To the Graduate Council:

I am submitting herewith a thesis written by Dana Rae Robertson entitled "A Variety Index for Toddlers: Development and Application." I have examined the final copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Nutrition.

Jean D. Skinner, Major Professor

We have read this thesis and
recommend its acceptance:

Accepted for the Council:

Associate Vice Chancellor and
Dean of The Graduate School

A VARIETY INDEX FOR TODDLERS: DEVELOPMENT AND APPLICATION

A Thesis

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PART I

LITERATURE REVIEW

BACKGROUND AND INTRODUCTION

Dietary variety is widely recommended for numerous reasons. Krebs-Smith et al suggested several, such as achievement of an adequate diet, reduction of the risk of developing a deficiency or excess of any one nutrient, achievement of an appropriate ratio of micronutrient intakes, and decreased likelihood of excessive exposure to contaminants in food[1]. In addition, dietary variety is recommended for general health promotion.

In 1993 Kant et al[2] examined 24-hour recalls from the first National Health and Nutrition Examination Survey (NHANES) Epidemiologic follow-up study. By counting the number of food groups consumed in one day the researchers calculated a Dietary Diversity Score (DDS), then compared this to all-cause mortality for men and women 25 to 74 years old. Even after correction for age, race, education, smoking status, and dietary fiber intake, risk of all-cause mortality was 50% greater in men and 40% greater for women who were consuming two or fewer of five possible food groups when compared to individuals consuming foods from all five food groups[2].

Results such as these lend credence to the emphasis on dietary variety in many nutrition recommendations and guidelines. The fact that variety is a desirable characteristic in the diet has been verified. However, consensus has not been reached as to the best way to measure or quantify the concept of dietary variety.

Dietary variety will be defined for this study as the consumption of different foods both among major food groups (eg, foods from the bread, dairy, vegetable group, etc.) and within the major food groups (eg, apples, oranges, and bananas

within the fruit group). This should not be confused with dietary diversity, which will be defined as the number of different foods consumed in a time period, regardless of nutrient content or food group. Variety and diversity are used synonymously at times throughout the literature, but these are the definitions that will be used for the purposes of this paper.

In order to best measure dietary variety for children, a measurement tool should have several characteristics. The tool should be based on the Food Guide Pyramid (FGP)[3], our most current and universally recommended food guide. The tool should measure variety within and among food groups. In order to quantify variety, the tool should use a quantitative measure of dietary intake rather than a non-quantitative measure of food frequency. The tool should also be specific to the child's age; for example, using serving sizes and numbers of servings appropriate for children 2 - 3 years old. Finally, the tool should be able to account for combination or mixed dishes.

Many indexes of variety have been published. However, none of these existing measures was appropriate for the children in this study. Table 1 (pp. 46-48) provides a summary of all the indexes cited, and only the Variety Index for Toddlers (VIT) fits all of the qualifications listed above. Because the VIT was developed to meet the research needs of this study, VIT does not account for dietary fat or energy intakes. These were not used in the calculation of the score because this score is simply measuring dietary variety. Fat and energy information on the children in the study were available, and they were analyzed separately.

ISSUES IN ASSESSING VARIETY

When embarking upon the development of an index of dietary variety for toddlers, several issues must be considered. The first issue is which food guide or pattern will be used as a model for variety. A second issue is what method will be used to assess dietary intake; considerations include the type of information desired, the amount of time available for collection, resources available, the degree of accuracy desired, and characteristics of the population. After information is collected, the way the data are analyzed is another consideration in the formation of an index of variety. If accurate quantification of variety is the goal, additional issues arise, such as the choice of serving sizes and the treatment of combination foods. Finally, the purpose of a variety index may influence its construction.

Each of these issues will be addressed individually in the chapters of this thesis. But in order to justify the need for measures of variety in the diets of children, it is important to determine what children are eating. Most existing measures for dietary variety are specific to adults, and if children are included in the analyses they are treated similarly to the adults. While information on the variety in the diets of children is limited, more information is available on their diets in general. This chapter will cover the current recommendations for feeding children and will briefly review the reports of actual intake.

CURRENT RECOMMENDATIONS FOR CHILDREN

Many nutrition challenges are facing children today. In a summary of objectives for child nutrition, Splett and Story identified several societal trends that have definite implications for child nutrition. Changes in the family structure, including single-parent families, working mothers, and day care, may influence nutritional status for children. Questions such as "who is responsible for feeding children? where and what will children eat? and how will this affect nutritional status?" are important questions in today's changing society[4].

General Recommendations

The Pediatric Nutrition Handbook is published by the American Academy of Pediatrics (AAP) as a guideline for general feeding practices of children[5]. The AAP recommends that after one year of age children should be encouraged to eat foods with a variety of textures, colors, consistencies, temperatures, and tastes. "Dependence on a single food...may lead to nutritional imbalance"[5].

Shea et al[6] added evidence that children should be responsible for regulating how much food they consume. By studying children in their everyday environment, the researchers were able to determine that coefficients of variation (standard deviation divided by the mean) for energy consumption at six different occasions throughout the day ranged from 46.5% to 165.8%. On the other hand, the coefficient of variation for whole-day energy consumption was 30.3%. In other words, while the caloric content of individual meals varied greatly throughout the day, the total energy consumption remained relatively consistent. The variation in total daily energy

consumption was significantly less ($P < .001$) than would be expected if the children were not regulating their own intake[6].

Dietary fat

In 1983[7] and in 1986[8] the AAP Committee on Nutrition recommended a prudent life-style for children, which stated their position on the controversial issue of dietary fat intake for children. They recommended that for the population over 2 years of age dietary intake of fat should be limited to no more than 30% of calories, saturated fat should be no more than 10% of calories, and dietary cholesterol should be no more than 300 mg per day[7,8]. With the publication of the 1995 Dietary Guidelines for Americans, the goal for fat intake was moderated to apply only to children over 5 years of age. For younger children, a more gradual decrease in the amount of dietary fat was recommended, with the goals stated above reached by the time the child is 5 years of age[9].

Debate continues over recommendations for dietary fat intake of children. In a recent review Lifshitz and Tarim proposed that severe restriction of dietary fat for young children could have adverse consequences[10]. They cited suboptimal growth and development, lowering of high density lipoprotein cholesterol levels, and psychological disorders as potential negative outcomes to the early restriction of fat in the diets of children. This information reflects results from actual studies[11], but Kennedy and Goldberg pointed out that a very small sample size was used, the children in the studies were both calorie and fat restricted, and no control group was used[12].

Supporters of early moderation of dietary fat for children claim that even though total fat and saturated fat intake of children have declined in the percentage of their contribution to total energy intake in the past 20 years, there has been no increase in the incidence of growth failure. In addition, they state that atherogenesis begins during childhood[13]. Kleinman et al found that healthy preschool children who were consuming a lower-fat diet appeared to be achieving appropriate growth and stature[14].

The FGP does not prescribe specific age-related guidelines for fat intake of children. Murphy et al warn that because individuals seldom select diets that are both high in nutrients and simultaneously low in fat, it would be unwise to focus on only the achievement of dietary fat recommendations[15]. Increased adequacy of the diet was found to be associated with increased fat intake in a study of adults. If this were also true for children, the same warning may be appropriate.

DIETARY INTAKE

The recommendations published by the United States Department of Agriculture (USDA) in 1958 entitled "Food for Fitness--A Daily Food Guide" is a common tool used to analyze food records based on servings of four major food groups[16]. Foods are categorized into milk and milk products, meat and meat alternative, fruits/vegetables, and bread and cereal groups. Recommended intakes for adults are two servings each for the milk and meat groups and four servings each for the

fruit/vegetable and bread groups. For children, three servings in the milk group is recommended; other food group recommendations are the same as for adults.

Through years of use, many names have been associated with this food guide. The Basic Food groups, the Four Food groups, and other names can be found in the literature. For the purposes of this paper, the recommendations will be referred to as the Basic Four.

Stanek et al[17] used the framework of the Basic Four to determine the diet quality of preschool children (2 - 5 years old). They used a 1-day diet record to measure the frequency of intake of servings from the Basic Four food groups. Results of the study showed, that based on one day, 67% of the children had four or more servings of breads and cereals; 78% had two or more servings of meat, fish, or poultry; 62% had four or more servings of fruits and vegetables; and 57% had at least three servings of milk or cheese products. Children who were eating with either parents or siblings had more servings of the Basic Four food groups ($r = .14$, $p \leq .05$) than those who ate alone.

Wolfe and Campbell studied the diets of children 6 to 12 years of age[18]. A nonquantitative 24-hour recall was administered, but no specific amounts of foods consumed could be determined from the results. However, the diets were analyzed and scored for the presence of the Basic Four food groups and the number of times foods from each food group were consumed. Combination foods were assigned to each appropriate food group as one serving. Children were given a good rating for the food group pattern if all of the Basic Four food groups were eaten at least two

times each; a fair rating if one food group was eaten only once, but the other three groups were consumed at least two times each; and poor if one or more of the food groups was completely absent or if two or more of the groups were eaten only one time each. The percentage of children who ate from a specific food group at least two times was 94% for breads and cereals; 76% for meats and meat alternatives; 91% for milk and dairy; and 85% for fruits and vegetables. It appears that the fruit/vegetable and meat/meat alternative consumption of this group was low. Wolfe and Campbell further reported that 15% of the subjects did not consume any vegetables, and 40% did not eat vegetables other than potatoes or tomato sauce; 20% of the children consumed no fruit at all, and 58% consumed no fruit other than juice[18]. The data were collected in the winter, which may partially explain the low consumption of fruits and vegetables.

Three-day diet records of toddlers aged 1 to 2 years were analyzed for dietary patterns and nutrient intakes[19]. The foods consumed were divided into groups, and the contribution of each group to percent of calories and percent intake of several nutrients was determined. The contribution to the energy content of the diet was as follows: cereal 24.3%, dairy 23.2%, meat 13.9%, sugar 11.8%, fruit 10.5%, vegetable 7.9%, fat 3.2%, egg 2.8%, legumes 2.6%. Because the data were not presented as number of servings consumed, it is difficult to compare these results to other information published about children. However, the study also found that the diets were low in specific nutrients, namely iron and magnesium[19].

