DIETARY INTAKE AND ANTHROPOMETRIC MEASUREMENTS OF PRESCHOOL CHILDREN

by

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INTRODUCTION

The development of the human body is greatly affected by heredity which to a large extent predetermines many physical traits and biochemical characteristics of the individual. The importance of a broad span of environmental factors, however, cannot be overlooked. Dietary intake is one such factor that has been shown to affect both physical and biochemical status of an individual. Animal studies have demonstrated the impact of proper diet on the development and achievement of the genetic or biologic potential. The principal muscle tissues as well as internal organs are affected to different degrees by restriction of nutritive supply. The fat depots are affected most and the central nervous system least.

Research by Macy and Hunscher (1951) has demonstrated that diet may be a limiting factor in the growth of young children. This and other studies illustrate the importance of finding simple methods of evaluating the physical-physiological status of preschool children. One such method involves taking anthropometric measurements. However, the literature contains few recent studies which relate dietary intake to anthropometric measurements--especially in preschool children.

It is difficult to obtain dietary information on preschool children because they are seldom found in a group where their food habits may be observed. Therefore, their dietary records must be kept by the mothers in the home. It is necessary to study the dietary intake of these children because the preschool years are important in forming patterns that may have an effect on the child the remainder of his life. The objective of this investigation was to study the relationship of dietary intake of 50 preschool children and their physical status as determined by anthropometric measurements.

REVIEW OF LITERATURE

Methods of Evaluating Physical-Physiological Status

When attempting to evaluate the physical-physiological status of an individual, there are several different methods that may be applied: 1) clinical observations; 2) determination of body composition; 3) anthropometric measurements; 4) dietary investigations; and 5) biochemical analyses. The greater the number of methods applied in a study, the more complete will be the description of the individual. However, most researchers find it possible to use only 1, 2, or 3 of these methods in one study. The Food and Nutrition Board (1964) stated that actual nutritional status of groups of people or individuals must be judged on the basis of physical, biochemical, and clinical observations combined with observations on food or nutrient intakes. Bengoa _et al._ (1959) suggested several methods of assessing protein-calorie malnutrition in young children: 1) use of vital statistics; 2) anthropometric measurements; 3) clinical signs; 4) food consumption; and 5) laboratory tests.

Clinical Observations. Clinical observations should be used only in combination with other methods of determining physical-physiological status. Observations may be made on eyes, lips, gums, teeth, tongue, buccal mucosa, skin, thyroid gland, tendon reflexes, lower extremities and blood pressure. However, these observations lack sensitivity in defining status since it is only possible to evaluate the gross clinical manifestations that may occur and the subclinical signs remain unnoticed. The clinical examination is therefore most effective only after visible clinical deficiency symptoms have occurred, and not when the first biochemical changes occur.

Determination of Body Composition. Forbes (1962) outlined a number of methods that have been used for determining the composition of the human body. When cadavers are available, direct chemical analysis may be done on the whole body or on individual tissues. Indirect methods of analysis are more likely to be used, however, when determining the body composition of living human beings. Indirect measurements of water and electrolytes are obtained by applying the isotopic dilution technique, using a whole body radiation counter, or doing quantitative roentogenography of the human skeleton. Indirect methods for estimating total body fat include total body water, body densitometry, creatinine coefficient, skinfold measurements, fat soluble indicators (gases), and total body potassium.

Brozek (1960) has discussed methods of soft tissue roentgenography, densitometry, and hydrometry for determining body composition.

Anthropometric Measurements. The use of anthropometric measurements makes possible an assessment of the body build of individuals. In the past it has been common to evaluate body build strictly from height-weight tables. The Committee on Nutritional Anthropometry (1956) stated that the growth, weight, and composition of the body depend in part on the supply of nutrients and may serve as a useful, though limited, criterion of one aspect of nutritional status. This committee suggested that for individuals the body weight be evaluated with reference to skeletal size by considering body height and width of skeletal framework. In this way an estimation of degree of underweight or overweight may be obtained. The proper interpretation of the biological significance of body weight is obtained by analysis in terms of body composition. The largest individual variable is body fat.

Body measurements are useful in several nutritional contexts (Brozek and Keys, 1956). These include evaluation of caloric requirements, assessment of the nutriture of individuals, description of the present nutritional status of different populations, and the effect of varying economic, agricultural, or dietary practices. Body measurements also serve as a means of assessing adequacy of caloric supply during periods of food restriction and shortage.

Kornfeld (1956) stressed that nutritional anthropometry in children cannot be separated from a more general appraisal of body build and physical development. Different methods should be applied in mass surveys, research projects, and pediatric practice. In addition, with different age groups, different measurements must be selected.

Recommended Measurements. Researchers are not in complete agreement on the anthropometric measurements that should be included to attain a complete description of the body build and physical status. McCloy (1938) discussed many different methods for classifying body builds. He suggested that for the purpose of evaluating physical status, measurements be divided into four groups that measure: 1) general nutritional status; 2) amount of subcutaneous fat; 3) muscular development; and 4) respiratory conditions.

Brozek (1956) said the following measurements were of primary importance for describing differences in nutritional status: 1) height; 2) weight; 3) width of pelvic girdle (bi-cristal diameter which serves as a measure of the width of skeletal framework); and 4) skinfold measurement at back of upper arm. Measurements of secondary importance were 1) subscapular skinfold as a measure of thickness of subcutaneous fat on trunk; 2) muscular development of upperarm (circumference or approximate diameter calculated from circumference, corrected for subcutaneous fat); and 3) bi-acromial diameter (bony width of shoulders). A measurement classified as being of tertiary importance was the sitting or cristal height. By using bony measurements, muscular development, and age, Brozek (1956) developed a formula for predicting "standard" weight with relatively high correlation coefficients. However, these formulas were not developed for children.

The Committee on Nutritional Anthropometry (1956) made recommendations for anthropometric measurements of children.

Brozek and Keys (1956) who were members of this committee stated that not all of the recommended body measurements on children are equally practicable or equally useful at all ages. Consequently, separate lists of recommended measurements were made for 5 age levels: 1) birth; 2) 10 days - 1 month; 3) 3, 6, and 9 months; 4) 1 - 6 years; and 5) 7 - 10+ years.

The following measurements for children from 1 - 6 years were recommended by the Committee on Nutritional Anthropometry (1956):

Minimum list for emergency conditions	A.	Length, stem length, weight, standing length
Should be added for survey work except in emergency	B.	Circumference_1 (head maximum) under 5 years Circumference_2 (chest maximum--mid inspiration)
Desirable for survey work, still requires little equipment	C.	Diameter_1 (pelvic) Diameter_2 (shoulder)
Desirable but requires equipment less readily available	D.	Skinfolds over triceps below scapula on chest (along mid-axillary line at level midway between nipples and umbilicus)
Desirable but rarely practicable in field	E.	Postero-anterior X-ray film of hand and wrist. It should include terminal phlanges as well as distal ends of radius and ulna.

Kornfeld (1956) selected the following measurements as minimum requirements for characterization of body build and physical development in infants: body length, stem length, body weight, head circumference, chest circumference at 2 levels (supramaxillary and xiphoid). He suggested that after 5 years of age the head circumference be omitted and to further characterize the relation between longitudinal growth and circumferential growth in older children, measurements of wrist circumference and hand length could be included. When studying soft tissue distribution, Kornfeld (1956) used circumference of forearm, arm, and calf, and skinfold measurements on chest (infraclavicular), abdomen (lateral from umbilicus), back (medial from the inner scapula), and cheek.

Montagu (1960) devoted part of his book to the description and definition of a large number of measurements of the body. He made no specific measurement recommendations and stated that his purpose in presenting the measurements was to give the reader a working knowledge of some of the methods of measurement most commonly used in physical anthropology. He suggested that only measurements which are pertinent to the study be taken.

Procedures. Procedures employed in taking most anthropometric measurements are relatively simple. Meredith (1935), Boynton (1936), and Knott (1941) have given detailed explanations of anthropometric procedures for height, weight, body diameters, body circumferences and skinfolds.

More material has been written recently about the skinfold measurement than other types of anthropometric measurement because of the introduction of the standard pressure skinfold caliper. With this instrument, the subcutaneous fat layer can be measured with greater accuracy and reproducibility of results.

Brozek and Keys (1956) and the Committee of Nutritional Anthropometry (1956) recommended a caliper with a constant pressure of 10 gm/mm^2. The following recommendations for calipers were made by Edwards <u>et al</u>. (1955): 1) faces of calipers should be rectangular of size 6 x 15 mm^2 with well rounded edges and corners; 2) pressure exerted at the faces should not vary more than 2 gm/mm^2 over a range of 2 - 40 mm; 3) for reproducible results the pressure should lie in the range of 9 - 20 gm/mm^2 with 10 gm/mm^2 suggested as the standard value; and 4) the scale should be so that the readings may be taken to nearest 0.5 mm and preferably to nearest 0.1 mm.

Garn and Gorman (1956) found that skinfolds averaged 70% of their calculated true value (as determined by teleroentgenogrammetric measurements of the subcutaneous fat) and this indicated a 30% reduction attributed to tissue compression under a total force of 300 grams. This illustrated that the pressure of the caliper has an important effect on the observed thickness of the fold as well as on the reproducibility of results. They suggested that 10 gm/mm^2 be used as the standard value for calipers but lower pressures might be used with small children.

When performing the skinfold measurement, a fold of skin is lifted by grasping firmly the fold between the thumb and forefinger. Brozek (1960) stressed that the width of the skin that is enclosed between the fingers is an important factor. When there is a thick subcutaneous layer of fat, a wider segment of the skin must be lifted. The width of the skin lifted should be minimal but still give a well defined fold. It was recommended that the skin be lifted approximately 1 cm from the site at which the calipers are to be placed and the skinfold measured (Brozek, 1960; Committee of Nutritional Anthropometry, 1956). The calipers should be placed the minimal distance from the crest of the fold where the surfaces are approximately parallel to one another (Brozek, 1960). Damon (1965) reported that skinfolds lifted by one hand measured about 0.67 mm, which is approximately 5% of the triceps and 4% of subscapular thickness more than skinfolds lifted and held by two hands. The difference is enough to justify use of two hands but it is not enough to make it obligatory.

Brozek (1956) stated that by use of skinfold measurements it is possible to evaluate the individual leanness-fatness against the distribution of skinfold thickness obtained for a normative group. Accuracy in the use of skinfold calipers involves practice. Also different researchers may obtain different results when measuring the same skinfold. Tanner and Whitehouse (1955) stated that differences between duplicate measurements made by different persons when using Harpenden calipers were approximately twice as large as those made by one person.

Brozek and Keys (1950) stated that the measuring of skinfolds has the advantages of simplicity and rapidity and the technique can be mastered in a short time. Relatively high correlations have been found between caliper readings and actual measurement of subcutaneous tissue. Lee and Ng (1965) reported a study in which skinfold measurements as determined by the Harpenden caliper were correlated with direct measurements of subcutaneous fat and skin on cadavers. The correlation coefficient between caliper readings and directly measured fat thickness varied from 0.70 - 0.88 for males and from 0.61 - 0.92 for females. Fry (1961) found that correlation between measurement with the Harpenden caliper and surgical incision was 0.82.

Relationship of Various Measurements to other Body Factors. In a study of total body fat and skinfold thickness in children, Parizkova (1961) found that thickness of skinfolds correlated closely with body density. Body density was obtained by hydrostatic weighing and simultaneous measurement of residual air by the nitrogen dilution method. The skinfold measurements which had the highest correlation with body density varied with age and sex. With girls, skinfolds of the trunk of the body (on the back, on the chest in anterior axillary fold, and on the chest in the anterior axillary line at the level of the 10th rib) had the highest correlations with body density. With younger boys, these three skinfold measurements plus a measurement below the chin had the highest correlation coefficient with body density. The highest correlation with body density for all groups was with the sum of all ten skinfolds. Young et al. (1961) found in a study of young women that a total skinfold thickness (determined from 12 measurements) showed a high correlation with body density (0.6866) and concluded that in the group studied, well chosen skinfold measurements indicated relative fatness better than some more elaborate chemical procedures.

Seltzer et al. (1965) in working with obese adolescent girls obtained a number of measurements and correlated these with body density (which was used as a measure of fatness) and with body weight. The arm circumference had the highest correlation coefficient with body density (r = -0.632) and gross body weight had the next highest correlation with body density (r = -0.527). Body density was well correlated with the height-weight ratio (r = 0.901). Body weight had correlation coefficients of r = 0.795, 0.784, and 0.625, respectively with triceps, pectoral, and subscapular measurements of skinfold thickness. When correlated with body density, the triceps skinfold was highest with r = -0.687 and the thigh skinfold was next with r = -0.655. A table for the conversion of triceps skinfold thickness to body density and percent body fat for the purpose of directly estimating the body fat in obese adolescent girls between the ages of 12 - 18 years was given.

Behnke (1961) used 11 anthropometric circumferences and stature to predict body weight of men and women with an accuracy of ± 2%. Lu and Savara (1962) statistically analyzed the factors height, chest girth, and calf girth for their growth effects on weight of children 3 - 8 years of age. It was concluded that these three factors were satisfactory in determining the weight of children 3 - 8 years of age. However, the overall relative importance of the three factors ranked differently in the two sexes.

Hammond (1953, 1957) used body measurements to describe body types of children. Factor analysis of body measurements of children from birth - 5 years showed that length, girth, and breadth types similar to those found in children of school ages were distinguished uniformly throughout the age range. The types are probably determined by the relative development of the long bones, muscle, and fat.

Reed and Stuart (1959) conducted a study on 134 children from birth to 18 years. They found that individuals with rapid growth before 6 years of age tended to have a large mature size and an early adolescent growth spurt.

Radiographs were used on children between 1.5 - 17.5 years by Garn and Haskell (1959a, 1959b, and 1960). Significant correlations were found between fat thickness, size, and maturity status of children between 1.5 - 11.5 years of age. They found that the increase in subcutaneous fat in boys and girls 6.5 - 10.5 years was small and roughly parallel for the two sexes. After this a sharp sex difference appeared. For boys, the thickness stabilized at approximately 4.5 mm between ages 11 and 17 but for girls the thickness increased to 8 - 9 mm by age 14. They also found that fat and developmental progress appeared to be linearly related. Between infancy and early adolescence, fat thickness and length were positively correlated. Children 1.5 - 12.5 years of age who were one standard deviation above the average in fat were advanced by approximately half a year's growth.

The chief purpose of a study by Reynolds (1951) was to provide quantitative information on the amount and distribution of subcutaneous adipose tissue in the body, particularly during the period of childhood and adolescence. Roentgenograms of normal children between ages 6.5 - 17.5 years were taken of the superficial adipose layer (plus skin) at various levels of the body. Results of the study were discussed under the following headings: 1) summary of group patterns in amount and distribution of fat; 2) relation between variables; 3) summary of measurements of subcutaneous tissue of the body in areas other than the 12 areas considered in the main body of the paper; 4) summary of 19 individual case histories; 5) sexual differences in amount and distribution of subcutaneous fat; 6) relation of sexual maturation to amount and distribution of subcutaneous fat; 7) hereditary aspects of fat distribution; 8) relation of over- and underweight to breadths of subcutaneous fat; and 9) means for breadths of fat in calf in 40 infants and 256 adults.

Dietary Investigations. In conducting a dietary investigation, it is important that the researcher obtain accurate information relating to the dietary intake of the persons whom he is studying. This information then may be evaluated in relation to a standard.

