

ABSTRACT

MUNDT, Mary P. The effects of vegan and traditional diets on five anthropometric measurements in children birth through five years of age. M.S. in Health Education, 1977. 72p. (Dr. Gary Gilmore).

Height (or recumbent length), weight, head circumference, triceps skinfold thickness, and subscapular skinfold thickness measurements were recorded on a total of 52 Ss following 2 different diets: vegan and traditional. Of the 26 children in each diet group, 14 were male and 12 were female.

An analysis of covariance, with age as the covariate, was calculated on the anthropometric readings. No significant difference was found between the 5 measurements of vegan and traditional Ss.

A Pearson Product-Moment Correlation was carried out on 6 intra-group correlations among the measurements: weight/triceps, weight/subscapular, weight/height, triceps/subscapular, height/triceps, and height/subscapular. The correlations between weight/height and triceps/subscapular were significant at $p \leq .05$ in all 4 diet-sex groups: male vegan, female vegan, male traditional, and female traditional.

A Fisher's Zf Transformation was calculated on the above 6 correlations on an inter-group basis. No significant difference was found at $p \leq .05$

A 24-hour Diet Recall and a Diet History Questionnaire were administered to the mothers of the Ss. Group mean scores were calculated for all 5 body measurements. In addition, anthropometric findings were descriptively examined in relation to 1976 National Center for Health Statistics Growth Norms.

It was concluded from this study that the vegan and traditional children were not significantly different in 5 anthropometric measurements. Among other variables, diet was shown to have no significant impact on these body measurements when comparing vegan and traditional Ss.

THE EFFECTS OF VEGAN AND TRADITIONAL DIETS
ON FIVE ANTHROPOMETRIC MEASUREMENTS IN
CHILDREN BIRTH THROUGH FIVE YEARS OF AGE

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by
Mary P. Mundt
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UNIVERSITY OF WISCONSIN - LA CROSSE
School of Health, Physical Education and Recreation
La Crosse, Wisconsin 54601

Candidate: Mary P. Mundt

We recommend acceptance of this thesis in partial fulfillment
of this candidate's requirements for the degree:

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The candidate has completed her oral report.

Jay D. Odum
Thesis Committee Member

August 5, 1977
Date

Clark E. Heimel
Thesis Committee Member

August 5, 1977
Date

William Lloyd
Thesis Committee Member

8-5-77
Date

This thesis is approved for the School of Health, Physical
Education and Recreation.

Glenn M. Smith
Dean, School of Health, Physical
Education and Recreation

8-5-77
Date

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CHAPTER I
INTRODUCTION

Background and Need for the Study

Cultural familiarity, availability of foods, and economic concerns are key factors in diet design. Food choices from the plant and animal worlds are made by people within groups, and in turn within cultures, and these choices are handed down from one generation to the next. Cultural and religious attitudes are reflected in any design. Often, it requires a change in values and beliefs or the passage of time to markedly change the diet of a culture.

Distinctions of a religious and economic nature have existed for centuries between the cultures of the east and the west. In the west, including the United States, foods are chosen from both the plant and animal worlds. Meat and related animal products are readily available and often serve as the principal component of the main meal from day to day. In the far east a near-vegetarian diet is followed. Differences as fundamental as these are bound to significantly affect the peoples of these cultures.

According to a publication of the American Dietetic Association, The Vegetarian Diet: Food For Us All (1974), there is a growing interest in the various forms of vegetarianism in this country today. Americans of all ages,

especially young adults, are reshaping their diets. Spiritual, physical, and environmental issues all seem to play a part in the decision to abstain from meat. It is a cultural challenge to some degree as well. These individuals are choosing to alter familiar food patterns in favor of a new diet design.

Certain religious groups have practiced vegetarianism in this country for a number of reasons. The Trappist order abstain from meat, considering it to be a luxury and at variance with their philosophy of the simple life. As Proctor (1973) reports, the Seventh Day Adventists encourage a meatless diet for health reasons, as well as their belief that the Bible advocates the use of fruits, vegetables, and nuts. A spiritual commune, the Farm, which took shape in the late 1960's and originated in Tennessee, follows a strict vegetarian or vegan diet. A magazine published by the Farm entitled Hey Beatnik states that all of the approximately 1500 members of the commune believe that it is wasteful and destructive to kill animals in order to feed people. They believe plant foods could replace meat in the diet.

The fact that antibiotics, hormones, pesticides, and nitrites are used in meat is feared by many who abstain from it. The greater the amount of additives and preservatives, the less appealing the food becomes to many vegetarians. In keeping with this attitude, the cyclical process of producing feed to fatten animals in order to provide food for man

could be viewed as wasteful in terms of land and resources.

Krause and Hunscher (1972) report that a vegetarian diet is nutritionally adequate provided certain precautions and planning skills are followed. Most vitamins and minerals can be derived from a vegetarian diet that is designed to include many different kinds of fruits, vegetables, legumes and nuts. Problems can arise when the diet relies too heavily on a select number of foods. Combining foods is also a key to nutritional adequacy. Krause and Hunscher (1972) further suggest that when cereal and legume proteins are eaten together, the mixture of proteins and the combined amino acids are of better quality than that provided by either alone. If this mixing is done judiciously, combinations of complete and incomplete proteins give mixtures of about the same nutritional value as animal protein according to the American Dietetic Association. Vitamins whose primary source are animal foods require special planning. Howe (1971) reports that vitamin B12 is found only in animal foods. Krause and Hunscher (1972) caution strict vegetarians or vegans to supplement their diets with a synthetic form of this vitamin.

An interest in the physical effects of a meatless diet has arisen from the increased popularity of vegetarianism. Nutritionists are wondering how the body adapts to a diet that draws its protein, iron, and fat from food sources other than meat. Variables such as height, weight, and muscle strength in addition to serum levels of proteins, fats,

carbohydrates, and certain vitamins, especially B12, have been tested in groups practicing a vegetarian diet and compared to those who eat meat. The interest in serum levels of fat is a single variable that has attracted much research due in part to its possible correlation to heart disease. Serum levels of cholesterol have been shown to be affected by a vegetarian diet. According to studies by Hodges, Krehl, Stone and Lopez (1967) and West and Hayes (1968) as the individual's diet approaches the pure vegan design, in which no meat or animal by-product is eaten, the lower becomes the level of cholesterol.

Questions about growth rate have also been raised in relation to a vegetarian diet. Do vegans grow as tall and weigh as much as their meat-eating counterparts of matching age and sex? The results of these and other anthropometric measures such as head circumference, arm circumference, skin-fold thickness and total body fat have been used to assess nutritional status of a given population (Jelliffe, 1966; Christakis, 1972; and Keet, 1970). Thorough nutritional assessment includes anthropometric, biochemical, and dietary information about a population.

To date, the great bulk of the research (Hardinge and Stare, 1954; Mirone, 1954; West and Hayes, 1968), has drawn its subjects from adult populations. A concern has been voiced, however, about the adequacy of a vegetarian diet for children of all ages. An emphasis is placed on infants and

children through six years of age. Watson and Lowrey (1952) suggest that neurological development and head size increases fairly rapidly during the first year of life. During a United Nations "Seminar on Education, Nutrition, Agriculture, and Man" held in Lima, Peru in 1972, reports were given about the nutritional status of children. In a subsequent report the following opinion was stated, "The effects of malnutrition on an individual, while he is in his mother's womb and through the age of six...are likely to be much more harmful than malnutrition at a succeeding age, particularly in connection with the ability to learn, remember, perceive and act in a coordinated manner" ("Scientific Study of Malnutrition as a Limiting Factor in the Development of Education", p.4).

Statement of the Problem

The problem was the cross-sectional comparison of anthropometric indicators in children ages birth through five who follow a vegan diet as compared to children consuming foods of animal origin.

Hypotheses

Group I: Hypotheses Related to Difference in Anthropometric Measurements Between Diet Groups

1. When using age as a covariate there is no statistically significant difference between weight values in boys (ages birth through five following a vegan diet) and boys

- (ages birth through five following a traditional diet).
2. When using age as a covariate there is no statistically significant difference between values for girls.
 3. When using age as a covariate there is no statistically significant difference between height values for boys.
 4. When using height as a covariate there is no statistically significant difference between height values for girls.
 5. When using age as a covariate there is no statistically significant difference between head circumference values for boys.
 6. When using age as a covariate there is no statistically significant difference between head circumference values for girls.
 7. When using age as a covariate there is no statistically significant difference between triceps skinfold values for boys.
 8. When using age as a covariate there is no statistically significant difference between triceps skinfold values for girls.
 9. When using age as a covariate there is no statistically significant difference between subscapular skinfold values for boys.
 10. When using age as a covariate there is no statistically significant difference between subscapular skinfold values for girls.

Group II: Hypotheses Related to Intra-Group Correlations

Among Anthropometric Measurements.

11. There is no statistically significant positive correlation between weight and triceps skinfold in boys (ages birth through five) following a vegan diet.
12. There is no statistically significant positive correlation between weight and triceps skinfold in girls (ages birth through five) following a vegan diet.
13. There is no statistically significant positive correlation between weight and triceps in boys (ages birth through five) following a traditional diet.
14. There is no statistically significant positive correlation between weight and triceps in girls (birth through five) following a traditional diet.
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34. There is no statistically significant positive correlation

between height and subscapular in traditional girls.

Group III: Hypotheses Related to Inter-Group Correlations of Anthropometric Measurements.