In 1973 Caliendo and Sanjur evaluated the diets of preschool children (n = 113), ages 1 - 4 years, who were attending a Well-Baby Clinic[20]. A diet quality score was calculated to determine how closely the diets matched recommendations in the Basic Four. One 24-hour recall was collected for each child, and a weighted score was assigned. The highest score of 6 was assigned if the diet met the recommended number of servings from the Basic Four and if the diet included citrus and dark green or deep yellow vegetables. If all of the above criteria were met except for the inclusion of dark green or deep yellow vegetables, a score of 5 was assigned, and a 4 if the citrus fruit was omitted. If only two servings from each group were consumed a 3 was assigned, and a 2 if only one serving from each group was consumed. If less than one serving of any group was consumed, then the child received a score of 1. The omission of fruits and vegetables represented the limiting factors for achieving the highest scores on this scale. Only 18% of the children in the sample had diets that received a score of 6[20].

The studies cited above indicate that all of the nutrition objectives for children are not being met. Many of the problems in dietary adequacy could be corrected by increasing the amount of variety in the diet. The development of a tool for measuring dietary variety specific to children and based on the most current nutrition education tool (the Food Guide Pyramid) is necessary.

Food Guides

Food guides have been used for many years. Because food guides are developed to provide consumers with a tool for determining what food choices are necessary to meet their estimated nutrient needs, a food guide is an appropriate reference for determining variety in the diet. The characteristics of the food guide chosen as a standard for measuring dietary variety have implications for the scoring of variety.

From the first food guide published by the USDA in 1917 through the Basic Four, the purposes of food guides or patterns were analyzed by Haughton et al[21]. The researchers reported five types of assumptions used in the construction of food guides: food and nutrient needs, economics, food habits and taste, food supply concerns, and nutrition education[21].

Food guides have been used to develop scores so that food intake could be analyzed quantitatively. This became a research use of food guides. Various food guides have been used to develop scores for diet analysis.

Using a food guide to measure achievement of food and nutrient needs has become intertwined with measures of dietary variety. Consumption of a variety of foods, as determined by compliance with the recommendations of a food guide, is expected to result in the achievement of food and nutrient needs[1]. Various food guides have been used to measure variety and nutrient adequacy[22-24].

THE BASIC FOUR

The Basic Four, published by the USDA in 1958[16], was intended to meet the 1953 Recommended Dietary Allowances (RDAs) and provide a foundation for an adequate diet. The Basic Four was used in a dietary score devised by Guthrie and Scheer to evaluate nutrient adequacy in a simple, efficient way[23]. Scores were based on the number of servings from each of the Basic Four food groups; one point was assigned for each serving of fruit and vegetables or bread and cereals, and two points were assigned for each serving of milk and milk products or meat and meat alternatives. A maximum of 4 points was possible from each of the Basic Four food groups, and a total of 16 points were possible[23].

The dietary score of Guthrie and Scheer[23] necessarily carried with it some characteristics of the Basic Four, which was developed to provide the *foundation* for an adequate dietary intake. The Basic Four does not account for excesses or for the need for moderation of nutrients such as fat and sugar. However, dietary scores based on the Basic Four have been criticized. Light and Cronin outlined three weaknesses of the Basic Four: failure to achieve nutrient adequacy, to face current dietary problems of the population, and to work as an effective and efficient nutrition education tool[25].

King et al pointed out some of the weaknesses of the Basic Four when they chose 20 menus published as well-balanced diets based on the Basic Four and conducted a nutrient analysis of the menus[26]. The menu items were classified according to the Basic Four and supplemental foods. Supplemental foods were

defined as any foods consumed in excess of the recommended number of Basic Four food group servings or any foods that did not fit into the Basic Four food groups. When the menus were analyzed using this criteria, the Basic Four foods alone met or exceeded the RDA for only 8 of 17 evaluated nutrients. It was also found that energy, vitamin E, B_6, magnesium, zinc, and iron were present in levels 60% or less of the RDA. Even though these menus were taken from reputable nutrition publications, they were nutritionally inadequate when analyzed by the Basic Four recommendations. Little was known about vitamin E, B6, magnesium, and zinc when the 1953 RDAs and the Basic Four were published. Based on this information, the authors suggested that modifications to the Basic Four were necessary[26]. The Basic Four was based on the assumption that it was a foundation to the diet. Other foods were expected to make up the difference in nutritional quality after the basics were met.

This assumption is not valid, as shown by Guthrie and Scheer[27]. They studied 1-day dietary records of young adults and found that self-selected diets that met the recommendations given in the Basic Four failed to achieve the RDAs for several nutrients. The authors submitted that if one assumption of a food guide is that compliance will result in the achievement of a nutritionally adequate diet, then modifications in the food guide may be necessary[27].

OTHER FOOD GUIDES

All food guides make assumptions about food and nutrient needs. Many are based on nutrients that are likely to be problematic in a population. The WIC (Women, Infants, and Children) program in the United States targets iron, vitamins A and C, protein, and calcium because women and children are at risk of deficiency in these nutrients. Murphy et al implemented this principle when they developed a score to evaluate the diets of Mexican-American children[28]. Like Guthrie and Scheer[23], their score was derived by counting the number of Basic Four servings consumed from milk, meat, bread, and fruit/vegetable groups. However, they also required that one serving of a vitamin C food and one half serving of a vitamin A food be consumed in order to obtain the maximum score[28]. Thus, they emphasized specific nutrients for which this population was at potential risk of deficiency.

In 1986 Ries and Daehler published an evaluation of the Nutrient Guide[29] as a tool for assessing the diet[24]. The Nutrient Guide grouped foods according to the major nutrients supplied by the food. The categories were (a) iron and protein; (b) iron, protein, and thiamin; (c) iron, protein, and B-vitamins; (d) calcium and protein; (e) vitamin A; and (f) vitamin C. The quantity of each food was expressed as an exchange that was calculated to provide nearly equal amounts of the major nutrients for that group[29]. In order to calculate a total diet score based on the Nutrient Guide, scores were determined from each food group and added together[24]. Within food groups, points were assigned for consumption of foods based on the number of recommended servings and a maximum possible food group score of 20. For

example, 10 servings of iron, protein, and B-vitamin foods were recommended, so each exchange counted for 2 points (20/10 = 2). The total diet score was calculated by adding the points from each of the six food groups (maximum of 20 points each) together. The maximum points in the total diet score was 120.

Ries and Daehler determined that this scoring system based on the Nutrient Guide could accurately assess adequacy[24]. They compared the diet scores to the mean adequacy ratio (MAR) score, which is an index of the percent recommended intake. The correlation coefficient for the total diet score compared to the MAR score was +0.69. The Nutrient Guide measured more than just nutrient adequacy. The Nutrient Guide also measured nutrient density, cholesterol, fat, and sodium because it offers energy, fat, cholesterol, and sodium ratings for the exchanges within a food group. These ratings can be multiplied out by a constant to determine fat, energy, and sodium in the diet[24].

Krebs-Smith et al[30] based their 1989 dietary score on the Food Wheel[31]. The Food Wheel, which was published in 1987 and based on the 1980 Dietary Guidelines for Americans[32], is a food guidance system developed to emphasize specific nutrients. It contains five major food groups: grains, breads, cereals; fruits; vegetables; meat, poultry, fish, eggs; milk, cheese, yogurt; and fats, sweets, alcohol[31]. Except for the fats, sweets, and alcohol group and the milk, cheese, yogurt group, the food groups contained subgroups that further classify foods. Krebs-Smith et al, like Murphy et al[28], gave special scoring status to certain subgroups, namely, whole grain products; citrus, melon, and berries; dark green/deep yellow vegetables; and starchy vegetables.

If these subgroups were not present, even if other grains, fruits, or vegetables were present, the dietary score was limited[30].

THE FOOD GUIDE PYRAMID

The FGP was developed from the concepts portrayed in the Food Wheel[31]. Some of the characteristics of the FGP which distinguish it from earlier food guides have been described by Achterberg[33]. The FGP is designed to address more than nutrient adequacy; it addresses the total diet, both deficiencies and excesses. The FGP is also based on extensive consumer research, so that the design is easily understood and remembered. Finally, the FGP focuses on three key principles: variety (defined as eating a wide selection of foods both within and among the major food groups), moderation, and proportionality[33]. One design limitation of the FGP is that it does not address all of the recommendations in the Dietary Guidelines for Americans, namely "Use salt and sodium only in moderation", "If you drink alcohol, do so in moderation", and "Maintain healthy weight"[9].

The Healthy Eating Index (HEI) was published by Kennedy et al in 1995[22]. They attempted to overcome the shortcomings of the FGP by including assessments of sodium, total fat, saturated fat, and cholesterol. In HEI 10 components are scored from 0 to 10, then added together for a maximum possible score of 100. The 10 components are grains, vegetables, fruits, milk, meat, total fat, saturated fat, cholesterol, sodium, and variety. Variety within the diet is based simply on the total number of foods consumed, and it constitutes 10% of the total score. Half of the HEI

score is based on servings consumed from the five FGP food groups. The major goal of the HEI was to develop a system for measuring compliance with the 1990 Dietary Guidelines for Americans[34]. Kennedy et al[22] were able to incorporate sodium into their score, but the HEI still does not address the Dietary Guidelines to "maintain healthy weight" and "if you drink alcohol, do so in moderation"[9].

In 1996, Schuette, Song, and Hoerr used the FGP as a dietary evaluation tool for college students[35]. They used two different scoring systems: system 1 gave one point for each of five food groups from which the subject consumed at least the minimum number of servings recommended by the FGP; system 2 gave one point for each of five food groups from which the subject consumed at least one serving. By comparing the results to a MAR score for five nutrients, Schuette et al determined that these methods were sensitive to the nutrient adequacy of the diets of the subjects[35].