Methods of Collecting Dietary Information. Indik and Beeuwkes (1960) found it useful to think of only two "distinctly different" methods of collecting dietary information: 1) food records in weighed, measured, or estimated amounts and 2) dietary histories. These two methods then may be modified in many ways to meet the needs of the investigator. Chalmers *et al.* (1952) said that one of the most widely used methods for collection of dietary data for research purposes has been the dietary record which consists of a detailed, quantitative listing of all foods consumed by an individual over a given period.

Indik and Beeuwkes (1960) stated that the dietary collection method to be used depends on the specific problems with which it is concerned. Factors influencing the selection of the method are: 1) level of data to be collected; 2) persons to be studied; 3) amount of detailed information necessary; 4) amount of error tolerable; 5) scope of the problem; 6) size of population being studied; 7) amount and source of variability of respondents; 8) seasons, weeks, and days involved; 9) duration of collection period; and 10) competence and number of staff.

Indik and Beeuwkes (1960) pointed out a number of sources of error which might affect the reproducibility of a method of studying food habits: 1) each assessment affects the result of subsequent assessments; 2) individuals eat differently at different times--in food items, amounts, and in methods of preparation of food; 3) individuals respond differently to different research methods, different investigators, and at different times; and 4) investigators affect the results because they differ as individuals in contacting different respondents, use methods differently, and act differently at different times.

Chalmers _et al_. (1952) recommended that dietary records cover a sufficient period of time to furnish an adequate picture of nutrient intake. However, an unduly long period of record keeping should be avoided because the interest and cooperation of the subject might be lost. The question of how many and which days to keep a diet record depends on whether individuals or groups are involved. Eppright _et al_. (1952) reported that data from dietary records are more accurate in describing groups than individuals.

Evaluation of Dietary Intake. Researchers often relate their dietary findings to the Recommended Dietary Allowances (RDA) proposed by the Food and Nutrition Board of the National Research Council (NRC). The RDA first were published in 1943 and were revised in 1945, 1948, 1953, 1958, and 1964.

It is the opinion of the Food and Nutrition Board (1964) that the Recommended Dietary Allowances will maintain good nutrition in essentially all healthy persons in the U. S. under current conditions of living. They were planned to afford a margin of sufficiency above average physiological requirements to cover variations among individuals. They also provide a buffer against increased needs during common stresses and allow realization of growth and productive potential. However, these RDA are not to be considered adequate to meet additional requirements of persons depleted by disease or traumatic stresses. The margin of sufficiency above normal physiological requirements is different for each nutrient because of differences in body storage capacity, range of individual requirements, precision of assessing requirements, and possible hazard of excessive intake of certain requirements.

The RDA for nutrients are the same for males and females from 3 to 6 years of age. They were developed for a child at the midpoint ($4\frac{1}{2}$ years) of the given age range (3 - 6 years). It is assumed that the "reference" $4\frac{1}{2}$ year old child weighs 40 pounds (18 kg) and is 42 inches (107 cm) tall (Food and Nutrition Board, 1964).

Biochemical Analysis. Another type of determination which might be employed for determining physical-physiological status is biochemical analysis of blood and urine. It is possible to determine the quantities of various vitamins and other substances that are being excreted from the body in the urine. If a normal healthy individual is excreting above average amounts of certain nutrients, his intake may be above the amount required by his body. On the other hand, if the excretion is below average, his intake may be low and the body is retaining as much of these nutrients as possible. Levels of various constituents of the blood also may be related to nutrient intake.

The Interdepartmental Committee on Nutrition for National Defense (ICNND, 1963) has outlined a number of biochemical analyses that may be done on urine and blood. Analyses of urine may include creatinine, thiamine, riboflavin, N' methylnicotinamide, iodine, and total urinary nitrogen. Analyses of blood may include hemoglobin, hematocrit, serum protein fractions, total serum protein, vitamins A and C, carotene, cholesterol, albumin, globulin, protein bound iodine, and total iodine.

Investigations of Anthropometric Measurements and Diets of Preschool Children

A number of studies on preschool children have dealt entirely with anthropometric measurements while others have involved only investigations of dietary practices. A smaller number of studies have included data on both anthropometric measurements and dietary practices of preschool children.

Anthropometric Measurements. The University of Iowa studies by Meredith (1935) on boys and Boynton (1936) on girls, although they are now old, are probably still the most complete sets of norms of anthropometric measurements for children from birth to 18 years. Meredith (1935) compiled data consisting of a total of 93,232 measured values for 18 anthropometric measurements on 1,243 Iowa City white males from birth to 18 years. The data were taken from physical measurement records made at the University of Iowa infant laboratory, preschool laboratory, elementary school, and high school. The tables present the mean, standard error of mean, standard deviation, coefficient of variation, and range of distribution for each of the following measurements at frequent intervals from birth - 18 years: 1) stature (cm); 2) sitting height (cm); 3) bi-deltoid diameter (cm); 4) bi-trochanteric diameter (cm); 5) transverse diameter of thorax (cm--nipple level); 6) antero-posterior diameter of thorax (cm--nipple level); 7) thoracic circumference (cm--nipple level); 8) body weight (kg); 9) maximum head length (cm); 10) maximum head breadth (cm); 11) bi-condylar diameter of left femur (cm); 12) bi-condylar diameter of left humerus (cm); 13) strength of grip; 14) breathing capacity (cubic inches); 15) skin and subcutaneous tissue at thorax front (mm); 16) skin and subcutaneous tissue at thorax back (mm); 17) skin and subcutaneous tissue at upperarm front (mm); and 18) skin and subcutaneous tissue at upperarm back (mm). The findings for the various age groups were related and presented in graphs and charts to show a "rhythm of physical growth".

Boynton's study (1936) was based on over 55,000 measured values for 22 anthropometric measurements of 1,241 Iowa City white girls from birth to 18 years. The same information about the various measurements was presented in tables for girls as was in Meredith's study (1936) for boys. The measurements taken by Boynton did vary some from those of Meredith. The bi-iliac diameter replaced the bi-trochanteric diameter, the grip strength was omitted, and girths for upperarm, forearm, thigh, and calf were included. The information about the girls was presented in tables and graphs to give a complete picture of the "rhythm of growth" for girls from birth - 18 years of age.

Growth of Iowa City white children with respect to circumference of arm, forearm, and leg during the period from birth to 18 years was reported later by Meredith and Boynton (1937). They discussed the proportional relationships between the limb girths studied and c ompared the girth growth to growth of selected limb breadths and stature.

Hammond (1953) correlated 20 anthropometric measurements of boys and of girls 5 - 18 years of age. The correlations were transformed to z coefficients to determine the extent to which corresponding coefficients differed from one group to another. It was found that only 2.5% of the coefficients for the boys and 3.1% for the girls differed significantly between social groups of the same age and 3.5% and 4.6% of the coefficients (for the boys and girls, respectively) differed significantly from one age group to another. These results showed that the relationship between any one measurement and the others were very constant.

Soft tissue distribution during childhood was studied by Kornfeld (1957). The children studied were white children in New Jersey from middle class families although the descent of the children was not always American or European. Kornfeld (1957) stated that it could be shown that the body build and physical development of these children did not differ essentially from other groups that are assumed to be typical for the average white U. S. population. The skinfold caliper used was not one with constant pressure but the author stated that the results presented might fit well into those obtained by research workers who used more refined methods. Skinfold measurements were made on cheeks, chest, abdomen, and back of children from newborn - 15½ years. Tables were presented with values for boys and girls at half-year intervals after 1 year (3, 6, 9 month values were given up to the first year) for each of the four measurements. The values obtained for girls were almost always larger than or equal to the values of the boys.

Tanner and Whitehouse (1962) have developed standards and percentiles for triceps and subscapular skinfolds for children from birth to 16½ years. They stated that the correlations between skinfold measurements and direct measurement of fat width by X-ray were high, $r = 0.85 - 0.90$.

A Canadian weight-height survey was conducted by Pett and Ogilvie (1956). Measurements of height, weight, and triceps skinfolds were obtained on 22,000 Canadians who ranged in age from preschool to adult. Tables containing average measurements by age and sex and percentiles of each of the measurements were given.

Fry (1960) measured subcutaneous tissue of Polynesian children. The mean skinfolds at waist, chest, back, forearm, and upperarm of 129 boys and at upperarm of 92 girls between ages

5 - 20 showed a gradual increase with age.

Adequacy of Diets. Macy and Hunscher (1951) studied the diets and visible and invisible growth of 10 children 4 - 9 years of age. Calorie intake was determined by 5-day balance periods and analyses of urine, feces, and blood were conducted. From the biological determinations it was found that neither appetite nor the recommended dietary allowances at that time could always be relied on to supply the children the nutrients required for growth.

Metheny *et al.* (1962) observed dietary patterns of preschool children and related them to income level of family, employment of mother, and marketing practices of family. Three-day diet records were obtained for 104 children 2½ - 5½ years of age. Adequacy of diet was determined by percentages of the RDA that were met. Only 1 in 5 of the preschool children studied met 100% of the RDA. Vitamin A was the best supplied nutrient and iron was the least well supplied.

Dierks and Morse (1965) investigated food habits and nutrient intakes of 121 preschool children 2 - 6 years of age. The parents of the children were college students at the University of Minnesota. Three-day food records were analyzed for nutrient intake and evaluated according to percentages of the RDA met. Total nutrient intake was calculated without including vitamin preparations that some of the children received. Intake of iron was significantly below the 1964 RDA but intake of other nutrients was generally good.

Burke *et al.* (1959) studied caloric and protein intakes of children 1 - 18 years of age. A total of 2707 dietary histories taken at 6-month intervals up to 6 years of age and at 1-year intervals thereafter were obtained on 125 children (64 boys and 61 girls). When the findings were compared with the 1958 RDA, the average intakes tended to be higher than the RDA, except for the caloric intakes of the girls.

Family food records obtained by Young and Pilcher (1950) showed that intake was adequate in relation to the RDA for all nutrients except calcium. Individual records indicated that young children (ages 1 - 10) had better food intakes than various age groups from 10 - 70+ years of age. Individual records were obtained on 78 males and 61 females between 1 - 6 years of age.

Seven-day diet records were kept for 52 healthy infants between 9 months and 2 years old by Guthrie (1963). The dietary intake was evaluated according to percentages of the RDA that were met. Nutrients provided by supplements were not included. Ascorbic acid and iron were the nutrients which most often were consumed at levels below recommended intakes. However, the diets were generally good and inadequacies occurred because of omission of one particular food group rather than an overall poor diet.

Beal (1953, 1954, 1955, 1956) used diet histories to obtain dietary information on children. The distribution of intakes during the first 5 years of life of each of the nutrients was presented in quartiles and maximum and minimum values were shown. Total intakes of calories, carbohydrate, and fat increased throughout the period. Intake of protein reached a plateau between 18 months and 3 years. The median calorie intake was close to the RDA and the median protein intake was above the RDA in the first 2 years and then similar to the RDA. Intake of calcium rose rapidly in the first 6 months, less rapidly between 6 and 9 months, then decreased to a lower level between 2 and 3 years. A sex difference occurred in calcium intake between 6 and 15 months. The boys reached a higher level than the girls and maintained that level for a longer period of time. Phosphorus intake increased during the first year, was between the stationary intake of protein and decreased intake of calcium in the second year and increased again between the third and fourth years. The sharp rise of iron during the first year decreased as commercially prepared cereals were replaced by regular foods. After 3 years, levels of iron intake increased, but from $2\frac{1}{2}$ - 5 years, more than 75% of the intakes remained below the RDA. Thiamine intake rose steadily during the first 15 months and reached and remained on a plateau until just after 3 years when it increased again. The median intake of thiamine was slightly above the RDA. After an initial rise in the first year, riboflavin intake decreased in the second and third years and rose again between 3 - 5 years. More than 75% of the children consumed an amount of riboflavin greater than the RDA. Niacin intake tended to increase throughout the age span although children with high intakes during the second year were likely to show a decrease during the third year. Although only 25% of the children met the RDA for niacin, there was no evidence that their intake was inadequate as judged by growth rate and absence of deficiency symptoms. After the first 3 months greater than three-fourths of the children exceeded the RDA with the vitamin A from the diet. The median vitamin D intake increased to a peak of 1000 IU daily at 4 - 6 months, then decreased to a level just below 400 IU daily by 5 years. In the first 6 - 9 months most of the ascorbic acid was from preparations, then the diet provided a larger amount. After 2 years, 75% of the children had dietary intakes of ascorbic acid which exceeded the RDA.

In a later report, Beal (1965) related caloric intake of children to a number of measurements of physical growth and physiologic changes: height, weight, bone, muscle, fat, basal metabolic level, and serum cholesterol. Data on 8 children with either high or low calorie intakes were used to illustrate individual variances in height, weight, body composition, and basal energy expenditure.

<u>Anthropometric Measurements and Adequacy of Diets</u>. Crispin <u>et al</u>. (1965) investigated the relationship between dietary intake and anthropometric measurements of preschool children. Children from families of middle income status (Group I) had significantly higher weight and height and average circumference values than children from low income families (Group II). It was suggested that the better physical development and more orderly pattern of growth observed in Group I than in Group II may have been a result of dietary and other environmental conditions of early childhood.

Hootman <u>et al</u>. (1967) obtained diet histories for 56 children

3 - 17 years of age from low income families. Adequacy of diets was determined by percentages of the RDA that were met. Anthropometric measurements including height; weight; skinfolds of triceps, subscapula, and chest; arm and leg circumferences; and pelvic breadth were taken. Hemoglobin determinations were also made for a number of the children. It was reported that the nutrient intake, measmrements and hemoglobin levels occurred in the same relative positions with respect to their means and ranges for slightly more than three-fourths of the subjects.

Investigations to appraise nutrition in Haiti were conducted by Sebrell _et al_. (1959). A number of age groups, including some preschool-age children, were studied. By use of the diet history, dietary practices were learned and it was possible to obtain some information relating to food intake. The average food intake per person was calculated by dividing the quantities probably available by the total number of persons in the family. No adjustment was made for age or sex although it was known that often the males received the most meat (when it was available) and the children, the least. It was calculated that the average caloric intake per person per day was 1580 calories. A number of blood and urine analyses and some anthropometric measurements also were made. As a result of the biochemical analyses, it was found that greater than 15% of the persons studied fell into the "deficient" or "low" ranges (ranges used by ICNND, 1957), for total protein, albumen, thiamine, and niacin. Greater than 5% of the persons fell into these ranges for vitamin A and ascorbic acid.

Behar _et_ _al_. (1960) conducted a study in Guatemala to determine the nutritional status of children of less than 5 years of age. Dietary, clinical, and biochemical results were compared. Of the 32 children studied, large percentages failed to meet one-half of the recommended allowances developed by the Institute of Nutrition for Central America and Panama (INCAP). Thirteen had less than 10% of the recommendation for vitamin A, 6 had less than 10% for vitamin C and 1 had less than 10% for thiamine. Heights and weights were plotted on curves adapted by INCAP and nearly all fell below the 16th percentile in weight and greater than 1 standard deviation below the mean in height. Subcutaneous fat values were very low compared to similar age children in Canada. Clinical deficiency symptoms occurred in a number of the children. The biochemical results also showed a number of the children to have low values. However, the majority of the children were classified as having good or fair nutritional status since both the heights and weights were low and standards for other countries were not used in the final nutritional evaluation.

PROCEDURE

Selection of Subjects

Children whose families lived in Jardine Terrace apartments for married students at Kansas State University were selected as subjects for this study. By contacting the Housing Office, information was obtained that consisted of the names and addresses of the families and the number and ages of children.