35. There is no statistically significant difference between the correlation coefficient of weight and triceps skinfold in boys (ages birth through five following a vegan diet) compared to the same coefficient in boys (ages birth through five following a traditional diet).
36. There is no statistically significant difference between the correlation coefficient of weight and triceps skinfold in girls from both groups.
37. There is no statistically significant difference between the correlation coefficient of weight and subscapular in boys from both groups.
38. There is no statistically significant difference between the correlation coefficient of weight and subscapular in girls from both groups.
39. There is no statistically significant difference between the correlation coefficient of weight and height in boys from both groups.
40. There is no statistically significant difference between the correlation coefficient of weight and height in girls from both groups.
41. There is no statistically significant difference between the correlation coefficient of triceps and subscapular in boys from both groups.

42. There is no statistically significant difference between the correlation coefficient of triceps and subscapular in girls from both groups.
43. There is no statistically significant difference between the correlation coefficient of height and triceps in boys from both groups.
44. There is no statistically significant difference between the correlation coefficient of height and triceps in girls from both groups.
45. There is no statistically significant difference between the correlation coefficient of height and subscapular in boys from both groups.
46. There is no statistically significant difference between the correlation coefficient of height and subscapular in girls from both groups.

Assumptions

1. The children chosen as vegan and traditional subjects were considered equal in terms of the possible emotional, social, psychological, and environmental factors that could affect their physiological make-up and metabolic functioning.
2. Normal metabolic functioning was assumed on the part of each subject.
3. The Diet History Questionnaire was assumed to be a valid and reliable tool for gathering related information from the mothers of the subjects.

Delimitations

1. No attempt was made to measure the following: review of vital statistics, clinical appraisal (general vitality, skin, eyes, hair, and gums), biochemical tests (blood and urine), and subject's history of disease.
2. This study was not intended to be a thorough nutritional assessment. It was intended to provide specific statistical data about one category that is an overall indication of nutritional status, namely anthropometric measurements.

Limitations

1. A scarcity of children following a vegan diet required that the subjects be drawn from one communal group that exclusively practice a vegan diet. As a result, the food choices that make up the diet of the vegan subjects were similar.
2. A 24-hour diet recall was used to compile average protein and caloric intakes. It should be noted that this method of diet analysis was somewhat superficial in adequately representing the nutritive values of the subjects' average daily diet.
3. All of the mothers of the vegan subjects were informed in advance that they would be asked to complete a 24-hour diet recall for their children. On the other hand, approximately 1/3 of the mothers of the comparison group were informed due to the fact that 2/3 of them were asked

to participate on the day of the measurements.

4. The 24-hour diet recall was administered to the vegan mothers in their homes. Diet recalls for the comparison group were administered in a clinic setting. It should be noted that the difference in environments may have affected the responses.
5. In seven cases, there was more than one child per vegan family participating in the study. Five of these families had two children participating, one had three, and one four. There were three similar cases in the comparison group each with two children who participated. Although an attempt was made to control for this, the groups were not evenly matched.

Definition of Terms

Diet. Food and drink consumed each day.

Vegetarian Diet. A diet in which no meat is eaten.

Lacto-ovo Vegetarian Diet. A diet of plant foods that is supplemented with milk (lacto) and eggs (ovo).

Vegan Diet. A diet in which only plant foods are eaten exclusive of animal products and by-products.

Traditional Diet. A diet in which animal products and by-products are eaten as well as plant foods.

Protein. Any of a group of nitrogenous compounds synthesized by plants and animals that yield amino acids upon hydrolysis by enzymes and which are required for all life processes in human metabolism including growth (The Random

House Dictionary of the English Language, 1967, p.1155).

Complete Protein. A protein containing all of the essential amino acids.

Incomplete Protein. A protein lacking one or more of the essential amino acids.

Essential Amino Acid. An amino acid that cannot be synthesized by the body from materials readily available at a speed commensurate with the demands for normal growth. It must, therefore, be supplied preformed in the diet. These are eight essential amino acids: isoleucine, leucine, lysine, methionine, phenylalanine, threonine, tryptophan, and valine (Nutrition and Diet Therapy Reference Dictionary, 1974, p.10).

Height or Length. (For children less than two years)
The distance of measure between the soles of the feet and the crown of the head when positioned in a linear supine fashion with the ankles at right angles to the measuring surface.

(For children two years and older)
The distance of measure between the soles of the feet and the crown of the head when standing erect.

Weight. The measure of heaviness or mass of an individual.

Head Circumference. A measure of the outward boundary of the head at the fullest part of the occiput around the lower forehead and above the supraorbital ridges.

Triceps Skinfold. The subcutaneous fat deposit at the posterior aspect of the upper arm midway between the elbow

and the acromial process of the scapula.

Subscapular Skinfold. The subcutaneous fat deposit on the back immediately below the inferior angle of the scapula.

CHAPTER II
REVIEW OF RELATED LITERATURE

A literature search and review was undertaken in order to develop a perspective on the current and past research related to diet and its effects on anthropometric measurements. A number of related topics guided the selection of literature. These were: Growth and Nutritional Adequacy from Birth Through Five Years; The Relationship Between Nutritional Status and Anthropometric Measurements; Choosing Appropriate Measurements for Children; Description of the Vegan Diet; Diet Recall as a Nutritional Assessment Tool; and Studies Pertaining to Diet as it Effects Height, Weight, Head Circumference, and Triceps and Subscapular Skinfold Thickness.

Growth and Nutritional Adequacy from Birth Through Five Years

A host of variables influence growth. Among these are: sex, intra-uterine environment, birth order, birth weight, parental size, and genetic constitution. Environmental factors such as climate, season, and socio-economic level including diet are factors as well. Jelliffe (1966) reports that nutrition is currently being considered of greater importance in determining growth than genetic background, especially during the growing period of early childhood.

Proteins, fats, and carbohydrates are needed in varying

amounts, depending on age and size, to ensure acceptable growth. Of these, protein is the substance most closely linked with the phenomenon of growth.

In addition, certain chemicals are necessary for the process of metabolism and the formation and maintenance of body tissues. Social and psychological influences play a part as well in every infant and child's growth. In this study, however, the role of nutrition will be discussed foremost.

What is nutrition? Turner (1970) explains it as the combination of processes by which the living organism receives and utilizes the materials (food) necessary for the maintenance of its functions and for growth and renewal of its components (p.3). During growing periods, cells are increasing in size and in number or both to provide for the growth and development of bones, muscles, and various organs and body structures.

Williams (1969) defines growth as simply an increase in size whereas development is the related process in which growing tissues and organs become more complex (p.369). Maturation changes involve both processes. Williams (1969) reports that by the age of six months there will be an average increase in weight of twice the weight at birth. By the age of one the weight may have tripled the birth weight (p.370). Filling out and broadening of the body occurs during infancy. After the first year, the legs begin

growing faster than the trunk. Muscle mass development accounts for about one-half of the total weight gain between the ages of one and three (p.387). During this period skeletal growth slows and the shape of the body undergoes great change. With the passage of the first year and the child's increased mobility, the "baby fat" slowly disappears and the child, generally speaking, becomes more slender. The head no longer appears proportionately large, as in infancy. Protein and calories are needed to sustain these growth changes.

Calories may be derived from any reasonable combination of carbohydrate, fat, and protein. According to the National Academy of Sciences (1974), carbohydrates and fats are eaten in nearly equal proportions, (46% and 42% respectively) in the typical American diet (p.33). The protein content has remained fairly constant at 11% to 12% (p.33). Protein is the key element for growth. Protein supplies amino acids essential for the formation and maintenance of muscle, nerve tissue and bone.

The child's growth pattern determines his or her need for protein. Williams (1969) reports that during the first six months of life an infant requires approximately two grams of protein per kilogram of body weight (p.373). This amount gradually decreases until adulthood when one gram of protein per kilogram of body weight is required.

Calorie needs are relatively low from age one to three. At one the toddler needs approximately 1000 calories and only

1300 to 1400 calories by the time he or she is three. Protein requirements are, however,

Table 1

Recommended Daily Dietary Allowances for
Growth: Age Birth Through Six Years
(National Research Council-1968)

AGE (years)	WEIGHT (lbs)	CALORIES	PROTEIN (grams)
0-1/6	9	480	9
1/6-1/2	15	770	14
1/2-1	20	900	16
1-2	26	1100	25
2-3	31	1250	25
3-4	35	1400	30
4-6	42	1600	30

relatively high for infants and pre-school children. It is, therefore, of interest to study the nature of protein in order to ensure that infant and childhood requirements are met.

According to the National Academy of Sciences (1974), proteins can differ in their nutritive value because they differ in their amino acid composition and digestibility (p.45).

Nitrogen intake and body losses are clues to the biological value of a protein. A chemical score can also be calculated for the amino acid composition of a protein using a reference protein. Whole egg protein has a chemical score of 100. The amino acid showing a deficit is called a limiting amino acid. Limiting amino acids must be combined to form complete

proteins in order for the nutritive value to be fully realized.

Animal protein, such as meat, eggs, and cheese, are given higher chemical scores than non-animal proteins, such as legumes, vegetables, and fruits. If growth is in part dependent on the metabolic functioning of complete proteins then diet planning becomes a critical issue to any vegetarian diet. This is especially true for the vegan diet in which no food of animal origin is consumed.

The Relationship Between Nutritional Status and Anthropometric Measurements

Undoubtedly the most reliable way to assess nutritional status of a group or a community is through evaluation on a number of levels including: records of vital statistics; clinical (general vitality, skin, eyes, hair, gums, and symptoms of malnutrition); biochemical (blood and urine); nutritional analysis (diet recall); and anthropometric measurements. There are also methods of assessing mental, social and emotional growth.

In growing infants and children, body measurements are an especially sensitive tool employed to evaluate nutritional status. This can be attributed to the continual and expected changes in body dimensions typical of children five years and younger. During this period, alterations in growth patterns are detectable and offer a visible clue to the health of the child.