VARIETY WITHIN AND AMONG FOOD GROUPS

The use of a food guide for determining dietary variety also raises the question of whether variety is best determined by looking at total food consumption, consumption of major food groups, or consumption of various foods within major food groups. Kant et al tried different methods to measure dietary variety (referred to as diversity) while analyzing data from the second NHANES[36]. First, the researchers looked at food group intake patterns. The presence or absence of each of five food groups (bread, meat, dairy, vegetable, and fruit) was indicated by a score of 1 (presence) or 0 (absence) for that food group. A minimum intake level was required

before the food could count toward the food group score, but the presence of just one food in an adequate amount constituted a perfect score for that food group. A second analysis of variety used a serving score to account for portions consumed[36]. The serving score used the five food groups mentioned above, but the total possible score was 20 points: 2 points for each serving of the meat, dairy, vegetable, and fruit groups; and 1 point for each serving from the bread group. The maximum score for an individual group was 4, and the food groups scores were added together to calculate a score out of a possible 20 points. While each of these methods did use the same food groups described by the FGP, neither one used the number of servings recommended by the FGP. The serving score was based on recommendations from the Basic Four[36].

Krebs-Smith et al dealt more directly with the question of whether variety is best measured by consumption of foods among major food groups or within major food groups[1]. Using data from the 1977-78 USDA Nationwide Food Consumption Survey (NFCS), the researchers measured overall variety (the number of different foods consumed in 3 days), variety among major food groups (the number of different major food groups that were represented in 3 days), and variety within major food groups (counted as both the number of separate foods mentioned and as the number of minor food groups represented in 3 days). Multiple regression analysis was used to determine the relationship between each type of variety and measures of dietary quality. Age, sex, the number of foods, and all two-way interactions with variety were controlled[1].

Because one of the purposes of variety is to increase the likelihood of consuming adequate levels of nutrients, the different measures of variety were examined by Krebs-Smith et al for their effect on nutrient adequacy[1]. The measure of nutrient adequacy was the MAR score[23]. Using this model it was determined that variety among the food groups explained as much variation in the MAR score as did variety within the major food groups by either definition. The R^2 values for variety among food groups and variety within food groups were 0.57 and 0.56, respectively. Thus, Krebs-Smith et al proposed that promotion of dietary variety among food groups would be the most beneficial[1]. While these results do suggest that nutrient adequacy is not significantly affected when variety is defined as variety among food groups versus variety within food groups, this study did not address the other purposes of variety.

Dietary Intake Methodology

The type of dietary information and the way in which it is collected can have a significant impact on how dietary variety can be assessed. Three major methods are commonly employed for collecting dietary information to be used for food variety scores as reported in the literature. Food frequency questionnaires are used to collect information on the number of times per day, week, or month particular foods are consumed and, thus, provide an estimate of usual food intake. The 24-hour dietary recall is either an interview or a questionnaire format in which the subject is asked to recall everything that was consumed within the previous 24 hour period. With the food record approach, the subject writes down everything s/he consumes for a given time period, usually 3 or 4 days. Amounts of food consumed are estimated in the 24-hour recall and the food record. Both methods reflect food intake for a specific, designated time period, which may or may not be the usual intake for some individuals. Each dietary intake method has its own strengths and weaknesses, which may influence index scores.

FOOD FREQUENCY

Myriad questionnaires exist that attempt to determine the frequency of food consumption, whether by determining what types of foods are being consumed or by determining if certain foods are consumed. In other words, the goal of a food frequency questionnaire can be to show food use, food non-use, or both. The major weakness of a food frequency questionnaire is limited quantification of serving sizes;

sometimes no information about serving sizes is obtained. Lack of serving size information may impede nutrient analysis.

While the food frequency questionnaire does have some definite advantages, such as low cost and low labor intensity for its administration, the compromised level of accuracy about serving size makes the use of this method questionable for a variety index. Campbell et al reviewed diet indexes based on food frequency questionnaire data, and they determined that the indexes were of greatest value for describing, not for assessing food patterns. They asserted that attempts to quantify information from food frequency questionnaires would be "more misleading than informative"[37].

Block et al worked extensively with the development of accurate food frequency questionnaires[38-40]. Block et al determined median intakes for foods listed on a 147-item food list[38]. On the self-administered diet history questionnaire, medium sized servings were defined for each food (eg, 1/2 cup applesauce), and subjects were asked to check the box of small, medium, or large according to their usual intake of that food. Using these serving size descriptions and nutrient values from NHANES II, the researchers quantified the nutrient intake of the subjects. Correlations between this and other methods of nutrient intake was +0.70[38], which indicates that this brief questionnaire may provide an accurate assessment of nutrient adequacy.

Many other indexes based on food frequency data have been published. Murphy et al[28] published a study looking at food group intakes of Mexican-American children. Subjects indicated whether they consumed 40 different foods daily, weekly, less than once a week, or never. Responses of the subjects were converted to the

daily number of servings of each food group by dividing the total reported servings by the appropriate number of days (eg, weekly servings divided by 7). The 40 foods were then grouped into six food groups and the serving information was compared with the recommended number of servings from the Daily Food Guide[41]. The food groups were the same as those used in the Basic Four food groups, except that fats and sweets were counted as groups. Each food group was truncated at the recommended level for each age group, and the maximum dietary score was 14. Acknowledging the potential for inaccuracy in serving size estimations, the researchers stated that portion size variations even out over a specific population[28], and thus, this score would be more suitable for evaluating groups rather than individuals.

Fanelli and Stevenhagen used information collected during the 1977-78 NFCS as the basis of their study[42]. During those interviews, a 24-hour dietary recall and a 2-day food record were collected. From this dietary information the researchers determined the 30 most commonly consumed foods, and these were termed core foods. The percentage of the sample who consumed the core foods on a daily basis (3 of the 3 days) ranged from 1% to 41%. Fanelli and Stevenhagen compared this information to a measure of dietary variety which they determined by counting the total number of foods consumed in the time period. This counting method showed no variety within the major food groups, so the investigators divided the nine NFCS food groupings (milk and milk products; meat, poultry, fish, and mixtures; eggs; legumes, nuts, and seeds; grain products; fruits; vegetables; fats, oils, salad dressing; sugar, sweets, and beverages) into 18 food groups. Divisions were made in the nine food

groupings on the basis of differences in fat, sugar, fiber, sodium, and vitamins A and C. These food components were singled out because of their role in disease or because of reports of inadequate intake by the general population. A food could count only once for a subject, no matter how many times it was consumed or in what portion size. For both men and women, each of the 18 food groups had mean food group scores over 1.0, indicating that there was some variety within all of the food groups. A score over 1.0 shows that subjects were consuming more than one kind of food from each of the 18 food groups[42]. Their results do not reflect quantitative variety because portion sizes were not used.

Randall et al used a different approach to measure diet composition[43]. Using a food frequency questionnaire containing 128 foods, 116 of which were considered nutrient-dense, subjects were asked to report frequency of intake over the last year. Portion sizes were estimated by showing the subjects a standard portion size model and asking them to describe their usual serving as a proportion of the standard. The 116 foods were separated into 6 food groups: vegetables, fruits, meats, poultry and fish, dairy products and eggs, and grains and nuts. The total number of servings from all foods was determined; then, percentage contribution of each food group to the total number of servings was calculated. The percentage contribution of each food group was defined as the diet composition. The method of Randall et al was developed to use in epidemiological studies involving cancer.

Block et al found that a food frequency questionnaire could accurately depict mean nutrient intakes of a group[40]. Subjects were part of the Women's Health Trial Feasibility Study of women aged 45 - 70 years. Three 4-day diet records were collected over one year's time, followed by a self-administered diet history questionnaire. Correlations between group mean nutrient estimates using the two methods were mostly in the range of 0.5 - 0.6.

While the type of dietary information can certainly have an impact on the accuracy of the results collected, Block and Hartman described factors that may affect the reliability (or the ability of an instrument to produce the same estimate on separate occasions) of the dietary information[44]. Many of these factors could be controlled by the investigators. The factors that could be controlled by the investigators included the degree of variability permitted by the instrument, susceptibility of the response format to error, quality control of coding and keying, and real dietary change in the time between administrations of the questionnaire[44].

Often these methodological factors described by Block and Hartman[44] are overlooked when determining sources of error. Instead, focus is sometimes placed on the respondents, who may not be able to estimate their diets reliably. For example, Blake et al tested the commonly reported assumption that overweight persons may systematically underestimate their food intake because of their inability to estimate portion sizes[45]. Using 94 women, 46 of whom were overweight and 48 of whom were normal weight, the researchers determined how accurately overweight and normal-weight subjects could estimate portion sizes of food chosen for a meal by

recall and by food items on display. They found no significant differences in the ability of the two groups to accurately estimate food portions[45].

Thus, it is important to focus not only on potential errors made by respondents, but to also guard against systematic biases associated with study design that can introduce error. For example, the variability permitted by the questionnaire can significantly affect the reproducibility of results. If the food frequency instrument does not allow for reporting of portion sizes or does not provide enough response options about the frequency of consumption, reproducibility will decrease. This is an important consideration when using food frequency questionnaires for the quantification of dietary variety.

DIET RECALLS AND RECORDS

If quantification of dietary variety is desired for more than just epidemiological studies, then more detailed measures must be taken. Crawford et al compared the range of absolute errors in dietary assessments from 24-hour recall, 3-day food record, and 5-day food frequency methods[46]. Data were collected from subjects in the National Heart, Lung, and Blood Institute Growth and Health Study. The food reports from the subjects were compared to data collected by unobtrusive observations of types and amounts of foods eaten. The data collected by observation were used as the standard or true value. The error ranged from 20 to 33% for the 5-day food frequency method, from 19 to 39% for the 24-hour recall, and from 12 to 22% for

the 3-day food record. The researchers concluded that the 3-day food record was the most accurate[46].