On the first visit to the Housing Office a list of 75 families with 94 children between ages 3 - 6 was obtained. After the second semester had begun an additional 21 families with 25 children between 3 - 6 years of age were added to the list. Of this total of 96 families, 50 participated in the study, 15 could not be contacted, 12 declined to participate, 5 had moved or were moving soon, and 14 were eliminated because the parents were foreign students whose cultural backgrounds suggested dietary and growth patterns that might differ from those within the United States.

Only one child in each participating family was selected as a subject for the study. In 5 families where more than one child was eligible, it was the option of the mother which child was selected.

Interview Schedule

The interview schedule consisted of a shortened form of the questionnaire and the entire form for dietary intake which were developed for the North Central Cooperative Project, NC-75 (Forms I and II, Appendix). Form I included information pertaining to characteristics and income of family. Form II consisted of sheets for recording the child's food intake and instructions for recording food eaten. A third form (Form III, Appendix) was used for recording the anthropometric measurements on each child.

The Interview

Interviews were begun on January 23, 1967, and the last interview was completed March 7, 1967. Interview appointments were made with the families by telephone with the exception of three families that did not have telephones and were contacted at their homes.

First Interview. The first of the two interview sessions included: 1) explaining the study to the mother; 2) obtaining information for Form I concerning family characteristics and income; and 3) explaining the method of keeping the 3-day dietary record for the child. When the child was cared for by someone other than the mother, the mother instructed the person about keeping the food records. On several occasions Form I was not completed until the second interview and at other times the anthropometric measurements were taken and recorded at the first interview.

Second Interview. The second interview which was generally conducted the day following the 3-day dietary record usually consisted of: 1) taking and recording the anthropometric measurements of the child and 2) reviewing the dietary record with the mother and recording any omitted information.

Following is a list and description of the anthropometric measurements which were conducted on the children:

> Standing Height--distance from the sole of feet to top of head measured without shoes. Child stood straight against a vertical surface with no baseboard and a square was lowered down the wall until firm contact was made

with the child's head. The child's height was marked on the wall and an "infa-rule" (Goodman-Kleiner Co., Inc., N. Y., N. Y.) was held in contact with the floor with the foot and the scale extended up the wall to measure the child's height.

Weight--in all cases was nude weight of child plus light weight panties or undershorts. A Health-O-Meter (Chicago, Ill.) scale was used.

Chest Circumference--circumference of chest at nipples measured with a steel millimeter tape. Tape was held tight enough to make contact with body but not tight enough to depress tissue.

Waist Circumference--circumference taken at navel with a steel millimeter tape. Tape was held tight enough to make contact with body but not tight enough to depress tissue.

Upperarm Circumference--taken near middle of humerus at level of greatest girth with arm hanging freely. The steel millimeter tape was applied at a right angle to the long axis of the arm at the level midway between the tip of the acromial process of the scapula and tip of elbow. Tape was applied light enough that arm contour was not deformed.

Calf of Leg Circumference--circumference at fullest part of calf of leg measured with steel millimeter tape. Tape was applied lightly so that tissue was not depressed. Measurement was taken with child seated.

Bi-condylar Diameter of Humerus--taken with a steel spreading caliper (30 cm., Gneupel, Siber Hegner & Co., Inc., N. Y.). Arm was held away from the body and enough pressure was used to press the calipers against the bone. Readings were taken on the largest diameter of the bone.

Bi-condylar Diameter of Femur--taken with a steel spreading caliper (30 cm , Gneupel, Siber Hegner & Co., Inc., N. Y.). Child was seated with knee extending past the edge of chair. Pressure was used to press the calipers against the bone and measurement was taken on largest diameter of the bone.

Bi-cristal Diameter--width of pelvic girdle measured with a steel sliding caliper. Greatest distance between the lateral margins of the iliac crests was measured. It was often necessary to exert strong pressure on contact surface of calipers to minimize amount of soft tissue included in measurement.

Bi-acromial Diameter--width of shoulder girdle measured with a sliding caliper. This was the distance between the most lateral margins of the acromial process.

Upperarm Skinfold--skinfold measured was located at the back of the right upperarm (over the triceps) at the level midway between the tip of the acromial process of the scapula and tip of the elbow. The level was located with the forearm flexed at 90 degrees. When taking the measurement, the arm was allowed to hang freely and the skinfold was lifted parallel to the long axis of the arm. Measurement was taken with a Harpenden skinfold caliper (Putney, S. W. 15, Emg England).

Sub-scapular Skinfold--measured below the tip of the scapula with a Harpenden skinfold caliper (Putney, S. W. 15, Emg England).

Waist Skinfold--measured midway between the navel and right side with a Harpenden skinfold caliper (Putney, S. W. 15, Emg England). The skinfold was lifted perpendicularly to the waist line.

The arm and leg circumferences, bi-condylar diameters, and skinfold measurements were taken on the "side of handedness" of the child. Only one child was left-handed and for this child measurements were taken on the left side.

Tabulation of Data

The data collected during the interviews were tabulated to characterize the children by age, sex, and family characteristics. The children were divided according to age groups: a) 3 - 4 years of age; B) 4 - 5 years of age; and C) 5 - 6 years of age.

Each food listed in the children's daily food records was assigned an identification number and percentage of an average serving as outlined in the manual Calculating the Nutritive Value of Diets (Davenport, 1964). Master punch cards (Data

Processing Services of Virginia) were used for machine tabulation of the diets. These computer cards contain the nutritive values for average servings of foods which are presented in Home and Garden Bulletin 72 (Consumer and Food Economics Research Division, 1964).

Mean daily nutrient intake from food for each child was determined for: 1) food energy; 2) protein; 3) calcium; 4) iron; 5) vitamin A; 6) thiamine; 7) riboflavin; 8) niacin equivalents; 9) ascorbic acid. In addition, the mean daily nutrient intake from food plus supplements was calculated for those children taking vitamin and/or mineral supplements.

The RDA for niacin is stated as niacin equivalents. This allows for intake of preformed niacin plus niacin from tryptophan. By using the assumed value of 1% tryptophan for dietary protein (Morgan, 1959) the following formula was used for transforming niacin plus tryptophan to niacin equivalents:

Protein (g) x 0.167 + niacin (mg) = niacin equivalents (mg)

The anthropometric measurements of each child were used to obtain mean, median, and range of values for each of the 13 measurements by sex and age group.

Evaluation of Dietary Data

Individual Nutrients. The mean daily intake of each nutrient in the child's diet was compared with the NRC recommendation (Food and Nutrition Board, 1964). The evaluation levels used were:

I - Mean nutrient intake was at least 100% of the NRC Recommended Dietary Allowance.

II - Mean nutrient intake was less than 100% but not less than 67% of the NRC Recommended Dietary Allowance.

III - Mean nutrient intake was less than 67% of the NRC Recommended Dietary Allowance.

Over-all Diet. The mean daily intake of all nutrients of each child was classified according to 3 levels based on the RDA. The levels used for evaluating over-all dietary intake were:

I - Mean intake of all nutrients was at least 100% of the NRC Recommended Dietary Allowance.

II - Mean intake of one or more nutrients was less than 100% but not less than 67% of the NRC Recommended Dietary Allowance.

III - Mean intake of at least one nutrient was less than 67% of the NRC Recommended Dietary Allowance.

Evaluation of Anthropometric Data

The weight and height of each child were plotted on the growth charts of Jackson and Kelly (1945). The children were grouped into 4 divisions according to their position on the charts.

Weight divisions.

1 - 84th percentile or above.

2 - Median up to 84th percentile.

3 - 16th percentile up to median.

4 - Below 16th percentile.

Height divisions.

1 - Mean + 1 SD or above.

2 - Mean up to mean + 1 SD.

3 - Mean - 1 SD up to mean.

4 - Below mean - 1 SD.

The mean, median, and range of values for each of the 13 anthropometric measurements by sex and age group were compared with measurements obtained by other researchers. Correlations between the various anthropometric measurements and the relationship between dietary level and anthropometric measurements were studied.

Statistical Analyses

Correlation coefficients were computed among anthropometric measurements for children within sex and age groups. The Chi-Square test of homogeneity among linear correlation coefficients (Snedecor, 1956) was conducted on several randomly selected sets of measurements. Linear correlation and covariance analyses (Fryer, 1966) corrected for age were performed to determine the relationship between dietary level and anthropometric measurements.

RESULTS AND DISCUSSION

Description of the Subjects and Their Families

Sex and Age of Subjects. The 50 children included in this study consisted of 24 boys and 26 girls. The plan was to divide them into 3 basic age groups: A) 3 - 4 years; B) 4 - 5 years;

and C) 5 - 6 years. However, one child was included in the 3 - 4 year group who was only 35 months old and one child was included in the 5 - 6 year group who was 74 months of age. The distribution of the children by sex and age group is given in table 1.

TABLE 1

Number of children by sex and age group

Group	Boys	Girls	Total
A	12	8	20
B	10	8	18
C	2	10	12
Totals	24	26	50

Composition of Family. In all 50 families both parents lived in the home. The number of children per family ranged from 1 - 4 with a mean of 2.0 children per family. The age range of the siblings of the children in the study was from 2 months to 10 years. There were 11 siblings less than 12 months of age and 12 siblings who were 7 to 10 years old. Table 2 gives the age range of siblings.

TABLE 2

Number and age of siblings

Total	0 - 12 mos	1 - 3 yrs	4 - 6 yrs	7 - 10 yrs
48	11	15	10	12

Ages of Parents. The age range of the parents is given in table 3. Most of the mothers and fathers were in the 21 - 30 year old group.

TABLE 3

Ages of parents (in years)

	No.	20 or less		21 - 30		31 - 40	
		No.	%	No.	%	No.	%
Mothers	50	3	6	46	92	1	2
Fathers	50	0	0	46	92	4	8

Education of Parents. All of the fathers were enrolled at Kansas State University as undergraduate or graduate students. In addition, some of the mothers were students or had already earned a college degree. Table 4 presents the education level of the parents with 9 - 12 years indicating high school training; 13 - 16, undergraduate college training; and 16+ years, graduate college training. More than half of the mothers (56%) had not received education beyond the 12th year and only 12% of the mothers had done graduate study.

TABLE 4

Education level of parents

	Total	Years of education									
	No.	9 - 11 yrs		12 yrs		13 - 16 yrs		16 yrs		16+ yrs	
		No.	%	No.	%	No.	%	No.	%	No.	%
Fathers	50	0	0	0	0	18	36	0	0	32	64
Mothers	50	2	4	26	52	13	26	3	6	6	12

Employment of Parents. As indicated earlier, all of the fathers were students at Kansas State University. In addition, 3 (6%) of the fathers were employed full-time and 35 (70%) of the fathers had part-time jobs or assistantships (table 5). In contrast, only 11 (22%) of the mothers were students and 32 (64%) did not work outside of the home. Thirteen (26%) of the mothers were employed on a full-time basis and 5 (10%) on a part-time basis.

TABLE 5

Employment of parents outside of home

	Total	Not Employed No.	%	Employed Full-Time No.	%	Employed Part-Time No.	%
Fathers	50	12	24	3	6	35	70
Mothers	50	32	64	13	26	5	10

Family Income. In this study, "income during the previous tax year" refers to money from all sources (job earnings, gifts, savings, etc.) used for family expenses (table 6). It should be

TABLE 6

Income (lived on) during previous tax year

Total	$2000 -3000 No.	%	$3001 -4000 No.	%	$4001 -5000 No.	%	$5001 -6000 No.	%	$6001 -7000 No.	%	$7001 - No.	%
49[1]	6	12	17	35	11	22	6	12	5	10	4	8

[1]Information was not obtained for one family.

recognized that these families were living in low-cost university housing. Greater than half of the families lived on $3001 - 5000 during the previous tax year. Information relating to income was obtained on 49 of the 50 families studied and of these, only 9 families had lived on incomes greater than $6001 during the previous tax year.

Dietary Intake Records

Mean Daily Nutrient Intake. Mean daily nutrient intake for each child was obtained from 3-day dietary records (table 32, Appendix). The mean, median, and range of daily nutrient intake and the RDA is presented for the 3 age groups of children in table 7.

The intakes of the individual nutrients were classified in diet levels according to the method described in the Procedure (p 30). In table 7, a number with no underline is in Level I; a single underline in Level II; and a double underline in Level III.

For all 3 groups the mean and median iron intakes were in Level II (table 7). In Group A the mean and median food energy intakes were in Level II. The mean and median intakes of all other nutrients were 100% of the RDA. In the 3 groups, the "high" intakes of each of the nutrients in all cases exceeded the RDA. In Group A the "low" nutrient intakes were below 100% of the RDA for all nutrients except niacin equivalents. In Group B only the "low" intakes of niacin equivalents and protein exceeded 100% of the RDA. The "low" intakes of protein, thiamine,

TABLE 7

Mean, median, and range of daily nutrient intake for children by age group

	Food energy	Protein	Calcium	Iron	Vitamin A	Thiamine	Riboflavin	Niacin equiv	Ascorbic acid
	cal	g	g	mg	IU	mg	mg	mg	mg
Group A (20 children)									
Mean	1570[1]	60.8	0.923	8.3	3741	0.84	1.58	19.6	100
Median	1510	60.6	0.955	8.5	3104	0.85	1.53	19.7	87
High	2209	102.1	1.434	12.5	6721	1.09	2.23	33.4	282
Low	1170	34.5	0.569	4.3	1652	0.51	0.98	11.7	16
Group B (18 children)									
Mean	1670	66.7	0.935	8.3	3668	0.91	1.68	21.6	60
Median	1706	65.6	0.975	7.8	3135	0.88	1.58	20.6	63
High	2438	99.0	1.408	12.1	8678	1.58	2.51	31.7	116
Low	1099	44.2	0.480	4.7	1306	0.44	0.98	13.1	24
Group C (12 children)									
Mean	1845	71.0	1.120	9.4	4437	1.01	1.92	23.0	118
Median	1826	69.2	1.145	9.6	4094	1.07	1.96	22.5	111
High	2364	87.2	1.555	12.2	6692	1.35	2.45	28.5	227
Low	1394	54.8	0.623	6.3	2266	0.66	1.33	17.2	13
RDA[2]	1600	40.0	0.80	10.0	2500	0.60	1.00	11.0	50

[1]Number without underline indicates Level I; single underline, Level II; and double underline, Level III for individual nutrients.

[2]RDA for children 3-6 yrs.

riboflavin, and niacin equivalents exceeded 100% of the RDA in Group C.

In general, the mean and median intakes of each nutrient increased with increasing age of the children. The exceptions were in Group B, where iron, vitamin A, and ascorbic acid remained the same or decreased from those of Group A.

Group and Sex Differences. It is shown in table 8 that in Groups A and B more children were in Levels II (50%, 33%) and

TABLE 8

Number and percentage of children by group, sex and age at 3 levels of dietary adequacy

Group or Sex	Sex	No.	Level of Dietary Adequacy I		II		III	
Group			No.	%	No.	%	No.	%
A								
	Boys	12	1	8	9	75	2	17
	Girls	8	1	12	1	12	6	75
	Total	20	2	10	10	50	8	40
B								
	Boys	10	1	10	3	30	6	60
	Girls	8	2	25	3	38	3	38
	Total	18	3	17	6	33	9	50
C								
	Boys	2	1	50	1	50	0	0
	Girls	10	4	40	4	40	2	20
	Total	12	5	42	5	42	2	17
Sex								
	Boys	24	3	12	13	54	8	33
	Girls	26	7	27	8	31	11	42
All children		50	10	20	21	42	19	38

III (40%, 50%) than in Level I (10%, 17%). However, in Group C equal numbers (42%) of the children were found in Levels I and II and a smaller number (17%) was in Level III. The children in Group C, which was the oldest age group of children, therefore appeared to have the most adequate diets. This was probably due to an increased intake of food rather than to a better choice of food. When the children were classified by diet level according to sex, the largest number (54%) of the boys were in Level II and the largest number (42%) of the girls were in Level III. When the diets of all children together were classified, 42% of the diets were in Level II, 38% in Level III and 20% in Level I.