Bailey (1970) reports that growth retardation directly

reflects inadequate intakes of protein and calories and supports the use of anthropometric measurements to determine levels of malnutrition (p.42). Christakis (1972) states that the possibility of experiencing nutritional deprivation increases during periods of rapid growth especially in infants two years and younger (p.42). In 1970, Visweswara Rao and Singh concurred in stating that body weight has proved to be a valuable tool for assessing nutritional status in growing children (p.89). Owen and Brozek (1966) report that there is evidence linking calorie reserves, as measured by body fat, with linear growth, weight gain, and bone development (p.223). Garn (1962) added that the presence of a calorie surplus will increase body size and maturational status during childhood growth (p.418).

In a publication on Recommended Dietary Allowances, the National Academy of Sciences (1974), it states that protein allowances for infants are calculated on the amount that will ensure satisfactory rates of growth. Thus, growth rate is assumed to reflect adequate nutritive intakes.

Jelliffe (1966) defines nutritional anthropometry as the measurement of changes in body dimensions at different ages and levels of nutrition (p.50). He concurs with Bailey (1966), Christakis (1972), Visweswara Rao and Singh (1970), Owen and Brozek (1966), and Garn (1962) in recognizing nutrition as an influencing factor on physical dimensions of the human body, particularly in the growing period of infants and pre-school

children (p.50). Working with norms and standards is typical in interpreting community nutritional status.

Several guidelines will aid in the interpretation of norms and standards of growth. Falkner (1966) reminds us that norms describe; they do not evaluate. Anthropometric norms and standards describe how many people fall within given limits in terms of certain body measurements. It is important to note that American growth standards are based on the measurements of children who, for the most part, consume animal protein.

There are no fixed points where normality and abnormality begin and end. Furthermore, norms do not evaluate the advantages and disadvantages of falling outside the expected range, i.e. weighing less than the norm. Falkner (1966) states that the height of a ten year old boy may fall in an overlap "grey" area. The boy may be either a very, very, small healthy boy or a very, very tall dwarf (p.11).

A range of "normality" could be conceived as ranging between the fifth and ninety-fifth percentiles. Individuals falling outside the range at either end would then be construed as a source of concern. However, if a child, despite the fact that he or she is in a low weight range for age, grows in height and weight within expected limits he or she may be considered to be within the normal range. In 1976, the National Center for Health Statistics published national standards for growth, ages birth to 18 years. Measurements

between the 25th and 75th percentiles were considered to be within the normal range.

Jelliffe (1966) prefers to relate anthropometric findings in terms of percentage below "standard". This is calculated by using existing standards. The range within these standards considered to reflect normal growth is used as a reference point. Each subject's measurements are related to this reference in terms of 10% categories. A reading of 90% or higher of the standard is considered within the normal range while a reading of 60% or below the standard is comparable to a measurement below the fifth percentile. Bengoa, Jelliffe, and Perez (1959) defined three categories or degrees of malnutrition. First degree malnutrition was indicated by anthropometric values from 75% to 90% of the average weight. Values for second degree malnutrition fell from 60% to 75% of the average while third degree values were below 60% of the average.

Choosing Appropriate Measurements for Children

According to Jelliffe (1966) a thorough anthropometric assessment usually includes a measurement of body mass (weight) and linear dimensions (height or length). Jelliffe (1966) reports that weight is the key anthropometric measurement (p.64). Falkner (1966), Bayer (1959), Bailey (1970), and Williams (1969) also concur that measurements of weight and height offer valuable preliminary information about childhood nutritional status. Christakis (1972) and Jelliffe (1966) further suggest

that measurements of subcutaneous fat be taken to evaluate protein and calorie reserves. Growth retardation in cases of malnutrition affects the anthropometric parameters of weight, height, subcutaneous fat, and muscle mass. Of these, weight is the most influenced by protein and calorie intakes.

Head circumference is another fairly routine body measurement, especially in children under two years of age. Jelliffe (1966) reports that brain size may vary with nutritional status as well. Head circumference values taken in the second year of life may reflect earlier malnutrition. Williams (1969) and Christakis (1972) concur. Among the recommendations for measurements offered at the 1968 White House Conference on Food, Nutrition and Health were the following: weight, height, head circumference, and triceps skinfold thickness.

Owen and Brozek (1966) and Keet, Hansen, and Truswell (1970) state when calorie and protein intakes are low, skinfold thickness readings have been found to be correspondingly low. Damon and Goldman (1964) report that the triceps and subscapular sites are considered to predict body fat more accurately than other sites. Seltzer and Mayer (1967) state that the triceps skinfold, in particular, has a high correlation with body density values as determined by water weighing. In addition, the triceps is easily accessible to the measurer and poses minimal inconveniences to the subject.

Description of the Vegan Diet

The vegan diet followed by the Farm is as much a spiritual design as a material choice of foods. Farming, in Wisconsin and Tennessee which produces most of what the commune members eat, is an important reflection of a philosophical stance of simplicity and "voluntary peasantry".

The Farm diet is strictly vegetarian, or vegan, excluding all foods of animal origin. The main elements of the vegan diet are legumes, vegetables, fruits, nuts, and seeds. The vegan diet, as distinguished from a macrobiotic diet, relies heavily on alternative sources of protein.

A large variety of beans are consumed, soybeans in particular. Soy milk, soy cheese, and soy yogurt are made on the Farm. Soy milk is a principle source of protein for the young children on the Farm. Other beans frequently consumed are black beans, broad beans, kidney beans, garbanzo beans, navy beans, and pinto beans. Additional sources of protein are: wheat germ, rice, peanut butter, sunflower seeds, millet, sesame seeds and nutritional yeast. Combining proteins is a common practice on the Farm. Beans eaten with grains, nuts and seeds or grains combined with nutritional yeast are considered high protein dishes.

An array of vegetables, fruits, and nuts are also an integral part of their diet design. According to the Farm publication, Hey Beatnik spinach, asparagus, broccoli, cauliflower, corn, peas, potatoes, okra, and tomatoes are

regularly eaten. Almonds, cashews, pecans, and walnuts are used in cooking as well. Fruits, in season are available.

White flour, wheat flour, rice and white sugar are all commonly used. In summary, the Farm vegan diet is based largely on beans, especially soy beans and draws from a great variety of supplementary plant foods.

Diet Recall as a Nutritional Assessment Tool

A variety of diet assessment tools are available to the researcher and the dietitian. The format chosen to collect data and analyze diets is dependent on the type of assessment desired and the particular time and financial limitations of the study.

Burke (1947) lists a number of methods of studying food intake. Chemical estimates of the food consumed and the corresponding urinary and fecal outputs, known as balance studies, are one method. However, time and cost factors render this impractical in many instances. Weighing food eaten is another method usually requiring the subject be in controlled conditions. In addition, an aliquot sample of the food eaten can be analyzed for nutritional value. Diet records and diet recalls or histories are methods of securing information about foods eaten. An individual can record foods he or she has eaten over a period of time and studies can be made of average daily intakes.

Diet recalls or histories rely on the individual's recollection of foods eaten in the past, usually the recent

past. These can span various lengths anywhere from 24-hour to 7-day recalls up to and including 3-month and 6-month histories of food intakes. Burke (1947) and Beal (1967) agree that an accurate assessment of an individual's diet can best be drawn from a history based on at least a number of days. In this way, an average can be calculated rather than relying on the fact that the foods consumed in a one day period are representative of average daily intakes.

Many factors, including subjects' unwillingness to record food eaten for long periods of time, make lengthy diet histories impossible in some cases. Young, Chalmers, Church, Clayton, Tucker, Werts, and Foster_a (1952) report that diet histories often overestimate the intake as compared with the results of a 7-day record kept by the subject himself or herself.

In a comparison of dietary study methods, Young, Hagan, Tucker, and Foster_b (1952) found that a 24-hour diet recall did not give the same estimate of intake for an individual as the dietary history (p.219). However, it was further reported that the 24-hour recall is an acceptable method of estimating food intakes when used to obtain group mean scores as opposed to individual scores. In such cases, Young et al_b (1952) found that the dietary intake obtained from the 24-hour recall was in closer agreement with the 7-day record than with the results of a more lengthy dietary history. The manner in which information is secured from the individual is also a

factor in a dietary study.

Beal (1967) and Burke (1947) discuss a number of interview techniques and characteristics that can be manipulated in the interview process. Among the personal qualities of the interviewer thought to influence the outcome of the study are: tone of voice, suggestion of approval, powers of observation, and ability to give consideration to economic and social background of the subject. In addition, the ability to recognize cues for additional questions, being alert and inquiring, and having an accuracy for detail are influencing qualities. One of the more difficult challenges facing the interviewer is the need to separate his or her food preferences from the interview process. Allowing sufficient time is also a key ingredient of an effective interview. As Burke (1947) reports these qualities are of primary importance in gaining the confidence and cooperation of the subject (p.1042).

Studies Pertaining to Diet as It Effects Height, Weight, Head Circumference, and Triceps and Subscapular Skinfold Thickness In Children Birth Through Five Years of Age

One anthropometric study directly pertaining to a vegan diet in children birth to five has been conducted to date. Studies pertaining to various forms of vegetarianism such as lacto-ovo vegetarian are more numerous. Studies related to diet, especially protein and calorie intake, have been undertaken and a number of these are presented.

In a 1975 study by Trahms, Clements, and Worthington, weight, height, and head circumference were reported on subjects

following a vegetarian diet. Thirty pre-school children between one and six years who followed a lacto-ovo vegetarian diet were measured. The height of 27% of the children was between the 10th and 25th percentiles on standard Stuart charts. Values falling between the 25th and 75th percentiles were considered to reflect normal growth on standard Stuart charts. However, values above and below these percentiles were not necessarily indicative of subnormal growth. Forty percent were between the 25th and 50th percentiles. Regarding weight, 20% of the children fell between the third and 10th percentiles, 30% were between the 10th and 25th percentiles and 40% were evenly distributed between the 25th and 75th percentiles. Head circumference readings for all children were normal for age.