This evidence is supported by the findings of Mullenbach et al[47]. A sample of adolescents was drawn from participants in the Children and Adolescent Blood Pressure Program. Subjects were given detailed instructions on how to complete a 3-day food record, then 2 to 4 weeks later a telephone interview was conducted to obtain a 24-hour dietary recall. All of the dietary information was analyzed to obtain mean nutrient intakes. Results of the study indicated that mean nutrient intakes in a group of adolescents can be determined using 24-hour recalls that are administered by phone. However, in order to estimate the nutrient intake of an individual with any accuracy, the 3-day food record was necessary[47].

Three-day dietary records have been used to generate scores for dietary variety. The protocol of the NFCS uses one 24-hour recall and 2 days of diet records for collecting dietary information. Because many studies of variety use this data, many of the indexes are based on this combination of 3-day diet information[30,42,48]. For example, Patterson et al used NFCS data from 1987 - 88 to measure diet quality. The Diet Quality Index (DQI) was intended to measure the components of the diet that are associated with increased risk for the major chronic diseases in the United States[48].

Using the eight dietary recommendations from *Diet and Health: Implications for Reducing Chronic Disease Risk*[49], subjects were assigned scores from 0 - 2 in each category, depending upon the degree of compliance with that health goal[48]. Categories specifically related to types and amounts of foods included "eat five or

more servings daily of a combination of vegetables and fruits" and "increase intake of starches and other complex carbohydrates by eating six or more servings daily of breads, cereals, and legumes"[49]. For the fruit and vegetable category, a score of 0 was assigned if the subject consumed 5 or more servings, a score of 1 was assigned if 3 - 4 servings were consumed, and a score of 2 was assigned if 0 - 2 servings were consumed. Other categories were similarly scored with 0 indicating the optimal score for that category. The points from the eight categories were added together for the DQI. The best possible score was a 0, and the worst possible score was a 16. The authors stated that the reason they used 3 days of diet information for the DQI was to better capture the true pattern of the diet and to avoid intraindividual variation and subsequent misclassifications[48]. Three days of diet information provided the necessary level of confidence for them to evaluate the diets.

In summary, all types of dietary intake methodology have strengths and weaknesses. The food frequency questionnaire is quicker and less expensive to administer than other methods, and it can account for seasonal variations in consumption patterns. However, the food frequency questionnaire cannot accurately be transformed into quantitative data for individual subjects' intakes, even though group means of nutrient intakes can be quite accurate. The diet recall and diet record (often used together) can more accurately quantify food intake. Three days of diet information collected in this way show the lowest percentage of error from actual intake. In order to accurately quantify variety, it is essential to accurately quantify food intake.

QUANTIFICATION OF VARIETY

Dietary variety can be described in terms of representation of food groups, or it can be quantified. Representation measures the simple presence or absence of food groups. Kant et al employed this method for their comparison of food group intake patterns and nutrient profiles in the United States[50]. They reviewed 24-hour recalls and documented the presence or absence of five food groups. A minimum intake level was required before the food could count toward the food group score, but the presence of just one food in an adequate amount constituted a perfect score for that food group[50]. This is a simple way of looking at variety, but, again, the degree of variety can not be determined.

If accurate quantification of dietary variety is desired, several additional questions must be answered before a variety index can be constructed. Standard serving sizes must be chosen, and a protocol for the treatment of combination foods must be adopted. In a separate analysis from the study mentioned above, Kant et al employed both a measure of food group representation and a measure of quantification of dietary variety based on consumption of minimum numbers of servings from the food groups[36]. The food groups were those used in the Basic Four, but the fruits and vegetables were considered separately. The researchers did not conduct a t-test to determine significant differences between the two scoring methods (they were used together), but the serving score does appear to be much more sensitive than the food group score. Frequency distribution of the serving score placed 12.9% of the sample in the lowest scoring category, while the food group score placed only 6.2% of the

sample in the lowest scoring category[36]. Simply measuring representation of food groups without quantification may not be sensitive enough to identify individuals with suboptimal variety in the diet.

SERVING SIZES

The FGP does provide information on serving sizes, but many foods are difficult to place on the FGP. Achterberg et al recognized foods that are "hard-to-place", such as cookies, fried corn chips, popcorn, pickles, fruit roll-ups, instant breakfast, bean dip, bacon bits, etc[33].

In addition to ambiguity about specific food items, the FGP also leaves room for question about serving sizes for children. According to the FGP, "preschool children need the same variety of foods as older family members do, but may need less than 1,600 calories. For fewer calories they can eat smaller servings"[3]. However, the FGP does not provide detailed information about how to adjust the recommendations for smaller servings.

Seeking clarification about child-sized serving sizes from sources outside the FGP may result in confusion. Consensus on serving sizes has not been reached even among major nutrition education tools currently employed for adults because the goals of these tools differ. For example, the Diabetic Exchange Lists base serving sizes on amounts of foods that provide similar macronutrient compositions[51]. Serving sizes on food labels are based on reference amounts customarily consumed per eating occasion by the United States population. The serving sizes on food labels are based on

amounts that are typically consumed, while the FGP serving sizes are based on recommended intakes[33]. None of these standards is specific to children, except for the food label serving sizes.

The HEI was adapted for children over two years of age by simply reducing the serving sizes used for adults[22,53]. Serving sizes were reduced by the same ratio as the calorie reduction. The lowest end of the calorie range described in the FGP is 1600 calories. The recommended caloric intake for children from 1 - 3 years of age is 1300 calories[52]. Thus, the ratio of actual calories for children and the lowest calories in the FGP was 1300/1600. This same ratio was used to adjust the serving size of an adult to a serving size appropriate for children[53].

The HEI protocol treated the calculation of portion sizes with detailed attention[22,53]. The developers of HEI attempted to maintain consistency in portion size throughout a food group. Consistency was maintained by determining a reference amount from a commonly consumed food within that group. To illustrate this, the most commonly consumed bread, or white bread, was used for comparison with all other breads. One slice of white bread contains 15.2 g of flour; this became the standard, or flour equivalent for all other sliced bread and similar products. The number of servings of any other type of bread consumed could be determined, not by counting the number of slices of that bread consumed, but by determining the ratio of flour consumed in the bread to the flour equivalent from the white bread standard (15.2 g). In this way, subjects were given credit for exactly the food they consumed. While this method may improve the consistency of serving estimations, it also adds

significantly to the time and skill required to evaluate a diet. The researchers did used computer software to determine the number of servings consumed from each food over 3 days, but the program only works with the food codes from the USDA's database[53].

Various serving size recommendations for children do exist, but they may not be adequate. When the rules and regulations for food labels were published in the Federal Register in 1993, they included standards for infants and toddlers. However, only a limited number of foods were included in this list of reference amounts[54]. Once again, information on serving sizes for all types of food is unavailable to researchers.

The American Dietetic Association has published a guideline for meal planning in child-care programs[55]. The guidelines include recommendations for serving sizes for children from 1 -2, 3 - 5, and 6 - 12 years of age. While portions sizes are recommended, no recommendations are made for a total number of servings to be consumed from each food group over an entire day. They make suggestions only for the eating occasions from breakfast through lunch, and no recommendation is given as to the percentage of daily intake that these eating occasions should comprise. This pattern inhibits the ability to determine an adequate amount of variety because an optimal or even a minimal number of servings is never suggested from individual food groups. By contrast, guidelines for the school breakfast and school lunch programs recommend that the foods provided at those meals should average out to meet one fourth and one third, respectively of the RDA over one week.

MINIMUM SERVING CUTOFFS

Determining which standard serving size to use for calculating a variety index is not the only question to address. People do not always consume foods in standardized reference amounts; sometimes the amount of a food consumed by an individual is very small (eg, one bite). In order to avoid giving credit when the amount of a consumed food was small, Kant et al[36] used a minimum cutoff amount for each food group. If a food was not consumed in an amount that exceeded the minimum cutoff, it was not included in the score. The minimum levels they chose to use were 30 g (2 Tbsp) for solid foods with only one ingredient; 60 g for beverages and combination foods, 15 g (1 Tbsp) for solid foods in the dairy and grain groups; and 30 g for liquids and mixed dishes within the dairy and grain groups. A food counted as one serving if it was consumed in an amount that was more than the minimum cutoff or up to one serving. Serving sizes for this study were determined by using the median gram weight of each food reported across all subjects. This method of determining serving sizes accounted for variation in types of foods and preparation methods, and it was specific to the sample. However, the median intakes compared well with amounts recommended by USDA[31]. By using this type of a minimum intake level, some foods were over-represented in the variety score. A food could be counted as a full serving, even though the amount consumed could have been well below the median serving size. This procedure could have a significant effect on the results because the sample consisted of adults between the ages of 19 and 74

years. Portion sizes consumed by 19-year-old men would be expected to be quite different from those consumed by 74-year-old women.

COMBINATION FOODS

Some indexes of variety factor every food into the score, no matter how small the amount consumed. This is especially significant with regard to combination foods. A combination food, or a mixed dish, is a food item that contains ingredients which contribute to more than one food group. The HEI protocol did not establish any type of a minimum cutoff for single foods, and every component of mixed dishes was counted, no matter how small the contribution. This method of treatment for combination foods required a special computer program that uses USDA food codes[53]. While this process again contributes to a high level of accuracy in determining servings from the different food groups, it is not practical to implement as a nutrition education tool to assess variety if that specific software is not available to most users.