Evaluation of Nutrient Intake with the RDA. There are RDA for food energy and 8 nutrients. The number of nutrients in the mean dietary intake below 100% and below 67% of the RDA was determined for each child. In addition, the number of diets supplying each of the nutrients at the 3 levels of adequacy was found for each age group.

Number of Nutrients below 100% of the RDA. Diets of 2 children in Group A and 2 children in Group B were below 100% of the RDA in as many of 6 nutrients (table 9). However, half of the children in Groups A and B and 5 of the 12 children in Group C were below 100% of the RDA in only 1 or 2 nutrients. Children in Group C appeared to have more adequate intakes of nutrients than those children in the first two groups since Group C had only 2 children below 100% of the RDA in 3 or more nutrients.

The largest number of children with nutrient intakes below

TABLE 9

Number of children by age group and sex with diets that were below 100% of the RDA in 1 to 6 nutrients

Group	Sex	No.	Number of nutrients below 100% of the RDA						
			0	1	2	3	4	5	6
A									
	Boys	12	1	4	3	1	3	0	0
	Girls	8	1	1	2	2	0	0	2
B									
	Boys	10	1	4	1	1	1	1	1
	Girls	8	2	3	1	0	1	0	1
C									
	Boys	2	1	0	1	0	0	0	0
	Girls	10	4	4	0	1	1	0	0

67% of the RDA were the boys and girls in Groups A and B (table 10). Most of these children were below 67% of the RDA in only one nutrient but 1 boy in Group B was below 67% of the RDA in 3 nutrients. Each age group had at least one child below 67% of the RDA in 2 nutrients.

TABLE 10

Number of children by age group and sex with diets that were below 67% of the RDA in 1 to 3 nutrients

Group	Sex	No.	Number of nutrients below 67% of the RDA			
			0	1	2	3
A						
	Boys	12	10	2	0	0
	Girls	8	2	5	1	0
B						
	Boys	10	4	3	2	1
	Girls	8	5	3	0	0
C						
	Boys	2	2	0	0	0
	Girls	10	8	1	1	0

Nutrients at 3 Levels of Adequacy. Table 11 presents information regarding the adequacy with which each nutrient was supplied in the diets of the children by age group. Food energy, protein, thiamine, riboflavin, and niacin equivalents were all supplied at Levels I or II in the diets of all of the children. Only 1 child in Group B was classified in Level II for calcium intake. More children in each age group were lower in iron intake than any other nutrient. A total of 13 of the 50 children (26%) were classed in Level III for iron intake. One child in Group A and 1 in Group B were in Level III for vitamin A intake. A total of 9 children (18%) were below 67% of the RDA (Level III) for intake of ascorbic acid.

More of the diets supplied the vitamins at Level I than supplied iron, calcium, protein, or food energy at this level. In this study, iron was supplied in the least adequate amounts, followed by ascorbic acid. Niacin was the only nutrient which was supplied at 100% of the RDA in diets of all the children.

Effect of Supplementation. Fifty percent or more of the children in all 3 groups received nutrient supplementation during the study (table 12). Mean daily nutrient intake from diets + supplements was determined for each child receiving supplements (table 33, Appendix). Table 13 shows the types of supplements received by the children and the number of children receiving each type. By far the largest number of children received a multi-vitamin supplement. Seven of the children received supplements consisting of multi-vitamins + iron and 1 child received ascorbic acid alone.

TABLE 11

Number and percentage of children by age group with diets supplying nutrients at 3 levels of adequacy

Group	No.	Dietary level	Food energy		Protein		Calcium		Iron		Vitamin A		Thiamine		Riboflavin		Niacin equiv		Ascorbic acid	
			No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
A																				
	20																			
		I	9	45	16	80	8	40	5	25	14	70	19	95	19	95	20	100	18	90
		II	11	55	4	20	12	60	9	45	5	25	1	5	1	5	0	0	0	0
		III	0	0	0	0	0	0	6	30	1	5	0	0	0	0	0	0	2	10
B																				
	18																			
		I	11	61	18	100	12	67	7	39	15	83	16	89	17	94	18	100	10	56
		II	7	39	0	0	5	28	5	28	2	11	2	1	1	6	0	0	3	17
		III	0	0	0	0	1	6	6	33	1	6	0	0	0	0	0	0	5	28
C																				
	12																			
		I	10	83	12	100	11	92	6	50	11	92	12	100	12	100	12	100	9	75
		II	2	17	0	0	1	8	5	42	1	8	0	0	0	0	0	0	1	8
		III	0	0	0	0	0	0	1	8	0	0	0	0	0	0	0	0	2	17
All children																				
	50																			
		I	30	60	46	92	31	62	18	36	40	80	47	94	48	96	50	100	37	74
		II	20	40	4	8	18	36	19	38	8	16	3	6	2	4	0	0	4	8
		III	0	0	0	0	1	2	13	26	2	4	0	0	0	0	0	0	9	18

TABLE 12

Number of children by age group receiving nutrient supplements

Group	No.	%
A	10	50
B	10	56
C	7	58
Total	27	54

TABLE 13

Type of supplement received by children

Type of supplement	No. receiving supplement
Ascorbic acid	1
Multi-vitamins	19
Multi-vitamins + minerals	7

Table 14 shows the adequacy of the diets of only the children who received dietary supplements without and with the supplementation included in the values. The diets of these children were rated as Level I or II before supplementation for all nutrients except iron, vitamin A and ascorbic acid. Then, with supplementation, diets of 3 children (1 in each group) remained in Level II for iron and the diet of 1 child in Group C remained in Level III for ascorbic acid. The 3 children remaining in Level II for iron had not received iron supplements, but the

TABLE 14

Effect of supplementation on dietary level of nutrients in diets of children by age group

Group Dietary level	Food energy		Protein		Calcium		Iron		Vitamin A		Thiamine		Riboflavin		Niacin equiv		Ascorbic acid	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
A (10 children)																		
Without supplements																		
I	5	50	9	90	6	60	2	20	8	80	10	100	10	100	10	100	10	100
II	5	50	1	10	4	40	7	70	1	10	0	0	0	0	0	0	0	0
III	0	0	0	0	0	0	1	10	1	10	0	0	0	0	0	0	0	0
With supplements																		
I	5	50	9	90	6	60	4	40	10	100	10	100	10	100	10	100	10	100
II	5	50	1	10	4	40	5	50	0	0	0	0	0	0	0	0	0	0
III	0	0	0	0	0	0	1	10	0	0	0	0	0	0	0	0	0	0
B (10 children)																		
Without supplements																		
I	7	70	10	100	8	80	5	50	9	90	9	90	10	100	10	100	5	50
II	3	30	0	0	2	20	2	20	0	0	1	10	0	0	0	0	2	20
III	0	0	0	0	0	0	3	30	1	10	0	0	0	0	0	0	3	30
With supplements																		
I	7	70	10	100	8	80	7	70	10	100	10	100	10	100	10	100	10	100
II	3	30	0	0	2	20	2	20	0	0	0	0	0	0	0	0	0	0
III	0	0	0	0	0	0	1	10	0	0	0	0	0	0	0	0	0	0
C (7 children)																		
Without supplements																		
I	6	86	7	100	7	100	4	57	6	86	7	100	7	100	7	100	6	86
II	1	14	0	0	0	0	2	29	1	14	0	0	0	0	0	0	0	0
III	0	0	0	0	0	0	1	14	0	0	0	0	0	0	0	0	1	14
With supplements																		
I	6	86	7	100	7	100	5	71	7	100	7	100	7	100	7	100	6	86
II	1	14	0	0	0	0	1	14	0	0	0	0	0	0	0	0	0	0
III	0	0	0	0	0	0	1	14	0	0	0	0	0	0	0	0	1	14
Total (27 children)																		
Without supplements																		
I	18	67	26	96	21	78	11	41	23	85	26	96	27	100	27	100	21	78
II	9	33	1	4	6	22	11	41	2	7	1	4	0	0	0	0	2	7
III	0	0	0	0	0	0	5	18	2	7	0	0	0	0	0	0	4	15

TABLE 14 (concl.)

Group Dietary level	Food energy		Protein		Calcium		Iron		Vitamin A		Thiamine		Riboflavin		Niacin equiv		Ascorbic acid	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
With supplements																		
I	18	67	26	96	26	96	16	59	27	100	27	100	27	100	27	100	26	96
II	9	33	1	4	1	4	8	30	0	0	0	0	0	0	0	0	0	0
III	0	0	0	0	0	0	3	11	0	0	0	0	0	0	0	0	1	4

child in Level II for ascorbic acid had received 15 mg of ascorbic acid in a supplement and even then had a total mean daily intake of only 27.7 mg.

By comparing percentages in table 11 and 14 it may be noted that children receiving supplements had higher dietary level ratings than those children not receiving supplements. Part of the reason for this was the improvement of nutrient intake with the supplementation. Another reason was that children receiving supplements also were consuming more nutritional diets than some of the other children. The higher mean and median intake of nutrients from the diet alone by the children receiving supplements compared to those of children not receiving supplements is shown in table 15.

Relationship Between Adequacy of Child's Diet and Family Income

Table 16 shows the level of dietary adequacy in each age group and the family income. Twenty-eight of the children or 57%, were from families who lived on incomes between $3001 and $5000 during the previous tax year. There did not appear to be any relationship between level of diet adequacy and family income level in any of the 3 groups of children.

Anthropometric Measurements

Thirteen different anthropometric measurements were made on each of the 50 children. Each measurement was taken 2 - 9 times on the child and an average value for the measurement was

TABLE 15

Comparison of mean and median intakes from the diet alone by children receiving supplements and those not receiving supplements

Group	No.	Food energy		Protein		Calcium		Iron		Vitamin A		Thiamine		Riboflavin		Niacin equiv		Ascorbic acid	
		M[1]	Md[2]	M	Md	M	Md	M	Md	M	Md	M	Md	M	Md	M	Md	M	Md
		cal		g		g		mg		IU		mg		mg		mg		mg	
A - NS[4]	10	1499[3]	1421	61.6	54.4	0.932	0.872	7.9	7.3	3560	2849	0.79	0.83	1.59	1.43	19.8	18.9	83	63
A - S[5]	10	1642	1585	60.0	60.6	0.913	0.982	8.7	9.0	3922	3534	0.90	0.89	1.58	1.60	19.4	19.7	118	100
B - NS	8	1541	1524	61.0	57.4	0.796	0.784	7.7	7.8	3448	2854	0.80	0.72	1.47	1.46	20.2	19.1	62	70
B - S	10	1774	1725	71.3	70.2	1.050	1.055	8.8	9.8	3843	3772	1.00	0.98	1.84	1.87	22.7	21.8	59	55
C - NS	5	1751	1823	69.2	65.3	1.038	0.995	9.0	8.2	3929	3533	0.94	0.93	1.80	1.60	23.6	23.2	84	86
C - S	7	1911	1829	72.3	72.9	1.178	1.150	9.7	10.3	4799	5281	1.06	1.11	2.01	2.07	22.6	21.5	142	156

[1] Mean

[2] Median

[3] Number without underline indicates Level I; single underline, Level II; and double underline, Level III for individual nutrients.

[4] NS indicates children not receiving supplements.

[5] S indicates children receiving supplements.

TABLE 16

Number of children by group, level of dietary adequacy and family income

Group	Dietary level	No.	$2000 -3000	$3001 -5000	$5001 -7000	$7000+
A						
	I	2	0	1	1	0
	II	10	3	5	1	1
	III	8	1	6	1	0
B						
	I	3	0	1	2	0
	II	6	0	3	2	1
	III	9	1	5	2	1
C						
	I	5[1]	1	3	0	0
	II	5	0	2	2	1
	III	2	0	2	0	0
Total						
	I	9	1	5	3	0
	II	21	3	10	5	3
	III	19	2	13	3	1

[1]Child was in Diet Level I but family income information was not obtained.

calculated. The number of values to be averaged for each measurement depended upon the cooperation of the child and the consistency of the measurements. The average value for each measurement for each child is shown in table 34, Appendix.

Weights and Heights. Mean, median, low, and high weights and heights of the children were determined by age group and sex (tables 17 and 18). The mean and median did not vary greatly from each other for either weight or height in the 3 age groups. The mean and median weights of the boys in Group A were larger than those for the girls. The mean and median weights for girls

TABLE 17

Mean, median, and range of weights (in pounds) of children by age group and sex

Group	Sex	No.	Mean	Median	Low	High
A						
	Boys	12	34.5	35.4	26.7	39.8
	Girls	8	32.5	32.3	27.0	40.2
	Total	20	33.7	33.8	26.7	40.2
B						
	Boys	10	36.8	35.8	31.7	43.0
	Girls	8	38.5	38.2	32.7	45.3
	Total	18	37.6	36.0	31.7	45.3
C						
	Boys	2	40.8	40.8	38.5	43.0
	Girls	10	40.7	39.6	37.8	47.8
	Total	12	40.7	39.6	37.8	47.8

TABLE 18

Mean, median, and range of heights (in inches) of children by age groups and sex

Group	Sex	No.	Mean	Median	Low	High
A						
	Boys	12	39.5	39.4	36.5	41.5
	Girls	8	38.5	39.0	36.1	40.5
	Total	20	39.1	39.0	36.1	41.5
B						
	Boys	10	41.3	41.4	39.5	43.4
	Girls	8	41.4	41.3	38.9	43.3
	Total	18	41.3	41.4	38.9	43.4
C						
	Boys	2	44.3	44.3	43.0	45.6
	Girls	10	43.9	43.6	46.4	41.3
	Total	12	43.9	43.6	46.4	41.3

in Group B were larger than for the boys. In Group C there was less weight difference between sexes than in the other groups. In Group A the mean and median values for height were larger for the boys than for the girls. Boys and girls in Group B were similar in height. Boys in Group C were taller than the girls of the same age.

Mean heights and weights of children in this study were compared with values obtained by Pett and Ogilvie (1956), Boynton (1936), and Meredith (1935) (table 19). Mean weights for the boys and girls in Group A fell between the mean weights of Pett and Ogilvie and those of Meredith and Boynton. The mean weight of the boys in Group B was close to the mean of Pett and Ogilvie but the mean weight of the girls in this group was closer to the value found by Boynton. Mean weights in Group C were closer to Pett and Ogilvie's values than the other values. The mean heights of all groups of children in this study fell between the values obtained by Pett and Ogilvie and those of Meredith and Boynton.

Comparison of Children's Weight and Height with Jackson and Kelly Standard. Weights and heights of the 50 children were plotted on growth charts developed by Jackson and Kelly (1945) for boys and girls (figs. 1 and 2). The number and percentage of children in each of the 4 weight and height divisions are shown in table 20.

Fifteen (62%) of the boys and 16 (61%) of the girls were between the 16th and 84th percentiles for weight on the charts.