In a subsequent study by Trahms and Feeney (1975) growth, development, and dietary intake were assessed in 32 vegan, 32 vegetarian, and 32 non-vegetarian pre-school children between one year and 63 months of age. Height and weight were recorded for each subject. The findings indicated there was no significant difference in height and weight measurements, although the vegan children demonstrated a definite tendency to weigh less and be shorter. The diet assessment revealed that the vegan children consumed significantly less total protein, fat, calcium, and riboflavin than the other two groups. Trahms (1975) suggests that young children on vegan diets are especially at risk for nutritional deprivation.

Jelliffe (1966) reports that nutritional status spans a wide range from normal to mild and moderate degrees of malnutrition to severe protein-calorie deficiencies. Protein-calorie malnutrition (PCM) is a term used to cover a whole range of mild to severe problems including kwashiorkor and nutritional marasmus. Nutritional imbalance is the principle cause of protein-calorie malnutrition although psychological and cultural indices may be related as well.

Among the constant physical signs of kwashiorkor and nutritional marasmus is growth retardation and muscle wasting. In both syndromes weight is affected more than height. Body weight may fall as low as 60% of "standard" or below, while height may remain in the 90% of standard category.

Despite the level of severity, Jelliffe (1966) found the first clinical indication of protein-calorie malnutrition is growth failure as evidenced by a low body weight and substandard weight gain. Christakis (1972) and Keet (1970) found a significant correlation between weight, height-weight index, and skinfold thickness for age with the clinical signs of protein-calorie malnutrition.

Given the following considerations a number of studies on protein-calorie malnutrition are included: the documented need for relatively high levels of protein in early childhood, the effects that severe deficiencies cause in relation to growth, the large amounts of complete proteins found in foods of animal origin, the strict abstinence from animal products

in a vegan diet and the fact that protein requirements in a vegan diet are met only by consuming foods with complimentary protein composition.

For the past twenty-five years, public health teams have maintained an interest in protein-calorie malnutrition in underdeveloped countries where the incidence of kwashiorkor and nutritional marasmus is high. Within these populations, children are the most severely affected. In 1970, Keet et al. measured three groups of children for weight, height, head circumference, and triceps and subscapular skinfold thickness. These values were obtained from well children, those suffering from dehydrating gastroenteritis, and children suffering from severe protein-calorie malnutrition. The study took place in Capetown, South Africa.

The findings showed that the well children fell within the normal range for weight, height, and head circumference. On the other hand, the weights of children suffering from protein-calorie malnutrition usually were below the third percentile. Their heights and head circumference readings were also the lowest of the three groups. Values for those suffering from gastroenteritis fell between the other two groups. The majority of children diagnosed with protein-calorie malnutrition had skinfold readings below the third percentile. Comparable values for the well children were above the third percentile.

A study undertaken in Hyderabad City, India reported

similar findings. Visweswara Rao and Singh (1970) recorded the weight, height, and head circumference of 3100 pre-school children classified in one of two broad groups. One group was normal without signs of nutritional deficiency and the other had one or more signs of deficiency. The second group was further divided into those with signs of protein-calorie malnutrition and those with signs of Vitamin A or Vitamin B-complex deficiencies.

A comparison of the magnitude of differences in the average value of each measurement was taken. Interrelationships between measurements were estimated by computing correlation coefficients of all possible combinations of two measurements.

The findings indicate that measures of normal children and those with signs of vitamin deficiencies were similar whereas the measures between normal children and those suffering from protein-calorie malnutrition were significantly different. The most striking differences were found in weight, weight/height ratio, calf circumference and arm circumference. Height and head circumference were only slightly affected.

In a 1963 study, Puget, Downs and Budeir measured 324 Palestinian refugee infants between three months and 23 months of age. None of the infants were acutely ill or in need of immediate medical treatment. Measurements of weight and length were recorded and the results were compared with American standards.

Food rations of 1500 to 1600 calories a day were available

for all refugees over one year. Meat, dairy products, fresh fruit, and vegetables were not included in this ration and these foods were purchase. A survey of 5000 charts revealed that the average weight curve was satisfactory during the first five to six months of life when compared to Western standards. After this period many of the children did not maintain expected growth rates. By age two the average weight level was below the range considered optimal. Observations indicated that the earlier the child was weaned the slower was his or her gain in weight.

CHAPTER III

METHODS

Introduction

The purpose of this study was to compare five anthropometric measurements of children following a vegan diet with the same measurements of meat-eating children ages birth through five years. The five measurements were: height (or recumbent length in children under two years of age), weight, head circumference, triceps skinfold thickness, and subscapular skinfold thickness.

Subject Selection

The children practicing a vegan diet were all drawn from a spiritual commune, the Farm, located in Ettrick, Wisconsin. Initially, the researcher required that each subject have followed a vegan or traditional diet for at least one year or since birth. As it turned out, all subjects had followed their respective diets since birth.

The researcher was assured of the strict adherence to the vegan diet because it was an integral part of the philosophy of the commune. No adult or child was allowed to remain in the commune if he or she ate foods from animal sources.

The comparison group was randomly selected from a La Crosse clinic's (Gundersen Clinic) pediatric patients age five years and younger. Two methods of recruiting subjects were used. During the three days prior to the first measuring

session the researcher asked the guardian of children who entered the clinic for a previously scheduled appointment to participate with their child in the study. Approximately 1/3 of the subjects were recruited in this manner. The rest were asked to participate on the day of the measurements. The number in the comparison group equaled those in the vegan group. The term "traditional" was used to describe the diet of the comparison group. There were four groups altogether: male vegan, female vegan, male traditional, and female traditional.

No child who was following any form of vegetarianism was included in the comparison group. The comparison group was comprised of the same ratio of boys to girls as the research group. No exact age match was attempted between groups although all children were aged birth through five years. No patient was included in the comparison group who was ill at the time of the measuring. Furthermore, if the child had been in the hospital for any reason except birth, he or she was not considered eligible. A nurse practitioner was consulted about the health status of each participant. As a result all of the traditional subjects had originally visited the clinic for a routine check-up, a follow-up check on a previous health problem, or to receive an injection. Children with health problems causing any degree of current or recent weight loss were not asked to participate. The patients who agreed to participate prior to the study day were asked to return to the

clinic on the day scheduled for measuring. A thirty minute time allotment was scheduled for each subject.

Vegan and traditional subjects were measured on two separate occasions. Each session consisted of two consecutive days: one measuring vegan children and one measuring traditional children. During the first session vegan subjects were measured on the first day. During the second session traditional subjects were measured on the first day. Approximately three months intervened between the measuring sessions. However, all scores were combined into two groups: vegan subjects and traditional subjects. Although the number of males and females was not equal within each group, they were equal across groups.

Experimental Treatment or Procedures

The independent variable was the type of diet being followed. The research group followed a vegan diet; the comparison group included foods of animal origin in their diet.

The dependent variables were: the numerical values of five anthropometric measurements taken on each child in both diet groups; the statistical results of six intra-group correlations; and the statistical results of six inter-group correlations.

Development of Instrumentation

Five anthropometric measurements were taken on each

subject in both diet groups. These measurements were height (or recumbent length), weight, head circumference, triceps skinfold thickness, and subscapular skinfold thickness.

The study team was made up of four individuals: three measurers or assistants and one interviewer. The measurers conducted the anthropometric measurements and recorded the findings. The interviewer was solely involved in administering the 24-hour diet recall and the Diet History Questionnaire to the mothers of the subjects.

Each of the assistants consistently measured one of the variables in every child three times. One assistant measured height or recumbent length and weight. One measured head circumference. Both skinfold measurements were recorded by the same measurer. Three readings were noted and the mean of these was used for statistical purposes. All instruments and equipment used were carefully checked for accuracy prior to the study dates. The same instruments and equipment were used throughout the study.

Training

A one day training session for the three measurers was held one week prior to the first measuring session. As the interviewer was a dietetic student, she had been trained to administer diet history and information forms. Therefore, she did not attend the training session.

Ten children, male and female, age birth through five years participated. The measurers were given the opportunity

to practice working with the equipment, positioning the children properly, and recording anthropometric findings. An individual trained to conduct skinfold thickness tests was present to offer instruction on triceps and subscapular measurements. In addition, one team member was a nutritionist. As such, she was able to offer guidance regarding height (or recumbent length), weight and head circumference measurements. During this session, the measuring techniques to be used throughout the study were discussed and applied. Furthermore, specific duties were assigned to each team member.

One of the most important lessons learned through the training pertained to the handling of uncooperative and frightened children. A decision was made by the team members to separate the child from the mother before beginning the measurements. Exceptions were made in a few cases where children were extremely uncooperative. The time needed to conduct all five measurements three times each was noted to allow for scheduling at the Farm and at the clinic.

Height

Recumbent length was recorded in all subjects under two years of age. The subject was stretched out on a measuring board with the crown of the head touching the fixed headboard. One assistant held the head, another straightened the body while holding the knees to the board. The measurer brought a footboard up firmly against the soles of the child's feet to create a right angle at the ankle.

Children two years of age and older were measured for height on a vertical measuring device. A metal measuring tape was fixed to this surface. The child was asked to stand with his or her back to the board. Heels, buttocks, and shoulders were held against the vertical surface of the measuring device. The assistants helped the child to maintain this position while the measurer noted each reading. A block, squared at right angles against the board, was brought to the crown of the head. Between each of the three measurements the child stepped off the platform. Measurements were recorded to the nearest $\frac{1}{4}$ inch.

Weight

Subjects under two years of age were weighed on a baby scale with a balance beam. Just prior to the measurements, the subjects were clothed in disposable diapers and the weight of the garment was noted. In addition, when measuring infants, a diaper was placed on the scale to protect the child.