In 1990 Krebs-Smith et al studied how the treatment of combination foods affects estimates of energy and nutrients contributed by individual food groups[56]. Using data from the Continuing Survey of Food Intakes by Individuals (CSFII), the researchers analyzed 6 days of dietary information in two ways. Using the first method, they classified a combination or mixed food as a single ingredient; the entire item counted toward the food group of the main ingredient. In the second method, the combination foods were assigned to all appropriate food groups using a nutrient database that included information on recipes used for combination foods reported in

CSFII. Foods that were not found in this database were not used in the calculations. For each method, the contribution of a food group to the amount of energy, protein, fat, saturated fat, cholesterol, carbohydrate, and dietary fiber was calculated by dividing the total amount of the dietary component (eg, energy) provided by one food group for all subjects by the total amount of energy provided by all food groups for all of the subjects. This is represented by the equation:

$$\frac{\sum \text{energy provided by one food group for all subjects}}{\sum \text{energy provided by all food groups for all subjects}}$$

Using this equation for method I and method II, the researchers found that by dividing mixed dishes into their component parts before assigning them to food groups, the meat, fish, poultry and grain groups showed a decreased contribution to all seven food components identified by Krebs-Smith et al[56]. They also found that milk products, fats, and oils showed an increased contribution to the seven categories when mixed foods were subdivided[56]. The implications of these findings are that the distribution of variety and nutrients can be significantly altered if mixed foods are not broken down to their component ingredients.

VALIDATION MEASURES

In 1996 Kant published a review of indexes of overall diet quality[57]. The article identified what the indexes were based on (nutrients, foods or food groups, or both) and also what standard was used to validate the index. The validation measures identified by Kant included fat intake, anthropometric data, biochemical indices, nutrient adequacy, clinical measures, sociodemographic information, lifestyle factors, all-cause mortality, dental caries, health behaviors, pregnancy outcome, duration of lactation, cardiovascular mortality, and several forms of cancer.

While not all of the indexes of overall diet quality reviewed by Kant included measures of dietary variety, most of the information available for measuring dietary variety is covered by the umbrella of overall diet quality. Therefore, the outcome measures generally fall into the same categories: nutrient intake or health status and lifestyle factors[57].

The most prevalent validation measure for indexes of dietary variety is a nutrient analysis. An evaluation of health status often involves invasive measures such as blood tests, or it requires a longitudinal study to track the incidence of morbidity and mortality in a population. Thus, comparison of an index of dietary variety to health status measures may be costly and time-consuming relative to comparing the index of dietary variety to nutrient information.

NUTRIENT ANALYSIS

Measurement of nutrient intake from a list of consumed foods can easily be accomplished using software packages which contain nutrient information for commonly consumed foods. The resulting nutrient values can be evaluated using the Recommended Dietary Allowances (RDAs)[52].

Recommended Dietary Allowances

The RDAs are defined as *the levels of intake of essential nutrients that, on the basis of scientific knowledge, are judged by the Food and Nutrition Board to be adequate to meet the known nutrient needs of practically all healthy persons*[52]. The allowances are expected to be met as an average over time, rather than daily. Over 3 days, the average intake of each nutrient should equal the RDA for that nutrient[52]. Safety factors of two standard deviations are built into the RDA for each nutrient (except for calories). This is to account for the variation in requirements for individuals within the population[52]. Because the variability of requirements is not the same for each nutrient, and indeed, it is not even known for most nutrients, fixing a cutoff point (eg two-thirds of the RDA) as a standard of adequacy can introduce serious error[58]. Using fixed cutoff points results in errors of inestimable magnitude, extent, and even direction[58]. Meeting the RDA is the most acceptable method of evaluating the nutrient adequacy of diets.

Mean Adequacy Ratio

One common validation measure for indexes of variety is the mean adequacy ratio, or MAR score, used by Guthrie and Scheer[23]. The MAR is based on twelve

nutrients. A nutrient adequacy ratio, or NAR score, is determined for each of the 12 nutrients by dividing an individual's intake of a specific nutrient by the RDA for that nutrient. Each NAR score is then truncated at 1.0. This truncation ensures that excessive intake of one nutrient will not compensate mathematically for poor intake of another nutrient. Finally, the 12 NAR scores (truncated as appropriate) are averaged to determine the MAR score[23].

Guthrie and Scheer used the MAR score to validate a dietary score based on the Basic Four food guide. They tested their 16-point score of variety for validity by running correlations between their total dietary score and the MAR and found that the MAR scores steadily increased as the total dietary score increased. The correlation coefficient was a +0.71. This indicates that better compliance with the recommendations in the Basic Four food guide resulted in more adequate nutrient intakes. In addition, Guthrie and Scheer tested the difference between the scores in individual food groups and the NAR scores of nutrients to which that food group makes major contributions. For example, the milk group makes major contributions to the calcium intake of the individual. The NAR score for calcium was significantly greater for individuals who consumed two servings of milk than it was for those individuals who consumed one or no servings of milk. The NAR scores for calcium were 0.94, 0.79, and 0.34 for milk groups scores of 4, 2, and 0, respectively. Some nutrients were more evenly distributed throughout the food groups, so the differences in NAR scores within an individual food group were not as dramatic[23].

HEALTH STATUS AND LIFESTYLE FACTORS

While nutrient adequacy is a common validation tool for indexes of dietary variety, other tools have also been used, especially in epidemiological studies. Nube et al measured the "dietary prudence" of Dutch civil servants and their spouses who had participated in a health examination in 1950[59]. The health examination included a survey of the prudence of the subjects' diets, which included white bread, brown bread, milk, porridge and yogurt, potatoes, vegetables, meat, fish, eggs, and fruit. These groups were chosen because they match the type of diet that contributes to a reduction of the risk for chronic diseases, such as cardiovascular diseases, stroke, and certain cancers. Each of these 10 food groups was given a score of 1 if the intake level of that group was considered indicative of a prudent diet. The highest possible diet score was 10, which would indicate a prudent diet. The diets of all subjects were scored, then the subjects were divided into three categories based on the scores: non-prudent, intermediate, and prudent. An age-standardized survival rate over the 25 years was determined for each scoring range, and the statistical significance of the differences between groups was tested using a linear trend analysis. Regression analysis was performed to control for smoking, serum total cholesterol, BMI, and systolic blood pressure. The results showed that 25-year survival increased from 43.2 $\pm$ 2.0 years, to 45.4 $\pm$ 2.4 years, to 50.4 $\pm$ 2.0 years when diet scores increased from 0 - 4, to 5, to 6 - 10, respectively. These values were significant at $p<0.01$[59]. A diverse diet resulted in less mortality among the subjects.

Kant et al looked at variety and all-cause mortality[2], as well as cause-specific mortality. In a 1995 follow-up[60] to the study conducted in 1993[2], the researchers determined the relationship between their measure of dietary diversity and cardiovascular (CVD), all-sites cancer, and other (non-CVD, non-cancer) mortality. For CVD mortality, they found that the age-adjusted risk (after adjusting for age, education, race, smoking status, systolic blood pressure, plasma cholesterol, BMI, and energy intake) for mean increased by 50%. This was the only result in the multivariate model that had a significant increase, but all models for men and women with CVD mortality showed a trend toward increase[60].

Whether comparing to nutrients or to health outcomes, the effect of dietary variety is significant. It has been shown to be correlated with nutrient adequacy and with improved longevity and quality of life. The frequency of the recommendation to consume of variety of foods in the nutrition education materials and guidelines used today is warranted.

SUMMARY

Dietary variety is important for many reasons. The most well-documented reason for promoting the intake of a varied diet is to avoid deficiency of any one nutrient, but other purposes of dietary variety which have not been studied as thoroughly may be just as important. These roles include ensuring that unidentified properties of foods are consumed in adequate amounts, avoiding large intakes of toxins, and ensuring an appropriate balance of nutrient intakes.

The purpose of this review of the literature on dietary variety was to show what is currently being used to measure variety and to uncover questions related to measuring dietary variety in children. The review of literature described the use of food guides as a basis for a measure of variety, the type of diet information collected, the quantification of variety, and validation measures for scales that have been used. Throughout the review, several questions emerged for measuring dietary variety in children 2 to 3 years old. The final chapter of this thesis will describe an original index of dietary variety designed to fill the voids left by other indexes with regard to children. The Variety Index for Toddlers, or VIT, was created specifically for children, it is based on the Food Guide Pyramid, and it can be used to quantify variety in the diets of children.

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Table 1
Summary of variety measures cited

Index (reference number)	Author(s), publication year	Food guide	Dietary data	Truncation among/ within food groups	Combin a-tion foods divided	Serving sizes
Dietary Diversity Score (2)	Kant et al, 1993	None[1]	1 24-hour dietary recall	Yes[2] / No	Yes[3]	N/A[4]
Dietary quality (17)[5]	Stanek et al, 1990	Basic Four	1-day diet record and food frequency	No / No	NR[6]	NR[6]
Food-group pattern score (18)[7]	Wolfe and Campbell, 1993	Basic Four	1 24-hour dietary recall	Yes[8] / No	Yes[9]	N/A[4]
Meal patterns (19)[5]	Sanjur et al, 1990	None[10]	3 sets of 3-day dietary records	Yes[11] / No	Yes[3]	N/A[4]
Dietary quality score (20)[5]	Caliendo and Sanjur, 1978	Basic Four[12]	1 24-hour dietary recall	Yes[8] / No	No[13]	Basic Four
Dietary score (23)	Guthrie and Scheer, 1981	Basic Four	1-day dietary record	Yes[8] / No	NR[6]	Basic Four
Dietary quality score (28)[5,7]	Murphy et al, 1990	Basic Four[14]	Food frequency	Yes[8] / No	NR[6]	N/A[4]
Total diet score (24)	Ries and Daehler, 1986	Nutrient Guide	1 24-hour dietary recall	Yes[8] / No	NR[6]	Yes[15]
Dietary Score (30)[5,7]	Krebs-Smith and Clark, 1989	Food Wheel	1 24-hour recall, 2-day food record	Yes[8] / Yes[16]	NR[6]	N/A[4]
Healthy Eating Index (22)[5,7]	Kennedy et al, 1995	FGP	1 24-hour dietary recall, 2-day food record	Yes[8] / No	Yes[3]	FGP[17]

Table 1 (continued)