TABLE 19

Comparison of mean weights and heights of children in this study with those of Pett & Ogilvie (1956), Boynton (1936), and Meredith (1935)

Group	Sex	Weight This study	Weight Pett & Ogilvie	Weight Meredith & Boynton	Height This study	Height Pett & Ogilvie	Height Meredith & Boynton
		lb	lb	lb	in.	in.	in.
A							
	Boys	34.5	32	36.8	39.5	36.6	40.0
	Girls	32.5	31	34.4	38.5	36.0	39.0
B							
	Boys	36.8	37	40.6	41.3	39.2	42.7
	Girls	38.5	36	38.8	41.4	39.2	41.6
C							
	Boys	40.8	40	45.0	44.3	41.9	45.1
	Girls	40.7	41	42.9	43.9	41.8	44.2

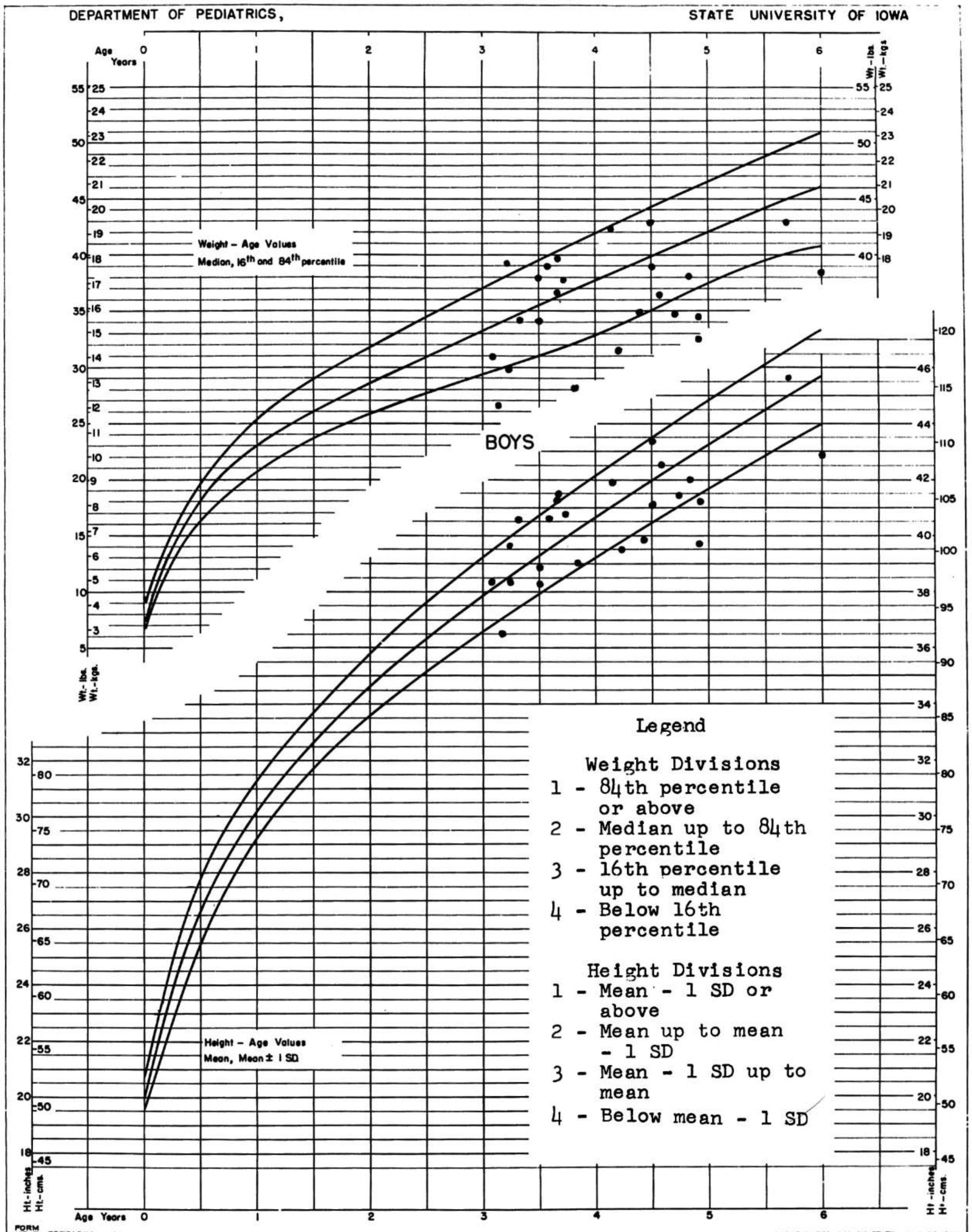

Fig. 1 Distribution of boys on Jackson and Kelly growth chart.

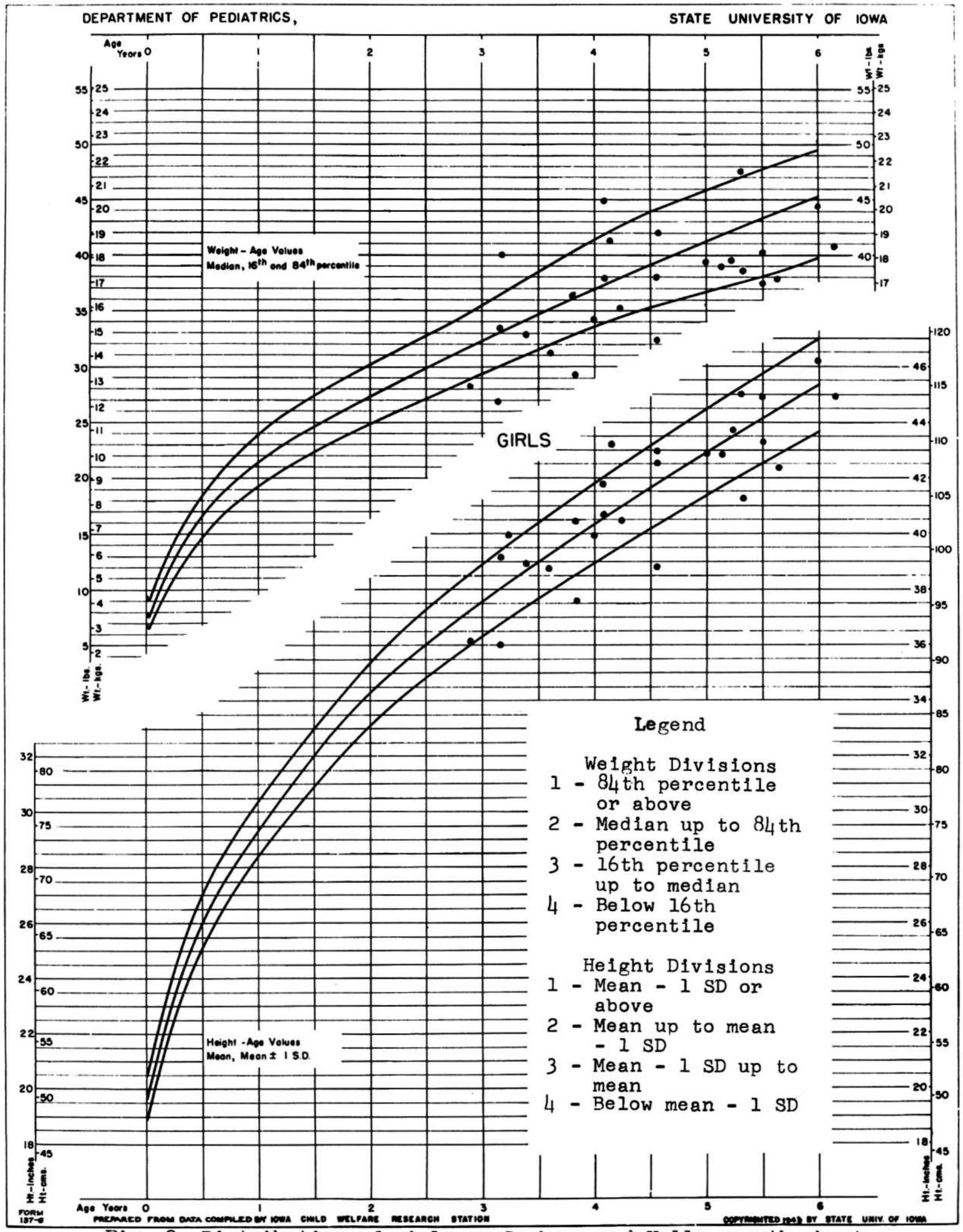

Fig. 2 Distribution of girls on Jackson and Kelly growth chart.

TABLE 20

Number and percentage of children by sex according to distribution by weight and height on Jackson and Kelly growth charts

Sex	No.	Division 1 No.	Division 1 %	Division 2 No.	Division 2 %	Division 3 No.	Division 3 %	Division 4 No.	Division 4 %
					Weight				
Boys	24	1	4	7	29	8	33	8	33
Girls	26	3	12	5	19	11	42	7	27
Total	50	4	8	12	24	19	38	15	30
					Height				
Boys	24	3	12	8	33	7	29	6	25
Girls	26	2	8	12	46	7	27	5	19
Total	50	5	10	20	40	14	28	11	22

One boy (4%) and 3 girls (12%) were above the 84th percentile and 8 boys (33%) and 7 girls (27%) were below the 16th percentile for weight. Fifteen (62%) of the boys and 19 (73%) of the girls were within $\pm$ 1 standard deviation of the mean for height on the charts. Three boys (12%) and 2 girls (8%) were taller than 1 standard deviation above the mean and 6 boys (25%) and 5 girls (19%) were shorter than 1 standard deviation below the mean for height. Thus, the majority of the children were in the middle 2 divisions for both weight and height but a larger number of children were in the lowest division than the highest division for both weight and height.

Comparison of Level of Dietary Adequacy with Weight and Height Divisions. Tables 21 and 22 present the number and percentage of children in the 3 levels of dietary adequacy and how the children in these dietary levels were distributed on the Jackson and Kelly growth chart. Most of the boys and girls in dietary Levels I and II were in weight Divisions 2 and 3 (table 21). Most of the boys and girls in dietary Level III were in weight Divisions 3 and 4. Table 22 shows that most of the boys

TABLE 21

Number and percentage of children by sex and level of dietary adequacy in 4 weight divisions

Dietary level	Sex	No.	%	Weight divisions 1	2	3	4
I							
	Boys	3	6	0	2	1	0
	Girls	7	14	0	2	4	1
	Total	10	20	0	4	5	1
II							
	Boys	13	26	1	5	5	2
	Girls	8	16	1	1	4	2
	Total	21	42	2	6	9	4
III							
	Boys	8	16	0	0	3	5
	Girls	11	22	2	2	3	4
	Total	19	38	2	2	6	9

TABLE 22

Number and percentage of children by sex and level of dietary adequacy in 4 height divisions

Dietary level	Sex	No.	%	Height divisions 1	2	3	4
I							
	Boys	3	6	0	3	0	0
	Girls	7	14	1	5	1	0
	Total	10	20	1	8	1	0
II							
	Boys	13	26	3	5	3	2
	Girls	8	16	0	4	2	2
	Total	21	42	3	9	5	4
III							
	Boys	8	16	0	0	4	4
	Girls	11	22	1	3	4	3
	Total	19	38	1	3	8	7

and girls in dietary Level I were in height Division 2. The children in dietary Level II were distributed throughout the 4 height divisions with the largest number being in Division 2. Most of the children in dietary Level III were found in height Divisions 3 and 4. The children who had the least adequate diets tended to be in the lower half of the Jackson and Kelly distributions for weight and height.

Circumferences. Table 23 presents mean, median, and range of circumference measurements on the boys and girls in the 3 age groups. The mean chest circumferences of the boys and girls in the 3 groups were only slightly under the means for this measurement for children 3.5, 4.5, and 5.5 years of age reported by Meredith (1935) for boys and Boynton (1936) for girls. Meredith and Boynton did not report waist circumferences. The upperarm girth values reported by Boynton for girls were very close to those values obtained in this study. The girth of calf was also reported by Boynton for the girls and the values were slightly above those obtained in this study.

Diameters. Table 24 presents mean, median, and range of diameters for humerus, femur, pelvic girdle, and shoulder girdle of the children in this study. The mean values reported by Meredith (1935) and Boynton (1936) for the bi-condylar diameters of the humerus and femur were above the mean values for this study. The mean bi-triochanteric diameters reported by Meredith and bi-iliac diameters reported by Boynton for girls were much higher than the mean pelvic girdle diameters of boys and girls in this study. The mean bi-deltoid diameters reported by Meredith and Boynton for boys and girls were much higher than the shoulder girdle measurement for children in this study.

Skinfold Measurements. The mean, median, and range of skinfold measurements for upperarm (triceps), back (subscapula), and waist of children in this study are presented in table 25. The mean upperarm (triceps) skinfold measurements for children in this study exceeded values reported by Meredith (1935) and Boynton (1936) as much as 3.5 - 3.7 mm in some cases. The skinfold measurements taken by Meredith and Boynton were taken with

TABLE 23

Mean, median, and range of circumferences (in cm) of children by age group and sex

Group	No.	Chest				Waist				Upperarm				Calf of leg			
		Mean	Median	Low	High	Mean	Median	Low	High	Mean	Median	Low	High	Mean	Median	Low	High
A																	
Boys	12	52.11	52.50	47.18	56.47	49.42	49.94	42.34	55.10	15.98	14.09	13.87	18.22	21.16	21.82	18.53	22.97
Girls	8	50.51	50.38	46.46	54.90	48.96	47.99	46.70	56.07	15.68	15.30	14.53	19.34	20.72	20.62	19.02	23.36
Total	20	51.47	51.72	46.46	56.47	49.23	49.06	42.34	56.07	15.86	15.70	13.87	19.34	20.99	20.88	18.53	23.36
B																	
Boys	10	53.26	52.94	49.38	57.73	50.67	50.77	47.44	53.38	16.12	15.94	14.60	17.78	21.51	21.06	20.32	23.56
Girls	8	54.22	54.54	51.24	58.50	52.24	52.79	47.30	57.93	16.28	16.02	14.88	18.73	21.64	21.68	19.90	23.46
Total	18	53.69	53.56	49.38	58.50	51.37	50.99	47.30	57.93	16.19	15.94	14.60	18.73	21.57	21.51	19.90	23.56
C																	
Boys	2	56.00	56.00	55.24	56.75	50.94	50.94	49.28	52.60	15.79	15.79	15.33	16.25	21.36	21.36	21.97	20.76
Girls	10	54.31	54.28	50.26	58.46	52.08	52.54	49.47	54.75	16.72	16.72	15.30	17.74	22.31	22.38	20.60	23.66
Total	12	54.59	54.45	50.26	58.46	52.39	52.52	49.28	54.75	16.57	16.58	15.30	16.25	22.15	22.30	20.60	23.66