The subjects two years of age and older were weighed while standing on a physician's balance beam scale. The subjects, male and female, were clothed in a light cotton gown and the weight of the garment was noted. Measurements were recorded to the nearest ounce.

Head Circumference

In accordance with Christakis (1974), a metal tape was used to measure head circumference. Head circumference on

children under two years of age was taken while the child was lying on his or her back. The tape was passed around the fullest part of the occiput and brought around the lower forehead above the supraorbital ridges. The tape was pulled snugly. Two measurers assisted by positioning the tape above the top of the ears. In children two years of age and older the same procedure was followed while the child was standing or sitting. Measurements were recorded to the nearest $\frac{1}{4}$ inch.

Skinfold Thickness

Triceps and subscapular skinfold thickness measurements were taken on all subjects. A Lange caliper was used. The child was either standing or being held depending upon age. Both measurements were taken on the right side of the body.

The subject's right arm was placed in a relaxed position for the triceps measurement. According to DHEW Publication No. (HSM) 73-1602, the triceps measurement was taken on the posterior aspect of the upper arm midway between the elbow and the acromial process of the scapula (p.3). Prior to the skinfold reading a tape was used to mark the midpoint of the upper arm. Depending on age, the subject was standing or being held for the subscapular measurement as well. It was taken on the back immediately below the inferior angle of the scapula at a 45° angle to the spinal cord (p.3).

Brozek (1960), described the technique of measuring skinfold thickness in a publication, An Introduction to Physical Anthropology. The skin was lifted by grasping

firmly the fold between the thumb and the forefinger. The calipers were placed on the fold at the point nearest the base of the fold where the skin surfaces were approximately parallel to each other. Measurements were recorded to the nearest 0.5 mm. Readings for each subject for all five anthropometric measurements are found in Appendix A.

Diet History Questionnaire and 24-Hour Diet Recall

While the measurers were recording the findings of five anthropometric measurements, the interviewer was speaking with the mother of the subject. A Diet History Questionnaire and a 24-hour diet recall were administered to each mother by this individual. To aid in the diet recall process, the interviewer used empty containers to suggest various food portion sizes. The interviewer asked the mother to recall everything her child ate and drank for the 24-hour period preceding the measuring day. Everything eaten at home or away from home was included. All information forms used in this study appear in Appendix B.

Statistical Treatment of Data

A one-way analysis of covariance was calculated on the numerical results of five anthropometric measurements at a .05 level of significance. The subjects were not matched for age although all of them were age birth through five years. The analysis of covariance was chosen in order to remove the affect of age on the findings. Therefore, age was the

covariate. This made it possible to interpret statistically significant findings as a reflection of variables other than age differences between subjects.

The analysis of covariance provided three different comparisons: vegan subjects vs. traditional subjects, all males (from both diet groups) vs. all females, and an interaction variable of diet and sex together. An example of an interaction comparison was female vegan vs. male traditional subjects.

A Pearson Product-Moment Correlation was carried out on the following six intra-group correlations: weight/triceps, weight/subscapular, weight/height, triceps/subscapular, height/triceps, and height/subscapular. These correlations were carried out on the following groups: male vegan, female vegan, male traditional, and female traditional. A Pearson Product-Moment Correlation was chosen due to the fact that the anthropometric data was interval.

A Fisher's Zf Transformation was then calculated to determine inter-group significance between the independent r's. Each of the above six correlations was conducted in the following manner: male vegan vs. male traditional and female vegan vs. female traditional.

CHAPTER IV

RESULTS AND DISCUSSION

Statistical results of the analysis of covariance, the Pearson Product-Moment Correlation, and the Fisher's Zf Transformation are presented in this chapter. In addition, mean scores for each of the five measurements for every age group were calculated. Information gathered via the 24-hour diet recall is tabulated and discussed along with the results of the Diet History Questionnaire both of which were administered to the mothers of the subjects. In order to provide supplementary information, the two group's scores for weight for age, height for age and weight for height are discussed in relation to 1976 standards compiled by the National Center for Health Statistics. Graphs depicting these findings are in Appendix C.

The independent variable, diet, had two levels: vegan and traditional. Vegan subjects were drawn strictly from the Farm and consumed no animal protein. Traditional was a term used to describe the subjects who consumed foods of animal origin such as eggs, milk, cheese and meat. All subjects had followed their respective diets since birth. The dependent variable was the results of the five anthropometric measurements.

Data for the analysis of covariance and the Pearson

Product-Moment Correlation was entered by diet group and sex. The groups were: male vegan, female vegan, male traditional, and female traditional. Age for each subject was entered by year and month for each child. For instance, 3.5 would signify a child who was three years and five months old on the day of the measuring. Two measuring sessions were held with three months intervening. Both vegan and traditional subjects were measured at each. Results from both sessions were combined in each diet category and no distinctions were made in any calculations.

The independent r 's were used to calculate the Fisher's Z_f Transformation Test.

Analysis of Covariance

The analysis of covariance was calculated on each of the five measurements: height, weight, head circumference, triceps, and subscapular skinfold. Age was the covariate in each instance. Fourteen of the fifteen resulting f values were not significant at the $p \leq .05$ level (see Table 2). Thus, all of the major null hypotheses in Group I were accepted. It should be noted that, although not stated as a hypothesis, the triceps skinfold was significantly different between male and female subjects, irrespective of diet.

The fourteen insignificant f values indicate that these two groups, vegan and traditional, do not significantly differ in five specified body measurements. It is not a statement of nutritional status but rather one of comparison.

Table 2

Analysis of Covariance Computed F Values (Using Age as a Covariate)
for Five Anthropometric Measurements of Vegan and Traditional Children
Age Birth Through Five Years

D E P E N D E N T V A R I A B L E S

COMPARISON GROUPS	HEIGHT	WEIGHT	HEAD CIRCUMFERENCE	TRICEPS SKINFOLD	SUBSCAPULAR SKINFOLD
A Vegan vs. Traditional	1.42	0.59	1.26	0.11	2.02
B Boys vs. Girls	0.10	0.75	1.52	5.02*	1.77
AB Interaction of Diet and Sex	1.73	0.49	0.10	0.01	0.00

*Significant at $p \leq .05$

In other words, the net effect of all the dietary, sociological, environmental, hereditary, emotional, and psychological factors that were affecting the subjects in both groups did not cause a significant difference in anthropometric findings. Thus, in this study, diet did not appear to have a significant impact. No assumptions were drawn about the general health and well being of the subjects. Nor was it appropriate to apply these results to all individuals who follow a vegan or a traditional diet. It must be stressed that these results pertain to the subjects measured.

The difference found in the triceps skinfold between males and females might be explained by physiologic and methodologic factors influencing growth and the statistical results. Natural physiological distinctions in male and female development may explain the difference in their scores. Watson (1952) and Tanner (1963) both report that the growth associated with adolescence occurs at widely varying chronological ages. In this regard, diet may be viewed as having little or no influence on lessening the distinctions between sexes. It is an accepted physiological phenomenon that men, generally speaking, are taller and weigh more than women. Females, on the other hand, are known to have greater percentages of body fat than men. From a review of the mean scores, it is apparent that in this study, the female subjects had greater triceps skinfold readings than the males. Jelliffe (1966) reports that sex differences in skinfolds

occur throughout life with skinfolds greater in females from birth onwards (p.75).

A methodological explanation was considered regarding the relatively high probability of turning up one significant f value out of a possible fifteen being tested. Hays (1963) reports that as the number of different tests increases, the likelihood of one being spuriously significant also increases. In view of this, it is important to interpret the one significant finding in relation to the fact that fourteen were not.

Pearson Product-Moment Correlation

A Pearson Product-Moment Correlation was carried out on six intra-group relationships among the measurements: weight/triceps, weight/subscapular, weight/height, triceps/subscapular, height/triceps, and height/subscapular. Of these, the correlation between weight and height and triceps and subscapular were found to be significant at the $p \leq .05$ level. These correlations were significant for males and females in both diet groups. Furthermore, in all but one case (vegan females) the correlations were significant at $p \leq .01$ as well (see Table 3). Thus, eight of the null hypotheses in Group II were not accepted.

These correlations indicate that as height increased so did weight. Similarly, as triceps skinfold increased or decreased so did subscapular skinfold. These two correlations reflect well known relationships between linear growth and

Table 3

Pearson Product-Moment Correlation Coefficients
for Six Correlations on Vegan and Traditional Children
Age Birth Through Five Years

VARIABLES CORRELATED	WEIGHT				TRICEPS				SUBSCAPULAR			
	V:M*	V:F	T:M	T:F	V:M	V:F	T:M	T:F	V:M	V:F	T:M	T:F
TRICEPS	-.10	.38	-.05	.31								
SUBSCAPULAR	-.10	.19	-.10	-.02	.85 ***	.61 **	.65 ***	.79 ***				
HEIGHT	.98 ***	.99 ***	.95 ***	.99 ***	-.20	.25	-.26	.28	-.24	.11	-.33	-.08

*V:M= Vegan Male; V:F= Vegan Female; T:M= Traditional Male

T:F= Traditional Female

**Significant at $p \leq .05$

***Significant at $p \leq .01$

weight gain and one subcutaneous fat measurement and another on the same subject, particularly subscapular and triceps. As reported in the findings of Damon and Goldman (1964) triceps and subscapular are both considered accurate indices of body fat.

Fisher's Zf Transformation Test

A Fisher's Zf Transformation test was calculated on the same six relationships: weight/triceps, weight/subscapular, weight/height, triceps/subscapular, height/triceps, and height/subscapular. These were carried out on an inter-group basis between diet groups by sex. None of the resulting z values were significant at $p \leq .05$ (see Table 4). Thus, all of the null hypotheses in Group III were accepted. This indicated that the intra-group correlations between anthropometric measurements were not significantly different when compared across groups.