Index (reference number)	Author(s), publication year	Food guide	Dietary data	Truncation among/ within food groups	Combin a-tion foods divided	Serving sizes
Food Group Scoring System 1(35)	Schuette et al, 1996	FGP	1-day dietary record	Yes[8] / No	Yes[18]	FGP
Food Group Scoring System 2 (35)	Schuette et al, 1996	FGP	1-day dietary record	Yes[2] / No	Yes[18]	FGP
Food Group Score (36)	Kant et al, 1991	Basic Four[19]	1 24-hour dietary recall	Yes[2] / No	Yes[3]	N/A[4]
Serving Score (36)	Kant et al, 1991	Basic Four[19]	1 24-hour dietary recall	Yes[8] / No	Yes[3]	Basic Four
Variety Among Major Food Groups (1)[5,7]	Krebs-Smith et al, 1987	Better Eating for Better Health	3-day dietary record	Yes[20] / No	Yes[3]	N/A[4]
Variety Within Major Food Groups (1)[5,7]	Krebs-Smith et al, 1987	Better Eating for Better Health	3-day dietary record	Yes[20] / No	Yes[3]	N/A[4]
Variety index (42)	Fanelli and Stevenhagen 1985	NFCS food groups-modified	1 24-hour recall, 2-day food record	Yes[2] / No	NR[6]	N/A[4]
(43)	Randall et al, 1989	NR[6]	Food frequency	No / No	NR[6]	Yes[21]
Diet Quality Index (48)	Patterson, 1994	Diet and Health[22]	1 24-hour recall, 2-day food record	Yes[8] / Yes[23]	Yes[24]	Diet and Health[22]
Patterns of food group intake (50)	Kant et al, 1991	Better Eating for Better Health	1 24-hour dietary recall	Yes[2] / No	NR[6]	N/A[4]
Total diet score (59)	Nube et al, 1987	Prudent Diet	Food frequency	Yes[2] / No	NR[6]	Prudent diet

Table 1 (continued)

Index (reference number)	Author(s), publication year	Food guide	Dietary data	Truncation among/ within food groups	Combin a-tion foods divided	Serving sizes
Dietary Diversity Score (60)	Kant et al, 1995	Better Eating for Better Health	1 24-hour dietary recall	Yes[2] / No	NR[6]	N/A[4]
Varitey Index for Toddlers (VIT)[5]	Robertson et al, 1996	FGP	1 24-hour recall, 2-day food record	Yes[8] / Yes[25]	Yes[18]	FGP[26]

[1]Five broad groups based on similarities in nutrient composition and uses in the diet
[2]Major food groups truncated at one serving
[3]Combination foods divided into component parts and counted toward variety in all relevant food groups
[4]Mention of a food (regardless of amount) counts toward the appropriate food group
[5]Index used for a sample of children <5 years of age
[6]Methods not reported
[7]Index used for children 6-12 years of age
[8]Major food groups truncated at minimum number of recommended servings
[9]Combination foods divided into component parts and counted toward variety in up to four food groups
[10]Food groups derived from sample (function of frequency of food consumption and common ways of combining foods)
[11]Multiple occurrences of foods within the same food group counted only once per meal
[12]Weighted for citrus, dark green, and yellow vegetables
[13]Combination foods counted only toward the food group of their major component
[14]Weighted for vitamin A and C foods
[15]Servings expressed as exchanges or quantities of foods in a group that supply approximately equivalent amounts of designated nutrients
[16]No limit for targeted subgroups, but non-targeted subgroups restricted
[17]FGP servings adjusted for consistency across various foods in a group. Children's serving sizes adjusted in proportion to decrease in calories
[18]Combination foods divided into component parts and counted toward variety in all appropriate groups if present in amount ≥ minimum cutoff
[19]Fruit/Vegetable group counted as 2 separate groups
[20]Truncated at total number of foods from the major food groups over 3 days
[21]Subject estimates serving size as a proportion of a standard model
[22]Diet and Health: Implications for Reducing Chronic Disease Risk
[23]Single foods truncated at 3 servings for any one food
[24]Combination foods containing fruits and vegetables or grains and legumes counted equal to 1/2 the weight of the serving

PART II

A VARIETY INDEX FOR TODDLERS (VIT): DEVELOPMENT AND APPLICATION

ABSTRACT

TITLE

A Variety Index for Toddlers (VIT): Development and Application

OBJECTIVE

To develop a variety index that is based on Food Guide Pyramid recommendations and to evaluate variety in childrens' diets at 24, 28, 32, and 36 months.

DESIGN

Subjects' mothers were randomly assigned two interviews with a Registered Dietitian; 3 days of dietary information were collected at each interview. Diets were scored for variety based on servings from food groups of the Food Guide Pyramid and variety within and among food groups. Mean Adequacy Ratio (MAR) scores were calculated for all subjects as a measure of validation of VIT.

SUBJECTS

Caucasian children aged 24 to 36 months (n=122) and their mothers from an ongoing longitudinal study (2 months to 60 months).

STATISTICAL ANALYSES PERFORMED

Descriptive statistics and MANOVA.

RESULTS

An index (range 0.0 to 1.0) was devised that assessed overall variety as well as variety within food groups for toddlers. The bread group scores were consistently the highest of the individual food groups ($\bar{x}$ = 0.94 - 0.96); the vegetable and meat

groups were consistently low ($\bar{x}$ = 0.68-0.73 and 0.73-0.76, respectively). Mean VIT scores (an average of the 5 food group scores) over the 4 collection points ranged from 0.79 $\pm$ 0.14 to 0.81 $\pm$ 0.15, with a score of 1.00 representing a perfect score. VIT scores were strongly correlated to the MAR score of nutrient adequacy ($r = +0.74$, $p < 0.01$).

APPLICATIONS/CONCLUSIONS

Results of the study indicate that the VIT can be used to measure dietary variety specific to toddlers. VIT scores can be compared to other characteristics of children and has the potential to be adapted for use with other age groups and populations.

INTRODUCTION

The benefits of eating a variety of foods are promoted by the United States Department of Agriculture[1], the Surgeon General[2], and other non-profit agencies and health [34]. The roles that dietary variety are expected to fill are many and diverse. Krebs-Smith et al suggested that consumption of a varied diet should result in achievement of an adequate diet, reduction of the risk of developing a deficiency or excess of any one nutrient, achievement of an appropriate ratio of micronutrient intakes, and decreased likelihood of excessive exposure to contaminants in food[5]. In a recent review, Kant described the use of foods or food groups as one of the major methods for assessing overall diet quality[6]. By scoring for the presence of specific foods or a particular variety of food groups, dietary quality has been determined[6].

Historically food guides were developed to provide consumers a tool for determining what food choices are necessary to meet nutrient needs[7]. Therefore, food guides are a natural source to rely on for quantifying variety. Several attempts were made to establish a measure of dietary variety based on food guides, such as the Basic Four[8,9], which are no longer in common use as nutrition education tools.

The Food Guide Pyramid[1] is the standard nutrition education tool at this time, but it, too, has limitations for accurately describing dietary variety. The Food Guide Pyramid recommends serving sizes and numbers of servings that are designed to meet the needs of adults with various caloric intakes. For children and others whose caloric intake may be less than 1600 (the lower end of the range of calories described in the Food Guide Pyramid), the Pyramid recommends that smaller servings should be

consumed, but the same variety should be preserved[1]. This description does not provide adequate structure for defining serving sizes for children.

A recent effort to create an index of variety comes as one component of the Healthy Eating Index (HEI)[10]. The HEI was developed to indicate how individuals comply with goals for overall diet quality as described in the Dietary Guidelines for Americans[11]. The goal of the Dietary Guidelines is to reduce the risk of chronic diseases, and, thus, moderation of total fat, saturated fat, cholesterol, and sodium are addressed as well as eating a variety of foods from the Food Guide Pyramid food groups.

While these goals may be very appropriate for adults, they do not necessarily apply to children, especially those under 5 years of age. The restriction of fat and cholesterol in children of the same age as those in this study (24 to 36 months) or older has been debated[12,13,14]. In the most recent publication of the Dietary Guidelines for Americans[11] the approach to fat and cholesterol restriction for children was moderated. While earlier editions[15,16,17] recommended fat restrictions to less than 30% of calories for children over 2 years of age, the 1995 Guidelines propose a gradual reduction in fat intake after 2 years of age until about age 5, when fat intake should represent no more than 30% of calories[11]. Even though the HEI included children over 2 years of age in its sample, the HEI was not specifically designed to address the nutrition concerns of children.

Food guides outline food categories that can form the foundation of dietary variety, but dietary variety implies more than just consumption of a variety of food

groups. Different foods should be consumed from within those food groups. For example, if rice, peaches, green beans, milk, and chicken were consumed in one day, each of the Food Guide Pyramid food groups would be represented in the diet. However, if those were the only foods consumed on consecutive days, the diet would not be considered varied, but, rather, monotonous. Additionally, the diet would not be nutritionally adequate. Variety implies consumption of various foods among and within food groups to ensure nutritional adequacy.

The purpose of the current study was to use the Food Guide Pyramid to develop a Variety Index for Toddlers (VIT) that also reflected dietary adequacy. The difference between the VIT and earlier attempts at quantifying variety are: 1) the VIT is based on the food groups described in the Food Guide Pyramid, 2) it is based on the number of servings recommended by the Food Guide Pyramid, 3) it is specific to toddlers aged 24 - 36 months, 4) it is appropriate for the most recent recommendations for fat intake in young children, and 5) it reflects variety both among and within food groups.

METHODOLOGY

SAMPLE

The subjects (n=122) for this study were 73 middle to upper socioeconomic status (SES) Caucasian children and their mothers from an ongoing longitudinal study (2 months to 60 months) of infants' and children's feeding practices[18] and 49 lower SES Caucasian children and their mothers who were part of the same study during the 24 to 36 month period only. SES was determined with the Hollingshead Four Factor Index[19], which is based on education and occupation of the family's wage earners. The scale ranges from 8 - 66, with 66 indicating the highest SES. The mean Hollingshead Index score for all subjects in this sample was 45.4 $\pm$ 14.7. Research protocol was approved by an independent review board for use of human subjects in research.