TABLE 24

Mean, median, and range of diameters (in cm) of children by age groups and sex

		Humerus				Femur				Pelvic girdle				Shoulder girdle			
Group	No.	Mean	Median	Low	High	Mean	Median	Low	High	Mean	Median	Low	High	Mean	Median	Low	High
A																	
Boys	12	4.42	4.26	3.73	4.74	6.33	6.36	5.25	6.95	12.77	12.65	11.40	13.90	19.52	19.25	18.42	20.66
Girls	8	4.24	4.19	4.00	4.82	6.06	5.88	5.67	6.77	12.00	11.94	11.00	13.42	18.35	18.62	15.58	20.08
Total	20	4.34	4.33	3.73	4.82	6.22	6.21	5.25	6.95	12.46	12.49	11.00	13.90	19.06	19.00	15.58	20.66
B																	
Boys	10	4.60	4.60	4.15	5.30	6.63	6.58	6.23	7.44	13.03	12.64	12.45	14.65	20.16	20.52	18.04	21.83
Girls	8	4.38	4.34	4.18	4.67	6.26	6.27	5.70	6.83	13.46	13.42	12.28	15.50	19.93	19.85	18.24	21.69
Total	18	4.50	4.42	4.15	5.30	6.46	6.46	5.70	7.44	13.22	12.78	12.28	15.50	20.06	20.26	18.04	21.83
C																	
Boys	2	4.74	4.74	4.52	4.97	6.38	6.38	6.35	6.41	13.27	13.27	13.04	13.50	21.70	21.70	20.76	22.63
Girls	10	4.80	4.62	4.07	6.35	6.29	6.37	4.57	6.98	13.88	13.85	13.53	15.53	21.21	20.64	19.46	22.65
Total	12	4.79	4.62	4.07	6.35	6.30	6.38	4.57	6.98	13.78	13.69	13.53	15.53	20.96	20.70	19.46	22.65

TABLE 25

Mean, median, and range of skinfold measurements (in mm) of children by age groups and sex

Group	No.	Upperarm				Back				Waist			
		Mean	Median	Low	High	Mean	Median	Low	High	Mean	Median	Low	High
A													
Boys	12	9.36	9.24	6.13	13.20	6.76	6.56	3.83	9.98	4.48	4.29	3.29	5.97
Girls	8	10.18	9.76	7.17	14.33	6.18	6.28	4.17	8.60	5.10	4.73	3.30	9.40
Total	20	9.69	9.24	6.13	14.33	6.53	6.42	3.83	9.98	4.72	4.29	3.29	9.40
B													
Boys	10	9.48	9.20	7.27	12.23	5.54	6.53	3.94	8.73	4.21	4.28	2.70	5.52
Girls	8	9.85	9.48	6.56	16.20	6.30	6.18	4.71	9.73	5.97	4.98	3.55	12.70
Total	18	9.65	9.46	6.56	16.20	5.87	5.70	3.94	9.73	4.99	4.76	2.70	12.70
C													
Boys	2	7.13	7.13	6.79	7.47	5.58	5.58	4.97	6.20	4.40	4.40	3.72	5.09
Girls	10	9.92	9.42	8.33	13.17	6.47	6.37	5.20	9.33	5.20	5.23	3.80	6.39
Total	12	9.45	9.16	6.79	13.17	6.32	6.17	4.97	9.33	5.07	5.14	3.80	6.39

calipers which did not have constant pressure. The skinfold measurements taken in this study were taken with constant pressure calipers. The mean skinfold measurements obtained by Pett and Ogilvie (1956) on triceps skinfold for boys and girls of ages 3, 4, and 5 corresponded much more closely with the measurements in this study. Pett and Ogilvie used a constant tension caliper and found that at all ages the female triceps skinfolds were greater than those of the male. This was true for the 3 ages of children in this study also. Mean triceps skinfold measurements for the 3 age groups in this study were above almost all of Tanner and Whitehouse's (1962) 50th percentile values for children of ages 3, 4, and 5. Their standard measurements were also obtained by use of a constant pressure caliper.

The mean values reported by Meredith and Boynton for the back skinfold measurement were 2 mm less than values found in this study in several of the groups. Mean values for measurements obtained by Kornfeld (1957) for 3.5, 4.5, and 5.5 year-old boys and girls agreed more closely with measurements of this study than those of Meredith and Boynton although Kornfeld, like Meredith and Boynton, had not used a constant pressure skinfold caliper. Mean values for the back skinfold measurements for the 3 age groups in this study were all above Tanner and Whitehouse's (1962) percentile values for children of ages 3, 4, and 5. They obtained these measurements with a constant pressure caliper.

Boynton reported mean skinfold measurements of subcutaneous tissue at the iliac crest for girls. These measurements were very similar to the mean values obtained on girls at the waist in this study. Mean abdominal skinfold measurements reported for boys and girls by Kornfeld were also very similar to the mean skinfold measurements obtained at the waist in this study.

Correlations between Anthropometric Measurements

Tables 26, 27 and 28 show the correlation coefficients between the various anthropometric measurements for children by sex and age group. The Chi-Square test of homogeneity among linear correlation coefficients (Snedecor, 1956) was conducted on several randomly selected sets of measurements. This test showed that the sample sizes were so small that no statistical test of the hypothesis that the population correlations are equal has acceptable power to avoid type II error. Therefore, no attempt was made to pool the estimates of correlation from age to age. Instead, separate tables are given by sex and age group. Correlation coefficients between measurements for boys 5 - 6 years of age are not presented (table 28) because of the very small size of this group.

Table 29 shows the correlations between measurements by sex and age group which were significant at the 0.05 level. Group C is shown only for the girls. By looking at table 29 it can be seen that Group C for the girls had fewer correlations significant at the 0.05 level than Groups A or B. Many correlations significant at the 0.05 level were found for weight, circumference, and diameter measurements of both boys and girls in the 3 age groups. More correlations significant at the 0.05

TABLE 26

Correlations between measurements for boys and girls in age Group A

				Circumferences				Diameters				Skinfold measurements		
		Ht	Wt	Chest	Waist	Upper-arm	Calf of leg	Humerus	Femur	Pelvic girdle	Shoulder girdle	Upper-arm	Back	Waist
								BOYS						
	Ht		.603[1]	.356	.189	.017	.168	.565	.293	.449	.274	.006	-.125	-.078
	Wt	.472		.758	.607	.580	.572	.718	.771	.760	.550	.424	.412	.309
Circumferences	Chest	.212	.906[2]		.898	.871	.945	.885	.844	.834	.932	.470	.653	.710
	Waist	.280	.873	.931		.877	.921	.775	.802	.875	.923	.661	.599	.635
	Upperarm	-.079	.615	.873	.850		.866	.662	.747	.724	.851	.641	.630	.669
	Calf of leg	-.129	.393	.677	.670	.926		.846	.824	.806	.960	.545	.765	.836
Diameters	Humerus	.263	.793	.942	.901	.893	.759		.749	.785	.800	.501	.547	.560
	Femur	-.216	.518	.809	.693	.945	.915	.840		.915	.805	.469	.672	.538
	Pelvic girdle	.056	.579	.719	.742	.780	.758	.778	.780		.842	.595	.521	.471
	Shoulder girdle	.280	.801	.857	.749	.776	.747	.817	.794	.743		.468	.617	.752
Skinfold measurements	Upperarm	.359	.881	.818	.728	.554	.405	.772	.586	.746	.819		.362	.356
	Back	-.012	.142	.378	.478	.633	.711	.559	.605	.837	.398	.312		.847
	Waist	-.504	.264	.590	.508	.825	.793	.547	.859	.668	.541	.293	.597	

GIRLS

[1] One underline indicates significance at the 0.05 level (0.576) with 10 degrees of freedom for boys in age Group A. The values indicating the 0.10 and 0.01 levels of significance are 0.498 and 0.708, respectively.

[2] One underline indicates significance at the 0.05 level (0.707) with 6 degrees of freedom for girls in age Group A. The values indicating the 0.10 and 0.01 levels of significance are 0.622 and 0.834, respectively.

TABLE 27

Correlations between measurements for boys and girls in age Group B

		Ht	Wt	Circumferences: Chest	Circumferences: Waist	Circumferences: Upper-arm	Circumferences: Calf of leg	Diameters: Humerus	Diameters: Femur	Diameters: Pelvic girdle	Diameters: Shoulder girdle	Skinfold measurements: Upper-arm	Skinfold measurements: Back	Skinfold measurements: Waist
							BOYS							
	Ht		.009	-.347	-.311	-.122	-.062	-.434	-.180	-.183	-.370	.096	-.188	-.597
	Wt	.110		.799[1]	.674	.519	.671	.660	.865	.674	.611	.817	.025	-.027
Circumferences	Chest	-.137	.804[2]		.865	.816	.889	.885	.796	.774	.825	.734	.467	.370
Circumferences	Waist	-.174	.587	.898		.692	.839	.700	.719	.680	.544	.758	.616	.314
Circumferences	Upperarm	-.164	.413	.803	.772		.862	.643	.491	.696	.752	.541	.663	.476
Circumferences	Calf of leg	-.374	.313	.774	.806	.857		.776	.675	.862	.736	.777	.663	.242
Diameters	Humerus	-.229	.779	.977	.816	.777	.797		.553	.733	.844	.657	.463	.483
Diameters	Femur	-.389	.368	.757	.864	.641	.905	.758		.685	.586	.649	.074	-.072
Diameters	Pelvic girdle	-.025	.843	.969	.853	.820	.725	.933	.653		.744	.746	.434	.128
Diameters	Shoulder girdle	-.231	.666	.964	.968	.841	.818	.910	.813	.919		.433	.467	.563
Skinfold measurements	Upperarm	-.280	.449	.763	.919	.758	.847	.695	.863	.764	.854		.276	-.134
Skinfold measurements	Back	-.132	.080	.609	.607	.815	.868	.638	.702	.537	.645	.554		.617
Skinfold measurements	Waist	-.361	.017	.591	.701	.854	.838	.568	.675	.527	.727	.670	.874	
							GIRLS							

[1]One underline indicates significance at the 0.05 level (0.632) with 8 degrees of freedom for boys in age Group B. The values indicating the 0.10 and 0.01 levels of significance are 0.549 and 0.765, respectively.

[2]One underline indicates significance at the 0.05 level (0.707) with 6 degrees of freedom for girls in age Group B. The values indicating the 0.10 and 0.01 levels of significance are 0.622 and 0.834, respectively.

TABLE 28

Correlations between measurements for girls in age Group C

		Ht	Wt	Circumferences: Chest	Circumferences: Waist	Circumferences: Upper-arm	Circumferences: Calf of leg	Diameters: Humerus	Diameters: Femur	Diameters: Pelvic girdle	Diameters: Shoulder girdle	Skinfold measurements: Upper-arm	Skinfold measurements: Back
						GIRLS							
	Ht												
	Wt	.500											
Circumferences	Chest	.247	.740[1]										
	Waist	.501	.705	.780									
	Upperarm	.356	.212	.536	.698								
	Calf of leg	-.270	.041	.417	.129	.303							
Diameters	Humerus	-.441	.264	.608	.364	.181	.768						
	Femur	.553	.752	.586	.529	-.051	.138	.290					
	Pelvic girdle	-.672	-.358	-.126	-.082	.009	.129	.287	-.589				
	Shoulder girdle	-.277	.802	.813	.602	.269	.272	.417	.549	-.011			
measurements	Upperarm	.378	.847	.853	.793	.461	.154	.360	.511	.007	.949		
	Back	-.038	.287	.246	.334	.480	.408	.413	-.072	.186	.366	.404	
	Waist	-.112	-.389	.089	-.158	.397	.678	.165	-.266	.014	-.132	-.206	-.024

[1]One underline indicates significance at the 0.05 level (0.632) with 8 degrees of freedom for girls in age Group C. The values indicating the 0.10 and 0.01 levels of significance are 0.549 and 0.765, respectively.

TABLE 29

Correlations among antropometric measurements significant at 0.05 level by sex and age group

		Ht	Wt	Circumferences: Chest	Circumferences: Waist	Circumferences: Upper-arm	Circumferences: Calf of leg	Diameters: Humerus	Diameters: Femur	Diameters: Pelvic girdle	Diameters: Shoulder girdle	Skinfold measurements: Upper-arm	Skinfold measurements: Back	Skinfold measurements: Waist
	BOYS													
	Ht		A[1]											
	Wt			AB	AB	A	B	AB	AB	AB		B		
Circumferences	Chest		ABC		AB	AB	AB	AB	AB	AB	AB	B	A	A
Circumferences	Waist		AC	ABC		AB	AB	AB	AB	AB	A	AB	A	A
Circumferences	Upperarm			AB	ABC		AB	AB	A	AB	AB	A	AB	A
Circumferences	Calf of leg			B	B	AB		AB	AB	AB	AB	B	AB	A
Diameters	Humerus		AB	AB	AB	AB	ABC		A	AB	AB	B		
Diameters	Femur		C	AB	B	A	AB	AB		AB	A	B	A	
Diameters	Pelvic girdle	C	B	AB	AB	AB	AB	AB	A		AB	AB		
Diameters	Shoulder girdle		AC	ABC	AB	AB	AB	AB	AB	AB			A	A
Skinfold measurements	Upperarm		AC	ABC	ABC	B	B	A	B	AB	ABC			
Skinfold measurements	Back					B	AB			A				A
Skinfold measurements	Waist					AB	ABC		A		B		B	
	GIRLS													

[1]"A", "B", or "C" denotes the age groups which had correlations between the measurements that were significant at the 0.05 level.

level were found for the upperarm skinfold measurement than for subscapular and waist skinfold measurements. Height was the measurement that was least well correlated with other measurements. These correlations between the various anthropometric measurements should be investigated further with larger numbers of children.

Relationship between Dietary Level and Anthropometric Measurements

Tables 30 and 31 show the analysis of covariance for males and females. Dietary level and height for boys in this study were related at the 0.01 level of significance after correcting linearly for age. Dietary level was related at the 0.05 level of significance to the boys' weight, diameter of pelvic girdle, and diameter of shoulder girdle. There were no significant relationships between dietary level and any of the girls' anthropometric measurements even after linear correction for age had been made.

Linear correlation and covariance analyses were performed for age although it is recognized that there was no correlation between age and the indicated measurements in some instances. However, the loss of one degree of freedom in the estimation of variances did not affect any decision about diet differences. Therefore, analyses of covariance have been given for all measurements.

TABLE 30

Analysis of covariance for dietary level and anthropometric measurements for boys

Source of variation	DF	Ht	Wt	Adjusted mean squares: Circumferences: Chest	Waist	Upper-arm	Calf of leg	Diameters: Humerus	Femur	Pelvic girdle	Shoulder girdle	Skinfold measurements: Upper-arm	Back	Waist
Dietary levels	2	8.092	68.379	20.029	17.511	1.794	2.039	0.080	0.043	2.160	3.893	1.404	3.519	0.535
Within dietary levels	20	1.207	12.319	6.966	8.777	1.456	1.774	0.159	0.174	0.521	0.954	4.109	2.250	0.750
		**	*	ns	ns	ns	ns	ns	ns	*	*	ns	ns	ns

ns - nonsignificant.
* - significant at 0.05 level.
** - significant at 0.01 level.

TABLE 31

Analysis of covariance for dietary level and anthropometric measurements for girls

Source of variation	DF	Ht	Wt	Adjusted mean squares: Circumferences: Chest	Waist	Upper-arm	Calf of leg	Diameters: Humerus	Femur	Pelvic girdle	Shoulder girdle	Skinfold measurements: Upper-arm	Back	Waist
Dietary levels	2	3.072	4.397	0.042	0.560	0.016	0.300	0.053	0.448	0.309	0.968	2.516	0.836	1.667
Within dietary levels	22	1.999	17.725	6.910	8.288	1.568	1.329	0.194	0.260	1.107	1.457	6.457	1.925	4.015
		ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns

ns - nonsignificant.

SUMMARY

The relationship of dietary intake and physical status as determined by anthropometric measurements was studied for 3 - 6 year old children. Three-day dietary records were obtained for 24 boys and 26 girls from 50 different families living in university married student housing. Thirteen anthropometric measurements including height, weight, 4 circumferences, 4 diameters, and 3 skinfold measurements were made on the children.