Mean Scores

To analyze mean scores and diet recalls the subjects were divided into groups according to age and sex. Each group had an average age within two months of the group with which it was being compared. For instance, male vegans between one and three (see Tables 5, 6, and 7) had an average age of one year and ten months or 1.10. Male traditional subjects between one and three had an average age of 1.8. Certain subjects were not included in these calculations.

Table 4

Fisher's Zf Transformation Computed z Values Between Coefficients
for Six Correlations on Vegan and Traditional Children
Age Birth Through Five Years*

VARIABLES CORRELATED	WEIGHT		TRICEPS		SUBSCAPULAR	
	Vegan Male vs Trad Male	Vegan Female vs Trad Female	Vegan Male vs Trad Male	Vegan Female vs Trad Female	Vegan Male vs Trad Male	Vegan Female vs Trad Female
TRICEPS	-.1126	.16758				
SUBSCAPULAR	0	.44972	1.12805	-.76791		
HEIGHT	1.09287	0	.14774	-.0700	.22983	.40305

* No Pair-wise Sex Differences in Level of Correlations Were Found to be Significant at $p \leq .05$

Table 5

Mean Scores for Five Anthropometric Measurements
for Vegan and Traditional Children:
Age Range 1-5 Years

Anthropometric Measurements	Male & Female Vegan (2.11)* 1-5**	Male & Female Trad (2.10) 1-5	Male Vegan (2.11) 1-5	Male Trad (3) 1-5	Female Vegan (2.11) 1-5	Female Trad (2.11) 1-5
Height (cm)	89.1	93.1	88.6	95.3	90.5	93.3
Weight (kg)	13.4	14.3	13.5	14.6	13.8	14.5
Head Circumference (cm)	49.3	49.1	49.3	49.9	49.3	48.9
Triceps Skinfold (mm)	12.5	12.3	11.2	11	13.4	13.6
Subscapular Skinfold (mm)	7.5	6.7	7	6.2	7.6	7

* Groups Average Age

** Age Range

Table 6

Mean Scores for Five Anthropometric Measurements
for Vegan and Traditional Children:
Age Range 1-3 Years

Anthropometric Measurements	Male & Female Vegan (1.9)* 1-3**	Male & Female Trad (1.8) 1-3	Male Vegan (1.10) 1-3	Male Trad (1.8) 1-3	Female Vegan (1.8) 1-3	Female Trad (1.7) 1-3
Height (cm)	80.2	83.7	80.4	86.2	79.7	81.3
Weight (kg)	11	12.1	11.2	13.1	10.6	11.1
Head Circumference (cm)	47.8	47.7	48.1	48.5	47.3	47
Triceps Skinfold (mm)	12.2	13.3	11.8	12.1	12.9	14.5
Subscapular Skinfold (mm)	7.8	7.9	7.7	7.3	7.9	8.4

* Groups Average Age

** Age Range

Table 7

Mean Scores for Five Anthropometric Measurements
for Vegan and Traditional Children:
Age Range 3-5 Years

Anthropometric Measurements	Male & Female Vegan (4.6)* 3-5**	Male & Female Trad (4.4) 3-5	Male Vegan (4.7) 3-5	Male Trad (4.6) 3-5	Female Vegan (4.3) 3-5	Female Trad (4.2) 3-5
Height (cm)	101.1	104.9	100.4	106.7	99.8	103
Weight (kg)	16.6	16.7	16.2	16.5	16.6	16.9
Head Circumference (cm)	51.1	50.8	51.6	51.6	50.8	50.1
Triceps Skinfold (mm)	12.4	11.1	10.7	9.5	13.9	12.7
Subscapular Skinfold (mm)	7	5.3	6	4.8	7.9	5.9

* Groups Average Age

** Age Range

For instance, when two groups being compared had average ages that were more than 2 months apart, one of the youngest or one of the oldest subjects was removed from one or both groups. This brought the averages within reasonable range for comparison purposes. No more than one subject was excluded from any one group. Furthermore, being excluded from one group did not necessitate being excluded from another. If a subject had been removed from the one to three age group, he or she could still be included in the one to five age group.

Mean scores for infants, birth to one year, were not calculated due to several factors. Growth and development in the first twelve months of life is fairly rapid and would require several age breakdowns for comparison purposes. The relatively small number of infant subjects measured would result in mean scores being derived from as few as two to three subjects. The researcher felt this would jeopardize the reliability of the resulting scores. However, the infants' measurements were included in the analysis of covariance where age was the covariate.

The comparison groups were:

Male and Female Vegan vs. Male and Female Traditional	1-5
Male Vegan vs. Male Traditional	1-5
Female Vegan vs. Female Traditional	1-5
Male and Female Vegan vs. Male and Female Traditional	1-3
Male Vegan vs. Male Traditional	1-3
Female Vegan vs. Female Traditional	1-3
Male and Female Vegan vs. Male and Female Traditional	3-5
Male Vegan vs. Male Traditional	3-5
Female Vegan vs. Female Traditional	3-5

There were 45 possible mean score comparisons between

vegan and traditional subjects (see Tables 5, 6, and 7). Of these, mean scores for the traditional group were larger in 26 cases; vegan scores were larger in 18 cases; and there was one tie. In general, however, the scores were relatively close and no major distinctions seemed obvious.

A further breakdown showed that in age range 1-3, traditional scores were larger in 12 cases as compared with three vegan scores. In age range 3-5, six traditional scores were larger as compared with eight vegan scores and one tie. Finally, eight traditional scores were larger as compared to seven vegan scores in the 1-5 age range.

In all comparisons the traditional subjects had larger mean scores for height and weight than the vegan subjects. In regard to height, the traditional subjects exceeded the vegan subjects by an average of 4.5 cm (age group 1-5); 3.6 cm (age group 1-3); and 4.4 cm (age group 3-5). Weight scores for the traditional subjects exceeded the vegan scores by an average of .9 kg (age group 1-5); 1.2 kg (age group 1-3); and .3 kg (age group 3-5).

On the other hand, a larger number of vegan mean scores for head circumference, triceps skinfold, and subscapular skinfold exceeded those of traditional subjects (see Tables 5, 6, and 7). For instance, of the possible nine comparisons for head circumference mean scores, six vegan scores exceeded traditional scores as compared with two traditional and one tie. Five vegan triceps mean scores were larger as compared to four

traditional. Lastly, seven vegan subscapular scores exceeded traditional scores leaving two traditional scores larger.

Although vegan and traditional mean scores vary by age group and measurement, it must be noted that the statistical test of significance revealed no significant differences between diet groups for any of the five body measurements. Nonetheless, it is important to recognize that in all diet/sex groups compared, the vegan subjects weighed less and were shorter than the traditional subjects. On the other hand, the vegan subjects showed a tendency to have greater head circumference and triceps and subscapular skinfold readings as compared to their traditional counterparts. In summary, although observable distinctions can be drawn between diet groups regarding mean anthropometric scores, it must be concluded that no major differences exist between the two groups.

Diet Recalls

The same age and sex groupings were used for the analysis of diet recalls. However, since there were only two factors discussed, namely calories and protein, there are 18 comparisons (see Table 8). Average intakes were not calculated for infants birth to one year of age. All of the vegan children under one year were breast fed at the time of the diet recall. Due to the unavailability of food values related to breast milk of vegan mothers, the researcher did not include these diet equivalents.

Table 8

Average Group Intakes of Calories and Protein Based on
24-Hour Diet Recall by Age Group for
Vegan and Traditional Children
Age Birth Through Five Years

DIET AND SEX GROUPINGS	GROUPS AVERAGE AGE	AGE RANGE	CALORIES	PROTEIN (grams)
Male & Female Vegan	(2.11)	1-5	2286	82.3
Male & Female Trad	(2.10)	1-5	1775	75.0
Male Vegan	(2.11)	1-5	2324	85.8
Male Trad	(3.00)	1-5	1822	77.2
Female Vegan	(2.11)	1-5	2271	76.8
Female Trad	(2.11)	1-5	1831	77.0
Male & Female Vegan	(1.9)	1-3	2211	86.1
Male & Female Trad	(1.8)	1-3	1749	63.3
Male Vegan	(1.10)	1-3	2433	96.7
Male Trad	(1.8)	1-3	1869	59.5
Female Vegan	(1.8)	1-3	1823	67.6
Female Trad	(1.7)	1-3	1630	67.1
Male & Female Vegan	(4.6)	3-5	2254	75.2
Male & Female Trad	(4.4)	3-5	2046	78.9
Male Vegan	(4.7)	3-5	1886	59.1
Male Trad	(4.6)	3-5	2242	78.4
Female Vegan	(4.3)	3-5	2334	80.8
Female Trad	(4.2)	3-5	1850	79.4

In 14 of the 18 comparisons, the vegan scores were larger than the traditional. With the exception of males age 3-5, the vegans consumed more calories than the traditional subjects by an average of 408 calories. Regarding protein intakes, in six of the nine comparisons the vegans consumed greater amounts of protein than their traditional counterparts by an average of 9.6 grams.

The higher calorie and protein intakes for traditional males age 3-5 was attributed, in part, to the comparatively large intake of one traditional subject in particular who consumed 3949 calories and 116.7 grams of protein. The remaining traditional subjects in this age group consumed an average 1673 calories and 65.3 grams of protein. Thus, the average intakes for traditional males age 3-5 were skewed by one subject's diet for that 24-hour period. When this subject's scores were excluded the average was reduced and brought within closer range of the vegan scores.

In general, the higher calorie intake of vegan subjects was attributed to certain foods in their diet. For instance, soymilk, a high calorie high protein food, was consumed by the majority of the children. Anywhere from one to six cups were consumed daily. Other high calorie foods in their diet include: soybeans, kidney beans, fried potatoes, and peanut butter. These foods are also principle sources of protein. The addition of sugar to many of their foods, especially soymilk, raised the calorie content.

