. 4
   - d. 5

%

83. 85 .56 .36 — An orange provides 70 milligrams of vitamin C. Approximately what percent of the daily recommendation of vitamin C is this?

a. a little over 100 %
b. 50%
c. 150%
d. more than 200%

56. 84 .54 -.01 — Diet guides suggest that 55% of one's calories should come from carbohydrates. This is

a. under half the total calories
b. over half the total calories
c. almost all the total calories
d. a quarter of the total calories

55. 80 .57 .05 — How many calories are there in 5 grams or 1 teaspoon of sugar?

a. 50
b. 100
c. 20
d. 5

LEVEL 2

12. 82. .37 .21 — It is recommended that we eat 3-5 servings of vegetables a day. According to the guidelines, one serving would be about

a. 3 cups
b. 2 cups
c. half cup
d. two tablespoons

82. 82 .44 .14 — Approximately what percent of the recommendation for cholesterol is there in an egg?

a. 100%
b. 75%
c. 200%
d. 150%

58. 75 .51 .01 — If a 2000 calorie diet provides 720 fat calories, what percent of the calories come from fat?

a. 25%
b. 50%
c. 36%
d. 75%

%

28. 73 .24 .53 In the diet guides, one serving of milk equals 1 cup. In ounces, this is

a. 2
b. 4
c. 6
d. 8

24. 71 .07 .46 How many ounces are there in a quarter of a pound?

a. 2
b. 3
c. 4
d. 8

21. 71 .08 .25 It is recommended that adults consume at least 2-3 servings of milk or a milk product a day. Which one of the following would equal one serving of milk?

a. 4 cups
b. 3 cups
c. 1 cup
d. half a cup

20. 70 .14 .49 It is recommended that we eat 6-11 servings of grain foods like bread and cereals daily. Which of the following would equal 1 serving from this group?

a. 3 slices of bread
b. half a bagel
c. 2 cups of oatmeal
d. 2 cups of cooked rice

84. 61 .51 .21 A supplemental tablet of vitamin C has 1000 milligrams. About how much in excess of the recommendation is this?

a. 6 times
b. 10 times
c. 100 times
d. 15 times

VITAE
Myrtle R. McCulloch, M.S., R.D.

EDUCATION:

1988-1994:	**Virginia Polytechnic Institute and State University:** Doctoral candidate, final defense, August 1994.
1965-1966	**Columbia University, New York, NY** : M.S. Public Health Nutrition
1963-1965	**Marymount University, New York, NY** : B.S. Foods and Nutrition
1957-1961	**Royal Technical College, Kenya, Manchester University Affiliate:** Teaching Diploma, Home Economics.

PROFESSIONAL EXPERIENCE:

1986 - 1994	**Georgetown University School of Nursing, Washington, D. C.:** Nutrition Instructor. 2, three-credit courses each semester: Normal Nutrition in a baccalaureate nursing program and Nutrition and Health for non-nursing students.
1981 - 1992	**Howard University College of Nursing Washington, D.C.**: Nutrition Instructor. Normal and Therapeutic Nutrition in a baccalaureate nursing program.
1988 - 1989	**American Health Foundation, Washington,D.C.:**(Katie C.Lewis School) Nutrition Consultant and Research Associate.
1981	**Georgetown University Medical Center, Washington, D. C.**: Member of an inter-disciplinary health team, training health care specialists in nutritional care of children with chronic lung diseases. Consultant for both in and out patients.
1980	**George Mason University, School of Nursing, Fairfax, VA**: Nutrition guest lecturer.
1975	**CARE, Costa Rica:** Nutrition Surveyor. Collected and tabulated data involving foreign and national infant and child feeding programs.
1968 - 1971	**Christ Hospital and School of Nursing, Jersey City, NJ**: Nutrition Instructor.
1968	**William Beaumont Hospital, Royal Oak, Michigan:** Clinical Dietician.
1966-1967	**Institute of Catering Technology and Applied Nutrition, Bombay, India:** Nutrition Instructor and Dietetic Internship Coordinator.
Summer 1966	**Public Health Nutrition, Hyderabad, India:** Graduate Research Intern.
1961 - 1963	**Star of the Sea High School, Mombasa, Kenya:** Teacher: Home Economics.

PROFESSIONAL AFFILIATIONS/AWARDS/ACTIVITIES:

American Dietetic Association; Membership No. R317847
Northern Virginia Dietetic Association and Virginia Dietetic Association
Registered Dietitian, with 300 of the 75 continuing education credits required for current registration period.
Thesis committee member and guest lecturer, Graduate School of Nursing, Howard University, Washington, D. C. , 1990
Chairperson, Northern Virginia Dietetic Association, Licensure Fund Raising Committee, 1985
Speaker, Pediatric Update, Holy Cross Hospital, Washington, D.C., November 1992.
Speaker, AARP Chapter Vienna, Va. May,1994.
Speaker, Occupational Health Nurses Conference, Washington, D. C. April, 1983
Speaker, Conference on Aging, Howard University, Washington, D. C., April 1982
Academic Awards: Full Scholarship, Marymount College, New York; General Foods Fellow, Columbia University, New York 1965;
Academic Achievement Tuition Grants, Virginia Polytechnic and State University, 1993 and 1994.

Myrtle McCulloch