The mean daily intake of the individual nutrients by each child was classified into Levels I (100%), II (67 - 100%) and III (below 67%) based on percentage of the RDA. An evaluation of the over-all diet of each child also was determined based on whether nutrients met the RDA. The children were divided into age groups A) 3 - 4 years; B) 4 - 5 years; and C) 5 - 6 years. In general, the mean and median intakes of each nutrient increased with increasing age of children. Group C had smaller percentages of children in dietary Levels II or III for individual nutrients than did Groups A or B. The largest number of boys were in Level II and the largest number of girls were in Level III. When diets of all children together were classified, slightly more were in dietary Level II than in Level III and the smallest number was in Level I.

More of the diets supplied the vitamins than iron, calcium, protein, or food energy at Level I. Iron was supplied in least adequate amounts, followed by ascorbic acid. Niacin was the only nutrient supplied at 100% of the RDA in diets of all the children.

No relationship between dietary adequacy and family income was observed.

Out of 27 children receiving dietary supplements, 20 received multivitamins, 1 received ascorbic acid alone, and 6 received multivitamins and minerals. All of the vitamins, except A and ascorbic acid, were supplied at dietary Levels I or II by the diets of all children. Dietary supplementation resulted in dietary levels of I or II for vitamin A and ascorbic acid for all children with one exception for ascorbic acid. The nutrient intake from diet alone of the children receiving supplements tended to be higher than that of the other children.

Mean, median, and range for 13 different anthropometric measurements were obtained. Children who had the least adequate diets tended to be in the lower half of the Jackson and Kelly distributions for weight and height. When correlation coefficients were calculated among the various measurements, it was found that girls in Group C had fewer significant ($P > 0.05$) correlations than did the other 2 age groups. Many significant ($P > 0.05$) correlations were found for weight, circumference, and diameter measurements of both boys and girls in all 3 age groups. More significant ($P > 0.05$) correlations were found for the upperarm than for subscapular and waist skinfold measurements. Height was the measurement that was least well correlated with other measurements.

Analysis of covariance, corrected linearly for age, indicated that dietary level was significantly correlated with height ($P > 0.01$) and with weight, pelvic girdle, and shoulder girdle ($P > 0.05$) of the boys. Dietary level was not significantly correlated with any of the anthropometric measurements of the girls.

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APPENDIX

IDENTIFYING INFORMATION

Form I

Name of respondent* ______________________________

Address ______________________________ Telephone No. _____

Name of child ______________________________ Sex ______________

Date of birth ______________________________
month day year

FAMILY CHARACTERISTICS

1. List all children living in this household who are under six years of age.
(List in chronological order, starting with the youngest child.)

	Name	Relationship to * child	Sex	Day of birth Month	Day	Year
1.						
2.						
3.						

Star (*) the child selected for study.

2. List all other people who live in the household by relationship to this child.

	Relationship to child	Age in years	Highest year of school completed	Present occupation	Hours of work per week
1.					
2.					
3.					
4.					
5.					
6.					

*(Star respondent or person interviewed; respondent should be the mother or the person who is serving as the mother of this child.)

**Head of household.

Form I (concl.)

3. Were parents or grandparents of this child born in another country? Yes _____ No ______

   If yes, indicate country:

   ____________________________ Mother of the child

   ____________________________ Father of the child

   ____________________________ Maternal grandmother

   ____________________________ Maternal grandfather

   ____________________________ Paternal grandmother

   ____________________________ Paternal grandfather

4. Are you employed outside of the home? Yes ____ No ______.
   If yes, how many days of the week are you away? __________.
   Which hours of the day are you away? ___ ____ ____ ____.

5. Do you give this child a vitamin, mineral, health food, or other kind of supplement? Yes ___ No ___. If yes, give name of supplement _____________________________
   Name and address of manufacturer _________________________
   How often is it given? __________ Amount given per dose ___.
   On whose recommendation? ___________________________.
   What do you think is the purpose of the supplement? ______
   ____.

DATA ON FAMILY ECONOMIC STATUS

I wish to be able to group the families I am interviewing according to the money they have to spend. For this purpose, add together the amounts of income from all sources for all members of your household for the previous tax year. Deduct your State and Federal Income Taxes, but do not deduct money withheld from earnings for savings, insurance, retirement, health plans, etc.

1. As described above, check the income bracket of your family for the previous tax year:

____ Under $2,000	____ $7,000 up to $8,000
____ $2,000 up to $3,000	____ $8,000 up to $9,000
____ $3,000 up to $4,000	____ $9,000 up to $10,000
____ $4,000 up to $5,000	____ $10,000 up to $12,000
____ $5,000 up to $6,000	____ $12,000 up to $15,000
____ $6,000 up to $7,000	____ $15,000 or more

2. How many people lived in this household during the previous tax year? ______________

Form II

RECORD OF FOOD EATEN BY THE PRESCHOOL CHILD

Name of Child ______________________________

Date ______________________________
month day year

Day of Week ______________ Date ______________

Time of Day	Food Child Eats & Drinks & Description	Amount Cups, Tsp., Tbsp., or Size

Vitamin, mineral, or nutrient supplement given this child for this day:

Name of supplement ______________
Amount given per dose ______________
No. of times given ______________

INSTRUCTIONS FOR FORM II

1. Record the time when any food is eaten.
2. Record all food the child eats or drinks for three consecutive days.
3. Record amount child eats or drinks using the following utensils for measurements.
   (a) set of "standard" measuring cups
   (b) 1 cup liquid measuring cup
   (c) set of "standard" measuring spoons
   (d) ruler

Record only the amount eaten, not what is left on plate.

<u>Beverages</u> - list all kinds of beverages as whole milk, chocolate milk, carbonated drink, fruit flavored drink or mix. Record by cups (1/4, 1/3, 1/2, 2/3, 3/4, 1) or tbsp.

<u>Bread</u>
- list kinds of bread or rolls as whole wheat, rye, white, hamburger bun
- record bread in number or parts of slices
- record rolls and crackers by number

<u>Butter, Margarine, Spreads</u> - measure and record butter and margarine, peanut butter, jam and other spreads if used

<u>Cereals</u>
- list kinds of cereal as raisin bran, cornflakes
- measure added milk, cream, or sugar

<u>Cheese</u>
- list kinds of cheese as cottage, Cheddar
- record cottage cheese by tbsp.
- record Cheddar cheese in slices as 2" x 2" x 1/8" or by ounce or by slice

<u>Desserts</u>
- list kind of dessert as apple pie, chocolate pudding, frosted angel food cake
- record puddings and ice cream by cups (1/4, 1/2, 1)
- record cupcakes and cookies by diameter as 2 3/4" diameter
- record pies in fraction as 1/8 of 8" pie

<u>Eggs</u> - record number and method of preparation as fried, scrambled, poached

<u>Fish, Meat, and Poultry</u>
- list kind and method of preparation as fried chicken, broiled lamb chop, roast pork
- record in inches as 2" x 3" x ¼" or 1 wing, 1 drumstick, 3" diameter hamburger patty
- record number of shrimp, scallops, fish sticks, wieners, sausages

INSTRUCTIONS FOR FORM II (concl.)

Fruits and Fruit Juices	- list the form (fresh, frozen, or canned) and kind of fruit - if fresh fruit, specify if small, medium, or large - list the form (fresh, frozen or canned) and kind of juice - if fruit flavored drink or mix, specify kind - if sugar added, indicate amount
Miscellaneous	- list kind and size of candy bar - list kind and number of nuts, pieces of candy - record amount of popped corn by cups ($\frac{1}{2}$, $\frac{1}{4}$, 1) - record amount of chewing gum
Mixed Foods (Casseroles, Salads)	- any food prepared from a combination of ingredients - record proportions of ingredients in recipes - record amount child eats
Vegetables	- list kind of vegetable, as broccoli, potatoes-baked, fried, mashed - measure and record added butter and sauces - record cooked vegetables by portions of cups (1/4, 1/3, 1/2) or tbsp - record raw celery as portion of 1 stalk - record potato chips and French fries by number
Vitamin or Other Food Supplement	- record brand name and amount

FORM II (concl.)

EXAMPLES

Kind of food child eats and drinks and description	Amount child eats (cup, tbsp., tsp., number)
Corn flakes with sugar whole milk	$\frac{3}{4}$ cup $\frac{1}{2}$ tsp. $\frac{1}{2}$ cup
Toasted cheese sandwich white bread American cheese margarine	 1 slice 1 slice 3"x3"x3/16" 1 tsp.
Raw apple	$\frac{1}{2}$ of small apple
Canned peaches	1 peach half 2 tbsp. juice
Fried chicken	1 leg
Roast beef	1 thin slice, $4\frac{1}{2}$"x2"
Mashed potatoes with milk and butter added	$\frac{1}{4}$ cup
Gravy on potatoes	1 tbsp.
Raw carrot sticks	4 - 3" long
Cherry pie	1/8 of a 9" pie
Milk chocolate bar	1 ounce
Pecan halves	6
Frozen orange juice	$\frac{3}{4}$ cup
Tuna noodle casserole $\frac{1}{2}$ lb. uncooked noodles 1-7 oz., can tuna fish 1 can cream of mushroom soup $\frac{1}{2}$ cup crushed potato chips	$\frac{3}{4}$ cup
XYZ brand vitamin	1 tablet

FORM III

Name ______________________________

Date ______________________________

Age of Child _____________________

Height _____ _____ _____ _____ _____ _____

Weight _____ _____ _____ _____ _____ _____

<u>Circumferences</u>

Chest _____ _____ _____ _____ _____ _____

Waist _____ _____ _____ _____ _____ _____

Upperarm _____ _____ _____ _____ _____ _____

Calf of Leg _____ _____ _____ _____ _____ _____

<u>Bi-Condylar Diameters</u>

Humerus _____ _____ _____ _____ _____ _____

Femur _____ _____ _____ _____ _____ _____

<u>Other Diameters</u>

Pelvic Girdle _____ _____ _____ _____ _____

Shoulder Girdle _____ _____ _____ _____ _____

<u>Skinfold Measurements</u>

Upperarm _____ _____ _____ _____ _____ _____

Back _____ _____ _____ _____ _____ _____

Waist _____ _____ _____ _____ _____ _____

TABLE 32

Mean daily nutrient intake and dietary level of 3-day diets of children in 3 age groups

Child	Sex	Food energy	Pro-tein	Cal-cium	Iron	Vit A	Thia-mine	Ribo-flavin	Niacin equiv	Ascorbic acid	Dietary level
		cal	g	g	mg	IU	mg	mg	mg	mg	
Group A (3-4 years of age)											
1	F	1341[1]	46.2	.936	6.3	3039	.66	1.42	12.5	64	III
2	F	1170	34.5	.711	4.3	2659	.51	1.13	11.7	20	III
5	F	1195	43.7	.809	5.4	2088	.78	1.34	15.2	62	III
9	M	1518	60.6	1.035	7.4	6721	.90	1.76	18.2	100	II
12	F	1906	67.8	1.041	10.4	4094	.88	1.77	23.0	99	I
16	F	1501	90.4	1.177	10.0	2107	.81	2.19	27.7	16	III
17	M	1800	62.7	.784	8.3	6002	.65	1.44	22.6	53	II
19	M	1173	50.6	.569	9.6	3095	.74	1.22	18.6	108	II
24	M	1985	75.2	1.028	9.2	2590	.83	1.65	22.7	86	II
26	F	1424	54.8	.974	10.1	1652	.94	1.56	16.5	174	III
28	M	1467	37.1	.579	6.2	5156	.99	1.13	14.6	282	III
32	M	1652	60.6	.757	10.0	6518	1.00	1.50	21.1	79	II

TABLE 32 (cont'd)

Child	Sex	Food energy	Pro- tein	Cal- cium	Iron	Vit A	Thia- mine	Ribo- flavin	Niacin equiv	Ascorbic acid	Dietary level
		cal	g	g	mg	IU	mg	mg	mg	mg	
33	M	1265	39.3	.731	6.2	3884	.85	1.22	13.1	132	III
34	M	2203	70.4	1.434	8.2	3956	1.09	2.21	20.8	56	II
41	M	1683	71.7	1.173	8.7	5883	.88	1.82	23.5	176	II
42	F	1268	36.3	.622	6.2	2462	.85	.98	12.5	174	III
43	M	1781	89.6	1.204	10.8	2293	1.07	2.23	25.8	84	II
44	M	1367	54.5	.730	7.2	2323	.80	1.24	16.9	103	II
47	F	1720	68.3	.991	8.8	3113	.78	1.76	22.1	88	II
50	M	1990	102.1	1.178	12.5	5180	.88	2.11	33.4	51	I
Group B (4-5 years of age)											
3	F	1605	68.8	1.024	7.7	3266	.71	1.76	20.2	67	II
4	M	1688	62.4	.786	9.1	5075	1.08	1.40	21.0	61	II
6	F	2200	99.0	1.408	12.1	5451	1.58	2.51	29.0	116	I
10	M	1236	45.4	.608	5.5	1306	.51	1.14	16.7	33	III
15	F	2438	83.1	1.285	10.4	6133	1.14	2.24	29.4	37	II
20	F	1352	50.1	.970	5.6	4435	.63	1.54	13.1	65	III

TABLE 32 (cont'd)

Child	Sex	Food energy	Pro- tein	Cal- cium	Iron	Vit A	Thia- mine	Ribo- flavin	Niacin equiv	Ascorbic acid	Dietary level
		cal	g	g	mg	IU	mg	mg	mg	mg	
21	F	1099	44.2	.590	4.7	2186	.44	1.11	14.1	39	III
23	F	1256	56.3	.796	7.8	2676	.67	1.43	19.0	24	III
25	F	1738	58.5	.866	7.8	2874	1.04	1.50	19.2	83	II
27	M	1724	70.7	1.085	7.6	2633	.90	1.95	22.5	76	II
30	M	2250	84.6	1.114	11.3	3451	1.57	2.24	26.8	26	III
31	M	1340	46.8	.480	6.3	2834	.62	.98	16.1	76	III
36	M	1986	83.9	.659	11.4	3211	1.15	1.63	31.7	74	II
38	M	1443	49.0	.771	5.5	1860	.73	1.35	16.1	33	III
39	M	1725	69.6	.985	10.4	3059	.87	1.79	21.0	33	III
45	M	1236	56.7	.996	5.3	2799	.64	1.47	17.1	48	III
48	M	1858	80.6	1.182	10.2	8678	1.05	2.00	25.2	96	I
49	F	1894	91.3	1.224	10.7	4092	1.06	2.16	30.1	91	I
Group C (5-6 years of age)											
7	F	1571	64.2	.898	8.2	2897	.78	1.58	25.4	23	III
8	F	1885	87.2	1.555	10.4	6692	1.14	2.45	27.4	39	II

TABLE 32 (concl)

Child	Sex	Food energy	Protein	Calcium	Iron	Vit A	Thiamine	Riboflavin	Niacin equiv	Ascorbic acid	Dietary level
		cal	g	g	mg	IU	mg	mg	mg	mg	
11	F	1394	58.4	.998	6.3	2266	.66	1.73	17.2	13	III
13	M	1823	74.5	1.121	10.4	3686	.93	2.04	23.2	86	I
14	F	1829	65.4	1.136	7.6	3095	1.24	1.88	20.8	198	II
18	F	2084	81.1	1.370	11.1	4502	1.35	2.33	25.2	227	I
22	F	1841	65.3	.995	8.1	3533	.80	1.60	21.8	109	II
29	F	1796	72.9	1.271	10.3	5281	1.12	2.09	21.5	156	I
35	F	2205	81.6	1.174	12.2	6618	1.11	2.07	26.1	112	I
37	F	2364	85.0	1.146	11.7	5932	1.07	2.12	28.5	184	I
40	M	1637	54.8	.623	8.1	2839	1.07	1.33	20.4	162	II
46	F	1710	61.5	1.150	8.9	5900	.89	1.88	18.8	106	II

[1] Number without underline indicates dietary Level I; single underline, Level II; and double underline, Level III for individual nutrients.