Dietary data were collected from the mothers when the children were 24 to 36 months old. Using a computer generated randomization technique, subjects were randomly assigned two interviews at 24, 28, 32, or 36 months. Interviews were conducted in the participant's home by one of two Registered Dietitians (R.D.). A 2-day food record was kept by the mother, and a 24-hour recall was taken at each interview for a total of 3 days of dietary data per interview. Three days of diet information are considered adequate to assess the diet of an individual[20].

CALCULATION OF THE VIT SCORE

Dietary information was entered in Nutritionist IV, Version 3.5 1994 (N-

Squared Computing, The Hearst Corporation, San Bruno, CA) for nutrient analysis. The database contained 12,500 foods. If reported foods were not in the database, standard recipes were entered, manufacturer's information was requested, or appropriate substitutions from the database were made. The first step in the calculation of the VIT score involved using Nutritionist IV to generate a list of foods eaten in the 3-day period and to aggregate portions of identical foods consumed on different eating occasions to give a total amount of food consumed. For example, if one half banana was consumed on each of the 3 days, the list combined those portions. A banana counted only once toward the VIT, and one and one half bananas was the amount consumed. Foods were then classified by the first author into the Food Guide Pyramid groups of breads, fruits, vegetables, dairy, and meat.

The fats, sweets, and oils group was omitted from the VIT because the Food Guide Pyramid makes no specific recommendations for the number of servings to be consumed. The recommendation states, "USE SPARINGLY" and "You decide how to use the additional fat in your diet"[1]. Additionally, the Dietary Guidelines suggest that fat restrictions for young children should not be comparable to that for adults[11].

Using the Food Guide Pyramid, recommended adult serving sizes were adapted for toddlers (Table 1). The standard of 1 Tablespoon per year of age[21] was also used for some foods, such as vegetables. Serving sizes in the dairy group were based on calcium equivalents compared to milk, as is done in the Food Guide Pyramid[1].

The recommended number of servings is given as a range in the Food Guide Pyramid and relates to estimated calorie levels. The lower end of the serving range

applies to a lower caloric intake (1600 calories), and the upper range is for a higher caloric intake (2800 calories). The Recommended Dietary Allowance (RDA) for calories for children 1 - 3 years old is 1300 calories, which is less than the lowest energy value given in the Food Guide Pyramid. Following the Food Guide Pyramid recommendation that preschool children should eat smaller servings and preserve the variety of other calorie levels, the VIT used the lowest end of the serving range with the adjusted serving sizes for toddlers (Table 1). However, the upper end of the serving range was used for the dairy group because 1 dairy serving was established as ½ cup of milk. The Food Guide Pyramid states that children should consume at least 2 cups of milk each day; therefore, 4 servings (½ cup per serving) are required to meet the Pyramid guidelines.

The number of daily recommended servings was multiplied by 3 because 3 days of dietary data were used from each interview to calculate VIT (Table 2). The minimum number of servings that had to be consumed in order to achieve a perfect food group score of 1.0 varied by food group. For example, at least 18 bread servings had to be consumed over 3 days for a perfect bread group score, and at least 9 vegetable servings had to be consumed over 3 days in order to achieve a perfect vegetable group score of 1.0.

For each child, the number of toddler-sized-servings consumed within each food group over the 3 days were added together to determine a total for each food group. Each food group total was compared to the serving recommendations shown in Table 2, and the resulting ratio was the food group score. Scores could range from

a potential 0.00 to a maximum of 1.00. For example, if the child consumed 16 bread servings over 3 days, 16 would be compared to the minimum number of servings from the bread group. The ratio of 16/18 would result in a food group score of 0.89. In the vegetable group, if 6 servings were consumed over the 3 days, the ratio would be 6/9 or a food group score of 0.67 rather than a perfect score of 1.00.

Once a score was calculated for each of the 5 food groups, the child's scores were averaged to determine a VIT score. The VIT scores could range from 0.00 to 1.00, with a perfect score of 1.0 indicating that at least the recommended minimum number of servings were consumed from each of the 5 food groups, averaged over 3 days.

COMBINATION FOODS

Many foods commonly consumed by the subjects did not easily fit into the 5 food groups because their component parts included more than one food group. The Food Guide Pyramid does not provide any direction for the classification of combination foods. As stated by Schuette, Song, and Hoerr, "although the Food Guide Pyramid has many strengths...instructions to handle combination entrees, which are a substantial portion of the foods consumed in the United States, are inadequate to classify food groups and estimate serving sizes"[22].

The diabetic exchange lists are one of the few established methods of dealing with combination foods. Because individuals with diabetes must be able to estimate the carbohydrate and other macronutrient content of the foods they eat, the exchange

lists classify many commonly consumed combination foods[23]. In developing VIT, the authors used a combination of diabetic exchange lists and standardized recipes[24] to estimate contributions of individual components of combination foods to separate food groups. Only the components that counted greater than or equal to ½ toddler-size-serving of a food group were included in VIT. Consequently, incidental ingredients, such as the egg in a bread product, did not count toward the variety score. The incidental ingredients do not make a major contribution to dietary variety, and omitting them simplified calculations.

EXCLUDED FOODS

In addition to smaller components of combination foods, some foods were deliberately excluded from the VIT. The rationale for the exclusion of specific foods from the VIT score originates with the goals of the VIT score. First, the VIT score was based on the Food Guide Pyramid, which does not give specific recommendations for all types of foods (eg, fats, sweets, oils). Secondly, the VIT score was intended to measure nutritious foods; it was not intended to enumerate the total food consumption. Condiments, candy, herbs/spices, soda, punch, oils, butter/margarine, and salty snack foods (eg, potato chips) are examples of foods that were excluded from the VIT score.

Any food that was consumed in a total amount less than ½ toddler-size-serving over 3 days was excluded from the VIT score. For instance, if a child consumed 1 fluid ounce (¼ serving) of milk over 3 days, milk would be dropped out of the VIT calculation. However, if the child consumed 1 fluid ounce on each of the 3 days,

these would be added together for a total of 3 fluid ounces (¾ serving) consumed over the 3 days. Three fluid ounces meets the criteria of equal to or greater than ½ toddler-size-serving, so it would count as ¾ serving in the dairy group.

TRUNCATION

The VIT score was established to measure variety. In order to measure variety both within and among food groups, truncations were used at several steps in the methodology. Within a food group the contribution of any specific, single food was truncated at 33%. Even if a subject consumed 10 servings of broccoli over 3 days the maximum contribution broccoli could make to the vegetable group score would be 3 servings (33% of vegetable servings over 3 days).

As was done in the HEI[10], cakes, cookies, and pies contributed to the bread group by determining the amount of flour in a standard serving. This amount of flour was compared to the amount of flour in a standard slice of bread to calculate the number of bread servings. However, all cakes, cookies and pies were counted together as a single food, so as a group they could not contribute more than 33% to the bread group score.

Another truncation was performed to ensure variety among the food groups. Each food group score was truncated at 1.0, or 100% of the minimum recommended number of servings. With this convention, high intake of one food group could not compensate mathematically for low intake in another food group.

An exception to the truncation rule was made with milk. The major goal of the dairy group is to provide calcium. Milk is the best source of calcium in the American diet, and the Food Guide Pyramid states that preschool children need at least 2 cups of milk each day[1]. Two cups of milk meet the serving requirements for the dairy group for a day. Thus, other dairy products (eg, cheese and yogurt) could contribute to the dairy group score, but a subject could still receive a perfect dairy group score if 2 cups of milk were consumed each day and no other dairy foods were consumed.

VALIDATION OF THE VIT

Because dietary variety is expected to fill several roles[5], a variety index can be compared to other standards that measure one specific dietary characteristic. As a measure of validation, the VIT score was compared to the Mean Adequacy Ratio (MAR) score, which is a measure of nutrient adequacy[8]. To determine a MAR score for each subject, the Nutrient Adequacy Ratio (NAR) was determined for each of 12 nutrients using the formula:

$$\text{NAR} = \frac{\text{Subject's daily intake of a nutrient}}{\text{RDA of that nutrient}}$$

NAR was calculated for protein, calcium, zinc, magnesium, iron, vitamins A, B6, and B12, ascorbic acid, thiamin, riboflavin, and folacin. As described by Guthrie and Scheer[8], each NAR value was truncated at 1.0 to prevent mathematical compensation of one nutrient in excess of the RDA for other nutrients with low intake[8]. To determine the overall dietary adequacy, the Mean Adequacy Ratio (MAR) score was

computed using the formula:

$$\text{MAR} = \frac{\text{Sum of the NAR for 12 nutrients}}{12}$$

To avoid intra-subject bias, the two VIT scores from the two interviews for each subject were averaged and the two MAR scores were averaged. Correlation coefficients were calculated from the average VIT and average MAR scores for each subject.

RESULTS AND DISCUSSION

SAMPLE

One hundred and sixteen of the 122 subjects completed 2 interviews. Averages of the 2 VIT and MAR scores were used in the Pearson Correlation analysis for 116 subjects. For the subjects who had only one interview, the VIT and MAR score from that interview were used in the correlation.

INDIVIDUAL FOOD GROUPS

As shown in Table 3, variety over time for the bread group was consistently the highest ($\bar{x}$ = 0.94-0.96). This finding was similar to Nationwide Food Surveys (NFS) data, which reported that 99.2% of white children aged 1 - 2 years consumed foods from the bread group in a day[25]. The bread group consistently had the greatest number of subjects receiving perfect scores (38 - 54 toddlers) despite the fact that the bread group requires the greatest number of servings to achieve a perfect score.