The possibility of a certain degree of inaccuracy in reporting needs to be mentioned as well. It is an accepted phenomenon that 24-hour diet recalls often give a somewhat erroneous picture of daily food intakes. This held true for both groups and can lead to over and underestimates.

Although calorie intakes were higher for vegans than for traditional subjects, the reverse was true for weight measurements. Several factors should be considered by way of possible explanation for this discrepancy. The vegan subjects may have engaged in a greater amount of exercise than the traditional subjects. The dwellings and support buildings on the Farm are spread out over approximately $\frac{1}{2}$ mile. The children walk or run between the buildings especially during spring, summer and fall months. Travel by car is limited. Watching television is not a focal activity, although a number of the dwellings have one. For the most part, the children are encouraged to keep busy playing with one another outdoors or in the game room.

The fact that meals are prepared communally at the Farm may also be a factor. Foods recorded during the recall were similar among the vegan children. However, the amounts varied according to age. Had the vegan children been living in separate households, their diets may have reflected a greater variety of vegetarian designs and food choices. In this regard, the traditional group differed in that they were drawn from separate households.

Diet History Questionnaire

The average age of the vegan mothers was 26.2 years compared to 27.5 years for the traditional mothers. The vegan mothers were also younger at the birth of the child, 23.6 years as compared with 25.3 years for the traditional mothers. Three vegan mothers reported having a child under 5½ lbs at birth. Two traditional mothers reported the same.

All of the vegan mothers with children under one year of age were breast feeding their infants at the time of the study as compared to 25% of the traditional mothers. Seventy-five percent of the vegan mothers with children one year and older breast fed their children during infancy as compared to 30% of the traditional mothers. Another 20% of these vegan mothers combined breast and bottle feeding. Furthermore, the vegan women breast fed their children for longer periods of time than the traditional mothers.

Approximately the same percentage of children in both groups (20% vegan, 19% traditional) were receiving supplemental vitamins and iron at the time of the survey. Sixty-seven percent of the vegan mothers with children one year or older gave their children vitamins and iron when they were infants as compared to 57% of the traditional mothers.

During pregnancy, 96% of the vegan mothers took vitamins and iron as compared to 58% of the traditional mothers. Twenty-six percent of the traditional mothers took only iron

during pregnancy and 4% of the vegan mothers took only vitamins. Twelve percent of the traditional mothers took neither vitamins nor iron.

The length of time vitamins or iron were consumed during pregnancy varied as well. Eighty percent of the vegan mothers took vitamins and iron during the entire term of their pregnancy, as compared to 50% of the traditional mothers. Thirty-four percent of the traditional mothers took vitamins and iron for 6-9 months of their pregnancy as compared to 12% of the vegan mothers. The remainder took supplements for less than six months of the term.

All of the traditional mothers and their children consumed foods of animal origin since birth. Similarly, all of the mothers of the vegan children were vegans themselves. Forty-four percent had followed a vegan diet for less than five years and 56% for more than five years. All of the vegan children had followed their diet since birth.

National Center for Health Statistics Growth Chart Comparison

Anthropometric values for vegan and traditional subjects were plotted against National Center for Health Statistics Growth Charts (1976)(see Appendix C). As stated in Dietetic Currents (1976), these percentile curves are based on large, nationally representative samples of children and reflect a broad consensus of experts in physical growth, pediatrics, and clinical nutrition (p.1).

Vegan and traditional scores appear by sex in two age

groups (0-36 months and 2 through 18 years) in the following categories: weight by age, height (or length) by age, and weight by height. Head circumference values were not plotted. NCHS growth charts represent children three years and younger only. A possible explanation for this is the fact that neurological development is seen as a process largely confined to infancy and the second year of life. However, vegan and traditional head circumference values were gathered for infants and for subjects who were over three years of age. As a result, none of the subjects' scores were plotted. National standards for triceps and subscapular skinfold were not readily available. Thus, these are not included either.

Plotting vegan and traditional subjects on NCHS graphs indicated where each child ranked relative to all contemporary United States children of the same age and sex. Thus, if a five year old boy was at the 10th percentile for weight and height then he is smaller than 90 out of every 100 United States boys his age.

The National Center for Health Statistics suggests that "normal" growth is represented between the 25th and 75th percentiles. Measurements between the 10th and 25th and the 75th and 90th may or may not be normal, depending on previous and subsequent measurements and on genetic and environmental factors affecting the child. Measurements above the 90th and below the 10th percentiles ordinarily deserve priority for checking, referral and follow-up.

Vegan and traditional scores from the 25th, 50th and up to the 75th percentiles were grouped into one category, 25th to 74th (see Table 9). In addition, percentile categories were included for scores falling below the 5th percentile and above the 95th. Male and female scores are presented separately. Table 9 was compiled from the growth chart rankings of three body measurements, thus each subject is represented three times.

Fifty-nine percent of the vegan male scores were plotted in the 25th-74th category as compared to 48% of the traditional males. Sixteen percent of both the vegan and traditional scores fell between the 10th and 24th percentiles. A total of 17% of the vegan males were plotted in or below the 9th percentile, with 10% below the 5th. On the other hand, 8% of the traditional scores were in the same category with no scores falling below the 5th.

A fairly distinct difference was found in scores plotted between the 75th and 89th percentiles (5% vegan males, 23% traditional males). Two percent of the vegan males fell above the 90th percentile as compared to 10% of the traditional males, with 5% of these above the 95th.

It appears the greatest distinctions between males in both diet groups is at the two extremes, below the 10th and above the 90th percentiles. The traditional males have a greater percentage (10%) above the 90th with very few (2%) below the 10th, while the reverse is true for the vegans (17%

Table 9

National Center for Health Statistics Growth Chart Percentile Distribution for
Vegan and Traditional Children, Male and Female, Age Birth Through Five Years:
Weight for Age, Height for Age, and Weight for Height

PERCENTILES	VEGAN				TRADITIONAL			
	MALE		FEMALE		MALE		FEMALE	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent
< 5th	4	10%	1	3%	0	0%	0	0%
5-9th	3	7%	3	8%	1	2%	3	8%
10-24th	7	16%	3	8%	7	16%	3	8%
25-74th	25	59%	16	44%	20	48%	18	50%
75-89th	2	5%	11	31%	10	23%	6	17%
90-95th	0	0%	2	6%	2	5%	3	8%
> 95th	1	2%	0	0%	2	5%	3	8%
TOTALS	42	99%	36	100%	42	99%	36	99%

below the 10th and 2% above the 90th percentiles).

A similar trend appears in the female scores. A comparable percentage (44% vegan females, 50% traditional females) fall within the 25th to 74th percentile category. Eight percent of the scores in both groups were plotted between the 10th to 24th percentiles.

Thirty-one percent of the vegan females as compared to 17% of the traditional females were plotted between the 75th and 89th percentiles.

A total of 11% of the vegan females fell in or below the 9th percentile, with 3% below the 5th as compared to a total of 8% for the traditional females. Sixteen percent of the female traditional scores were plotted above the 90th, 8% of these above the 95th, as compared to 6% of the vegan females.

In summary, the greatest percentage in both diet groups fell in the 25th to 74th percentile category representing "normal" growth. The greatest differences between groups are the scores plotted above the 89th and below the 9th percentiles. For males and females both, the vegans have a greater number of scores falling in or below the 9th percentile than the traditional subjects (eleven vegan scores, four traditional scores). The reverse holds true above the 89th percentile where traditional scores outnumber vegan scores (ten traditional, three vegan scores).

This comparison was not intended to provide causal/correlation analysis. It was designed to be descriptive. Rankings

of vegans and traditional subjects in relation to national standards are included solely as backdrop information. A more in-depth assessment, including biochemical and clinical appraisals, would make a sound nutritional evaluation of these rankings possible. It is of interest, however, to note that a greater percentage of vegan scores are below the 9th percentile when compared to traditional scores. In addition, traditional scores appear more frequently above the 89th percentile than do vegan scores.

CHAPTER V

SUMMARY, FINDINGS, CONCLUSIONS, AND RECOMMENDATIONS

Summary

An anthropometric study of children following two different diets was undertaken. The 26 subjects in each diet group were aged birth through five years. Both groups were composed of 14 males and 12 females for a total of 28 males and 24 females. Vegan and traditional were terms used to describe the two diets. Vegan subjects did not eat foods of animal origin (i.e. cow's milk, eggs, cheese, meat). Traditional subjects did consume foods of animal origin. A Diet History Questionnaire, administered to the mothers of the subjects, revealed that all of the children had been following their respective diets since birth.

Height (or recumbent length), weight, head circumference, triceps skinfold, and subscapular skinfold measurements were taken on each subject. The mean score of three readings was used for statistical purposes. An analysis of covariance was calculated on each measurement using age as the covariate. The data was entered by diet group and sex in the following manner: male vegan, female vegan, male traditional, female traditional. A Pearson Product-Moment Correlation was carried out on six intra-group relationships among the measurements: weight/triceps, weight/subscapular, weight/height,

triceps/subscapular, height/triceps, and height/subscapular. In addition, a Fisher's Zf Transformation test was calculated to determine inter-group significance between correlation coefficients for the above six relationships.

Findings

No statistically significant difference was found in any of the five body measurements between subjects in the two diet groups at $p \leq .05$. Thus, all of the null hypotheses in Group I were accepted. However, the analysis of covariance did include a test of significance between males and females, irrespective of diet. Although not stated as a hypothesis, triceps skinfold values were found to be significantly different between boys and girls measured at $p \leq .05$.

Two intra-group correlations were found to be significant at $p \leq .05$. These were weight/height and triceps/subscapular. Both of these were significant in all four diet and sex groups. As a result, 8 null hypotheses in Group II were rejected.