TABLE 33

Mean daily nutrient intake from diets plus supplements and dietary level of 3-day diets of children in 3 age groups

Child	Sex	Food energy	Pro-tein	Cal-cium	Iron	Vit A	Thia-mine	Ribo-flavin	Niacin equiv	Ascorbic acid	Dietary level
		cal	g	g	mg	IU	mg	mg	mg	mg	
Group A (3-4 years of age)											
9	M	1518[1]	60.6	1.035	7.4	11,721	2.10	3.26	28.2	160	II
12	F	1906	67.8	1.041	10.4	8093	2.38	2.97	33.0	174	I
19	M	1173	50.6	.568	9.6	8096	1.94	2.72	28.6	168	II
24	M	1985	75.2	1.028	21.2	7592	2.33	3.45	34.7	146	I
26	F	1424	54.8	.974	20.1	4652	.94	1.56	16.5	234	II
28	M	1467	37.1	.579	6.2	13,157	3.37	4.13	44.6	432	III
32	M	1652	60.6	.757	10.0	10,519	2.20	3.00	36.1	154	II
34	M	2203	70.4	1.434	23.2	8956	3.09	4.71	40.8	106	I
44	M	1367	54.5	.730	7.7	7322	2.00	2.74	26.9	163	II
47	F	1720	68.3	.991	8.8	7113	1.98	3.26	37.1	163	II
Group B (4-5 years of age)											
4	M	1688	62.4	.786	9.1	5075	1.08	1.40	21.0	661	II
6	F	2200	99.0	1.408	12.1	9450	2.78	4.01	44.0	191	I

TABLE 33 (concl)

Child	Sex	Food energy	Pro-tein	Cal-cium	Iron	Vit A	Thia-mine	Ribo-flavin	Niacin equiv	Ascorbic acid	Dietary level
		cal	g	g	mg	IU	mg	mg	mg	mg	
10	M	1236	45.4	.608	20.5	6306	2.51	3.64	36.7	83	II
15	F	2438	83.1	1.285	10.4	9466	2.48	3.91	42.7	70	I
20	F	1352	50.1	.970	5.6	8435	1.83	3.04	28.1	140	III
27	M	1724	70.7	1.128	8.0	6532	2.90	3.95	40.5	156	II
30	M	2250	84.6	1.114	11.3	8451	4.57	4.74	46.8	76	I
39	M	1725	69.6	.985	10.4	7059	2.87	3.79	39.0	108	I
45	M	1236	56.7	.996	17.3	7800	2.14	3.27	29.1	108	II
49	F	1894	91.3	1.224	20.7	9091	2.26	3.66	40.1	151	I
Group C (5-6 years of age)											
11	F	1394	58.4	.998	6.3	7264	2.66	4.23	37.2	28	III
14	F	1829	65.4	1.136	7.6	8095	2.44	3.38	30.8	258	II
18	F	2084	81.1	1.370	11.1	7836	3.35	4.83	45.2	277	I
29	F	1796	72.9	1.271	10.3	9280	2.32	3.59	36.5	231	I
35	F	2205	81.6	1.174	12.2	10,620	3.11	4.07	44.1	187	I
37	F	2364	85.0	1.146	11.7	10,931	3.07	4.62	48.5	234	I
46	F	1710	61.5	1.150	23.9	10,901	2.89	4.38	38.8	157	I

[1]Number without underline indicates dietary Level I; single underline, Level II; and double underline, Level III for individual nutrients.

TABLE 34

Anthropometric measurements and weight and height positions on Jackson and Kelly growth charts of children in 3 age groups

Child	Age	Sex	Ht	Wt	Circumferences				Diameters				Skinfold measurements			Positions on Jackson and Kelly growth chart	
					Chest	Waist	Upper-arm	Calf of leg	Humerus	Femur	Pelvic girdle	Shoulder girdle	Upper-arm	Back	Waist	Wt	Ht
no.	mo		in	lbs	cm	cm	cm	cm	cm	cm	cm	cm	mm	mm	mm		
Group A																	
47	35	F	36.23	28.50	46.46	46.80	14.74	19.60	4.22	5.67	11.23	17.15	8.41	6.40	5.36	4	3
43	37	M	38.42	31.00	51.70	49.80	15.15	19.18	4.40	6.12	12.20	19.30	10.53	5.60	4.08	3	2
2	38	F	36.12	27.00	48.51	47.54	15.53	19.02	4.03	5.76	11.00	15.58	10.74	6.45	5.38	4	4
42	38	F	39.27	33.50	51.75	48.44	14.53	20.54	4.13	5.89	11.41	18.55	7.60	5.81	5.36	2	2
44	38	M	36.50	26.69	47.18	42.98	13.87	18.53	3.73	5.25	11.40	18.73	7.23	6.20	3.86	4	4
16	39	F	40.06	40.25	54.90	56.07	19.34	23.36	4.82	6.77	13.42	19.69	14.33	8.60	9.40	1	1
19	39	M	39.67	39.17	56.47	53.05	18.22	22.32	4.72	6.95	13.90	20.52	13.20	9.98	5.97	1	2
24	39	M	38.40	30.00	47.68	47.60	14.28	18.95	4.28	5.95	11.93	18.78	7.18	5.08	3.65	3	3
34	40	M	40.50	34.25	52.50	50.33	15.75	20.83	4.43	6.30	12.37	20.35	8.90	6.58	3.97	3	1
12	41	F	39.02	33.17	51.08	49.05	15.88	20.93	4.30	6.72	12.48	20.08	13.50	6.74	4.10	3	2
17	42	M	38.92	38.00	56.28	54.50	17.26	22.48	4.45	6.66	13.84	20.66	7.55	6.54	4.34	2	3
33	42	M	38.38	34.17	50.50	47.48	16.46	22.30	4.42	6.12	12.80	18.78	11.00	7.90	4.90	3	3
5	43	F	38.88	31.50	49.56	47.52	15.64	20.20	4.16	5.83	12.63	18.68	7.17	5.12	4.00	4	3
50	43	M	40.52	39.00	54.33	50.67	17.25	21.75	4.74	6.66	13.76	18.70	9.90	7.94	4.24	2	2
32	44	M	41.48	39.75	54.43	55.10	17.57	22.72	4.65	6.71	13.66	20.66	12.30	9.60	5.67	2	1
41	44	M	41.32	36.50	52.58	49.07	16.10	22.97	4.59	6.54	12.50	20.18	9.47	5.28	4.52	2	1
9	45	M	40.69	37.83	52.50	50.08	16.02	21.88	4.36	6.36	12.97	18.42	9.00	6.58	5.23	2	2
1	46	F	37.65	29.56	49.67	46.70	14.73	20.70	4.00	5.88	11.25	17.78	10.92	4.17	3.30	4	4
26	46	F	40.48	36.62	52.18	49.54	15.08	21.45	4.22	6.00	12.57	19.31	8.79	6.16	3.86	2	2
28	46	M	39.09	28.17	49.22	42.34	13.90	20.02	4.24	6.37	11.90	19.23	6.13	3.83	3.29	4	3

TABLE 34 (concl)

Child	Age	Sex	Ht	Wt	Circumferences: Chest	Circumferences: Waist	Circumferences: Upper-arm	Circumferences: Calf of leg	Diameters: Humerus	Diameters: Femur	Diameters: Pelvic girdle	Diameters: Shoulder girdle	Skinfold measurements: Upper-arm	Skinfold measurements: Back	Skinfold measurements: Waist	Positions on Jackson and Kelly growth chart: Wt	Positions on Jackson and Kelly growth chart: Ht
no.	mo		in	lb	cm	cm	cm	cm	cm	cm	cm	cm	mm	mm	mm		
Group B																	
20	48	F	40.29	34.33	51.23	47.30	15.12	21.19	4.28	5.72	12.28	18.24	7.07	4.98	4.92	3	3
15	49	F	40.62	38.00	55.46	52.34	17.28	21.73	4.59	6.17	13.56	21.29	10.48	6.55	6.10	2	2
23	49	F	41.90	45.33	58.50	57.93	18.73	23.46	4.67	6.83	15.50	21.69	16.20	9.73	12.70	1	2
6	50	F	43.30	41.83	55.82	53.62	15.87	22.42	4.34	6.60	14.37	20.45	7.22	6.15	5.00	2	1
48	50	M	41.98	42.75	56.26	53.08	17.07	23.56	4.65	6.81	14.65	20.60	12.23	8.73	5.52	2	2
25	51	F	40.52	35.50	51.47	53.24	16.17	21.38	4.20	6.14	12.52	19.30	9.80	6.20	5.92	3	3
39	51	M	39.54	31.67	49.38	47.44	14.60	20.72	4.27	6.46	12.49	18.63	7.67	5.12	3.65	4	4
10	53	M	39.81	35.00	51.46	50.78	15.35	20.32	4.42	6.23	12.45	18.04	8.65	6.15	5.33	3	4
36	54	M	43.43	43.00	56.40	53.38	17.78	22.52	5.30	7.44	14.54	21.62	10.07	5.39	5.10	2	2
45	54	M	41.28	39.00	57.73	50.76	17.03	21.65	4.81	6.75	12.54	21.37	11.72	5.00	3.79	3	3
3	55	F	42.58	38.33	54.41	49.80	15.57	21.64	4.33	6.37	13.27	20.08	6.56	4.71	3.55	3	2
4	55	M	42.50	36.50	53.90	49.73	15.30	20.55	4.82	6.37	12.50	20.63	7.27	4.85	4.30	3	2
21	55	F	38.94	32.67	52.24	50.18	14.88	20.18	4.18	5.70	12.30	18.74	9.17	6.24	4.95	4	4
49	55	F	43.09	42.25	54.66	53.50	16.65	22.88	4.43	6.58	13.85	18.62	12.32	5.84	4.60	2	2
30	57	M	41.41	34.92	53.23	50.20	16.00	21.30	4.37	6.68	12.65	20.44	9.76	6.03	4.26	4	3
27	58	M	42.10	38.33	52.66	51.20	16.56	22.00	4.57	6.76	12.92	21.83	8.08	3.94	3.12	3	3
31	59	M	41.34	34.50	50.57	48.82	15.58	20.83	4.63	6.29	12.91	19.16	8.06	4.60	2.70	4	4
38	59	M	39.56	32.67	51.05	51.33	15.88	19.90	4.15	6.47	12.63	19.30	11.30	5.55	4.30	4	4
Group C																	
18	60	F	42.96	39.50	50.26	49.73	16.85	22.33	4.40	6.11	13.53	19.98	8.49	7.44	5.20	3	2
7	62	F	42.92	39.00	53.47	51.33	16.50	22.83	4.57	6.44	13.58	20.43	12.00	5.20	5.37	3	3
37	63	F	43.90	39.62	54.23	49.47	16.57	22.80	5.35	6.87	13.80	20.63	8.40	5.26	3.68	3	2
22	64	F	45.16	47.83	58.46	54.75	17.28	23.66	4.90	6.98	15.53	22.65	11.00	7.23	6.62	1	2
46	64	F	41.32	38.83	53.48	53.52	17.74	22.63	4.31	6.29	12.46	19.46	10.10	9.33	6.39	3	4
29	66	F	45.12	40.50	54.58	52.62	17.15	22.28	4.66	6.50	14.80	21.63	13.17	6.60	5.37	3	2
35	66	F	43.31	37.83	54.72	52.64	15.30	20.86	4.07	6.28	12.60	20.22	9.28	5.38	5.26	4	3
14	68	F	42.40	38.00	52.60	51.52	15.88	20.60	4.43	6.30	13.90	20.64	8.38	6.90	5.37	4	4
13	69	M	45.59	43.00	56.75	52.60	16.25	21.47	4.97	6.41	13.50	22.63	6.79	4.97	3.72	3	2
8	72	F	46.36	44.50	56.95	52.45	16.60	22.15	6.35	4.57	14.68	21.62	9.56	6.14	4.94	3	2
40	72	M	42.95	38.50	55.24	49.28	15.33	20.76	4.52	6.35	13.04	20.76	7.47	6.20	5.09	4	4
11	74	F	45.11	41.00	54.32	52.80	17.38	22.42	4.91	6.55	13.94	20.92	8.77	5.26	3.80	3	3

DIETARY INTAKE AND ANTHROPOMETRIC MEASUREMENTS OF PRESCHOOL CHILDREN

by

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B. S., Kansas State University, 1966

AN ABSTRACT OF A MASTER'S THESIS

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Department of Foods and Nutrition

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The relationship of dietary intake and physical status as determined by anthropometric measurements was studied for 3 - 6 year old children. Three-day dietary records were obtained for 24 boys and 26 girls from 50 different families living in university married student housing. Thirteen anthropometric measurements including height, weight, 4 circumferences, 4 diameters, and 3 skinfold measurements were made on the children.

The mean daily intake of the individual nutrients by each child was classified into Levels I (100%), II (67 - 100%), and III (below 67%) based on percentage of the RDA. An evaluation of the over-all diet of each child also was determined based on whether nutrients met the RDA. The children were divided into age groups A) 3 - 4 years; B) 4 - 5 years; and C) 5 - 6 years. In general, the mean and median intakes of each nutrient increased with increasing age of children. Group C had smaller percentages of children in dietary Levels II or III for individual nutrients than did Groups A or B. The largest number of boys were in Level II and the largest number of girls were in Level III. When diets of all children together were classified, slightly more were in dietary Level II than in Level III and the smallest number was in Level I.

More of the diets supplied the vitamins than iron, calcium, protein, or food energy at Level I. Iron was supplied in least adequate amounts, followed by ascorbic acid. Niacin was the only nutrient supplied at 100% of the RDA in diets of all the children. No relationship between dietary adequacy and family income was observed.

Out of 27 children receiving dietary supplements, 20 received multivitamins, 1 received ascorbic acid alone, and 6 received multivitamins and minerals. All of the vitamins, except A and ascorbic acid, were supplied at dietary Levels I or II by the diets of all children. Dietary supplementation resulted in dietary levels of I or II for vitamin A and ascorbic acid for all children with one exception for ascorbic acid. The nutrient intake from diet alone of the children receiving supplements tended to be higher than that of the other children.

Mean, median, and range for 13 different anthropometric measurements were obtained. Children who had the least adequate diets tended to be in the lower half of the Jackson and Kelly distributions for weight and height. When correlation coefficients were calculated among the various measurements, it was found that girls in Group C had fewer significant ($P > 0.05$) correlations than did the other 2 age groups. Many significant ($P > 0.05$) correlations were found for weight, circumference, and diameter measurements of both boys and girls in all 3 age groups. More significant ($P > 0.05$) correlations were found for the upper-arm than for subscapular and waist skinfold measurements. Height was the measurement that was least well correlated with other measurements.

Analysis of covariance, corrected linearly for age, indicated that dietary level was significantly correlated with height ($P > 0.01$) and with weight, pelvic girdle, and shoulder girdle ($P > 0.05$) of the boys. Dietary level was not significantly correlated with any of the anthropometric measurements of the girls.