The vegetable and meat group scores were consistently low ($\bar{x}$ = 0.68-0.73 and 0.73-0.76, respectively). In the NFS data 80.4% of white children aged 1 - 2 consumed meat, while only 74.8% consumed any vegetables in one day[25]. In the current study the vegetable group contained the largest number of subjects in the lowest scoring category (0.00 - 0.25), with a total of 25 subjects over the four interview periods compared to a total of 8 in the meat group.

The fruit group had the widest range of mean scores over the four collection periods ($\bar{x}$ = 0.71 - 0.84). In the NFS data, the fruit group showed the lowest

percentage of children (aged 1 - 2 years) consuming servings from this group (69.0%) in one day[25]. However, the fruit group percentage was higher (76%) in the NFS data for children in the southern region of the United States[25].

VIT AND MAR

Mean VIT scores ranged from 0.79 to 0.81 (Table 4), and mean MAR scores ranged from 0.91 to 0.92. The correlation between the VIT and MAR scores was $r = +0.74$ ($p < .01$). Consumption of a limited number of nutrient-dense foods may yield a high MAR score, but the VIT score would be low. Conversely, consumption of several different foods of marginal nutritional quality could result in a high VIT score, but the MAR score would be low. The VIT score is somewhat more sensitive than the MAR to dietary differences among children, as is shown by the distribution of scores in Table 4. Over the four data periods, from 86-95% of the MAR scores were found in the highest scoring category, as opposed to the VIT scores, which had slightly less than 50% of the subjects in the highest category and almost an equal percentage in the second highest. No subjects received scores in the lowest category of either scale because if they consumed even minimal amounts of food their scores would be higher than 0.00 - 0.20.

The VIT and the MAR scores for these subjects were stable over time. Using MANOVA, there were no significant differences in VIT and MAR scores for the group as a whole between the first and the second interviews. When the subjects were grouped according to the number of months between their interviews (4-, 8-, or

12- month time interval) and changes in VIT and MAR scores over time were analyzed with MANOVA, again no significant difference was found between the first and second interviews for VIT or MAR scores.

Based on data presented in this paper the VIT score appears to be an appropriate measure of variety among the food groups. Even though many of the children received perfect scores in individual food groups (Table 3), very few of the subjects received perfect VIT scores (Table 4). A perfect VIT score indicates consumption of the minimum number of recommended servings from each of the food groups. Thus, although some subjects had high scores in a few food groups, this did not compensate for low intake in another food group.

As expected, total calories were correlated to the VIT scores over the 4 data periods ($r = 0.54 - 0.66$). An increase in calories would be expected to provide more foods, and, potentially, more food group representation. It is more difficult to eat a variety of foods if fewer foods are consumed. The percentage of calories from fat had a low, nonsignificant positive correlation with the VIT score. This may demonstrate that the VIT score was not designed to quantify or address dietary fat.

IMPLICATIONS

The VIT score measured dietary variety based on the Food Guide Pyramid and was developed specifically for toddlers. The results indicated that the VIT is a valid measure of dietary variety which can be compared to other characteristics of children, such as growth parameters or behavior patterns. The VIT score can potentially also be adapted to other age groups and populations by adjusting the serving sizes and number of recommended servings per day; therefore, it can be used to track changes in dietary variety over time. As used in this study, the VIT assessed dietary variety over a 3-day period, which is preferable to considering a single day. Dietary variety is stressed in many dietary guidelines and recommendations, and the VIT score provides a method to quantify this concept. The VIT score has many potential applications in academia, research, and industry.

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Table 1
Food Guide Pyramid serving sizes adapted to toddlers (aged 24 to 36 months) for use in the Variety Index for Toddlers (VIT) calculation

Food Group and Item	Serving size for 1 serving
Bread group	
Bread, sliced	1/2 slice
Cereal, ready-to-eat	1/2 ounce
Cereal, cooked	1/4 cup
Pasta or rice	2 Tablespoons
Crackers	1/2 ounce
Sweets	equivalent of 7.6 grams flour
Vegetable group	
Vegetables, processed or cooked	2 tablespoons
Potatoes, french fried	35 grams
Potatoes, mashed	2 tablespoons
Vegetables, raw leafy	1/2 cup
Vegetables, whole raw	1/2 item
Sauce, tomato	2 tablespoons
Fruit group	
Fruit, large raw (apple, banana)	1/2 item
Fruit, small raw (apricot, plum)	1 item
Fruit, processed (applesauce)	2 tablespoons

Table 1 (continued)

Dairy group	
Milk, yogurt, or pudding	1/2 cup
Cheese, natural	3/4 ounce
Cheese, processed	1 ounce
Cheese, cottage	1 cup
Ice cream or frozen yogurt	1 cup
Meat group	
Meat	1 1/2 ounce
Egg	1 1/2 item
Peanut butter	3 tablespoons
Beans, cooked dry	3/4 cup
Nuts	1/2 cup

Table 2
Serving recommendations used in the Variety Index for Toddlers[1] (VIT)

Food Group	Number of Servings		Corresponding Food Group Score[2]
	Daily	3-day Totals	
Bread	6	18	1.0
Vegetable	3	9	1.0
Fruit	2	6	1.0
Dairy	4	12	1.0
Meat	2	6	1.0

[1]Recommended servings adjusted for toddlers (24 - 36 months) and based on Food Guide Pyramid recommendations
[2]Maximum score equivalent to meeting total number of servings over 3 days

Table 3

Means, standard deviations, and distribution of food group scores used in the VIT[1] by month

	Month			
	24 (n = 56)	28 (n = 59)	32 (n = 68)	36 (n = 55)
Bread Group Score				
Mean ± S.D.	0.95±0.12	0.94±0.12	0.96±0.10	0.94±0.16
Score distribution (frequency)				
0.00 - 0.25	0	0	0	1
0.26 - 0.50	1	1	0	1
0.51 - 0.75	3	7	4	3
0.76 - 0.99	9	9	10	12
Perfect scores (1.00)	43	42	54	38
Vegetable Group Score				
Mean ± S.D.	0.71±0.32	0.68±0.31	0.68±0.29	0.73±0.33
Score distribution (frrequency)				
0.00 - 0.25	6	4	8	7
0.26 - 0.50	12	16	9	5
0.51 - 0.75	5	10	21	12
0.76 - 0.99	12	9	11	8
Perfect scores (1.00)	21	20	19	22

Table 3 (Continued)

	Month			
	24 (n = 56)	28 (n = 59)	32 (n = 68)	36 (n = 55)
Fruit Group Score				
Mean ± S.D.	0.84±0.26	0.71±0.33	0.81±0.28	0.74±0.35
Score distribution (frequency)				
0.00 - 0.25	1	6	4	7
0.26 - 0.50	8	12	7	7
0.51 - 0.75	5	9	12	9
0.76 - 0.99	8	5	4	4
Perfect scores (1.00)	34	27	41	28
Dairy Group Score				
Mean ± S.D.	0.84±0.25	0.85±0.25	0.82±0.23	0.83±0.24
Score distribution (frrequency)				
0.00 - 0.25	2	2	3	1
0.26 - 0.50	6	5	4	5
0.51 - 0.75	6	9	15	9
0.76 - 0.99	12	7	18	13
Perfect scores (1.00)	30	36	28	27

Table 3 (Continued)

	Month			
	24 (n = 56)	28 (n = 59)	32 (n = 68)	36 (n = 55)
Meat Group Score				
Mean ± S.D.	0.73±0.30	0.74±0.25	0.76±0.27	0.74±0.28
Score distribution (frequency)				
0.00 - 0.25	5	2	5	3
0.26 - 0.50	11	10	7	9
0.51 - 0.75	9	17	16	14
0.76 - 0.99	11	14	18	10
Perfect scores (1.00)	20	16	22	19

[1] Variety Index for Toddlers is based on the Food Guide Pyramid with serving sizes adjusted for toddlers (ages 24-36 months)

Table 4

Means, standard deviations, ranges, and distribution of VIT[1] and MAR[2] scores by month

	Month							
	24 (n = 56)		28 (n = 59)		32 (n = 68)		36 (n = 55)	
	VIT	MAR	VIT	MAR	VIT	MAR	VIT	MAR
Mean ± S.D.	0.81 ± 0.15	0.92 ± 0.06	0.79 ± 0.14	0.91 ± 0.07	0.81 ± 0.13	0.92 ± 0.07	0.80 ± 0.14	0.92±0.06
Range	0.44 - 1.00	0.73 - 1.00	0.48 - 1.00	0.63 - 1.00	0.38 - 1.00	0.65 - 1.00	0.41 - 1.00	0.79-1.00
Score distribution (frequency)								
0.00 - 0.20	0	0	0	0	0	0	0	0
0.21 - 0.40	0	0	0	0	1	0	0	0
0.41 - 0.60	6	0	9	0	2	0	3	0
0.61 - 0.80	22	4	21	7	31	6	25	3
0.81 - 0.99	24	49	25	50	33	61	23	48
Perfect scores (1.00)	4	3	4	2	1	1	4	4

[1]Variety Index for Toddlers is based on the Food Guide Pyramid with serving sizes adjusted for toddlers (ages 24 - 36 months).
[2]Mean Adequacy Ratio, a measure of nutrient adequacy calculated as the average ratio of intake to the RDA for 12 nutrients.

VITA

Dana Rae Robertson grew up in Colby, Kansas, where she attended public school until she moved to Idaho in 1986. After graduating from Twin Falls High School in 1988, she attended Utah State University in Logan, Utah. From January of 1991 to July of 1992 she volunteered as a missionary in Manila, Philippines, then resumed her studies at Utah State University upon returning. She received a Bachelor of Science degree in dietetics from Utah State University in June of 1995, and she successfully completed the registration examination for dietitians in October of 1995. After graduating from Utah State University, Dana moved to Knoxville, Tennessee to pursue a Master of Science degree in Nutrition at the University of Tennessee.

During her graduate program, Dana worked as a Graduate Research Assistant in the Department of Nutrition, and in the summer of 1996 she taught the introductory level nutrition course for the University of Tennessee. After graduation, Dana will begin the doctoral program at the University of Tennessee.