No inter-group correlations were significant at $p \leq .05$. Thus, all of the null hypotheses in Group III were accepted.

Conclusions

Although an understanding of these two group's nutritional adequacy was not a by-product of this study, it was apparent that the subjects did not differ significantly in 5 specific body measurements. This lack of significance cannot be

wholly attributed to a comparable level of nutritional adequacy between the two groups. From a more inclusive standpoint, the lack of significance suggests no major dietary, sociological, environmental, hereditary, emotional or psychological influences have produced results that cause anthropometric indicators to vary significantly between groups. Furthermore, since diet was a factor that did distinguish the two groups, it was concluded that diet was not causing the groups to differ significantly. This conclusion was applicable exclusively at this point in the children's growth and development. It was not within the purvue of this study to extend these findings to other groups of children following a vegan or traditional diet.

Two possible conclusions were drawn about the significant difference in triceps skinfold values between males and females irrespective of diet. Physiologically, this finding may reflect naturally occurring differences between the sexes with females having a greater percentage of body fat than males. In this study, the larger female triceps group mean scores would support this conclusion. From a methodological standpoint, it could be concluded that this one f value was spuriously significant. This is based on the fact that as the number of f values being tested increases so does the likelihood of one being spuriously significant.

The two intra-group correlations found to be significant not only support well-known relationships between height and

weight and subscapular and triceps but also affirm the consistency of the measuring techniques employed.

The fact that no inter-group correlations were found to be significant suggests that the relationships between measurements were fairly similar between the diet groups.

Subjects in both diet groups were consuming well above recommended amounts of calories and protein as defined by the National Research Council's Recommended Daily Dietary Allowances (see Table 1, p.18). In 14 of the 18 diet/sex group comparisons, the vegans consumed more calories and more protein than their traditional counterparts. It was concluded from the 24-hour diet recall that calorie and protein requirements were being met satisfactorily by both diets. However, no conclusions can be drawn about the vitamin, mineral or fat content of either diet. As such the nutritional assessment is limited.

Recommendations

Additional insight regarding the adequacy of vegetarian diets, vegan in particular, could be gained through conducting longitudinal studies. Anthropometric studies of the same group of vegan subjects extending from birth, infancy, childhood, puberty, adolescence, and through adulthood would provide growth rates at many stages of development. Recording anthropometric findings at three month, six month, and one year or longer intervals would produce reliable anthropometric data on which to base dietary assessment. These findings could be

compared to non-vegan children and a more definitive conclusion might be reached about the adequacy of vegetarian diets. It would become important to evaluate American standards which are based on the growth of persons consuming animal foods. Anthropometric standards for countries where animal foods are not regularly available could be used as a supplementary index of comparison.

A discussion of the relationship between American standards for growth and desired levels of health might be helpful in placing American standards in perspective. Generally speaking, Americans have made use of a great variety of animal foods. To some extent, growth rates reflect these diet choices. Drawing from a variety of lifestyle and diet choices in forming a concept of optimum health would enable researchers to combine the best from all cultures and societies. Therefore, it is appropriate to recognize that the American diet may not prove to be a standard in its effects on growth and development. Furthermore, it may release from attention the notion that increased body size reflects greater levels of health (i.e. the tall child as a model of exemplary health).

A larger sample size ($n > 30$ for males and females) would render the results more representative. Vegetarianism is still a fairly unique diet choice in the United States. Vegans are even more rare. It might be difficult, therefore, to gather large numbers of children. However, a larger group

of subjects would ensure that the statistical findings were applicable in a broader scope than this study. It would also be preferable to choose subjects from separate households representing a cross section of vegetarianism. The anthropometric findings would then reflect the effects of the diet when practiced in a variety of circumstances. Matching for age might also be considered.

The homogeneity of the subjects in terms of their diet planning may have affected the outcome of this study. The Farm members comprise a group that is aware of nutritional planning skills perhaps more so than other vegetarians. This has yet to be explored. In addition, further research could address the subjects' exposure to sunlight and level of exercise as factors influencing growth.

A more thorough combination of nutritional indicators could be employed in future studies. As a supplement to anthropometric findings, laboratory analysis of urine and blood samples, clinical appraisals of general vitality, review of health records, and more extensive diet recalls would provide a firm basis for nutritional assessment.

A principle recommendation emerging from this study pertains to education. The findings of this study and others have indicated that growth is sustained under a vegetarian diet. Information pertaining to the creative and healthful use of vegetables, legumes, fruits, and nuts is key to a broader understanding of diet alternatives. This is especially

true in the United States where protein is primarily derived from animal foods.

Educational efforts through school systems, medical groups, and people interested in food alternatives would enable more individuals to evaluate and redesign present food choices. Nutritional information including diet alternatives could be made available through health-related courses in the school system. A theme of this educational experience might be that awareness of food choices and diet alternatives are personal decisions based on factual information and, broadly speaking, sociological influences.

Factual information regarding nutritional needs and food values could be designed and presented at grammar school levels. Values clarification regarding diet would begin in junior high school and continue through senior high school.

In community interaction nutritionists and dietitians could continue to foster a clearer understanding and appreciation for diet alternatives through open-minded counseling.

Education may also be helpful in promoting a more sensitive appreciation of foods and their preparation and influence on the whole person. Food choices might become a more significant reflection of the individual's perspective on himself or herself and one's total health.

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APPENDIX A

Table 10

Anthropometric Readings for Height (or recumbent length), Weight,
Head Circumference, Triceps Skinfold, and Subscapular Skinfold:
Male Vegans Age Birth Through Five

AGE OF SUBJECT	HEIGHT (or recumbent length) cm	WEIGHT kg	HEAD CIRCUMFERENCE cm	TRICEPS SKINFOLD mm	SUBSCAPULAR SKINFOLD mm
1.10*	79.4	12.8	47.4	16.7	13.3
1.1	68.6	8.5	45.1	9.7	7
2.11	88.9	12.7	47	8	5.7
4.6	101.6	15.9	51.2	11	6
1.7	83.2	11.3	51.2	15	7.7
.3	57.4	5.8	89.5	13.7	8.7
.1	52.3	4	34.9	10.3	5
1.4	76.8	10.6	48.9	11	7.7
5.9	110.9	18.1	51.2	9	5
3.11	97.2	15.9	51.4	11.7	7.3
2.10	87.6	13.2	49.5	12	7.3
5.3	102.4	16.8	52.1	9.3	4.7
.3	58.2	5.4	40.6	10.3	7
1.2	78.3	9	47.6	10.3	5.3

*1.10 signifies one year and ten months

Table 11

Anthropometric Readings for Height (or recumbent length), Weight,
Head Circumference, Triceps Skinfold, and Subscapular Skinfold:
Female Vegans Age Birth Through Five

AGE OF SUBJECT	HEIGHT (or recumbent length) cm	WEIGHT kg	HEAD CIRCUMFERENCE cm	TRICEPS SKINFOLD mm	SUBSCAPULAR SKINFOLD mm
5.6*	103.5	17.7	50.2	14.7	9.7
1.8	81.3	11.8	48.9	14	9
4.11	109.2	17.7	51.6	8.7	4.7
1.6	78.7	10.8	47.4	15.3	7.7
3.6	97.8	16.3	48.9	12.3	6.7
3.3	96.5	16	51.4	16.3	13
.3	62.2	6	40	10	7
2.6	85.9	11.3	49.7	10.3	6.7
4.11	101.6	17.2	50.8	16.3	7
3.3	90.4	14.7	51.9	15	6
1	73	8.6	43.2	12	8
.10	69.6	7.5	44.2	11.3	5.3

*5.6 signifies five years and six months

Table 12

Anthropometric Readings for Height (or recumbent length), Weight,
Head Circumference, Triceps Skinfold, and Subscapular Skinfold:
Male Traditional Age Birth Through Five Years

AGE OF SUBJECT	HEIGHT (or recumbent length) cm	WEIGHT kg	HEAD CIRCUMFERENCE cm	TRICEPS SKINFOLD mm	SUBSCAPULAR SKINFOLD mm
3.6*	102.2	14.5	50.8	10	4
.6	68.2	7.4	44.5	11	5.7
4.4	104.8	15.4	51.4	9	5
1.11	87.6	12.3	46.8	8	5.3
2.9	91.4	13.6	49.5	10	6
.1	56.7	4.9	39.2	8.3	7
.9	70.7	8.2	46.6	10.3	7
4.9	108.6	16.3	51.4	9	4
.9	67.9	8.8	43.8	14.7	5.3
1.10	88.7	13.4	50	15.3	7.7
1	80.2	13.9	47.4	17.3	11.3
.6	69	9	43.8	13	5.7
1.6	83	12.4	48.9	10	6.3
5.4	11.1	19.7	52.7	10	6.3

*3.6 signifies three years and six months

Table 13

Anthropometric Readings for Height (or recumbent length), Weight,
Head Circumference, Triceps Skinfold, and Subscapular Skinfold:
Female Traditional Age Birth Through Five Years

AGE OF SUBJECT	HEIGHT (or recumbent length) cm	WEIGHT kg	HEAD CIRCUMFERENCE cm	TRICEPS SKINFOLD mm	SUBSCAPULAR SKINFOLD mm
.9*	70.9	7.7	43.8	10.3	6.3
1	72.2	9.7	43.8	14.3	9.3
.1	52.7	4.3	36.2	10	5.7
5.2	118.1	21.3	53.1	15.3	7
3.3	94.8	14.5	47.4	14.3	6.7
.1	55.9	4.5	36.8	9.7	5.7
1.6	80	11	45.7	18.3	10.7
1.6	80	10.7	47.4	10	7
1.6	82.3	12.8	48.9	16	8.7
3	88.9	12.1	49.5	12	4.7
2.6	91.9	14.1	48.9	13.7	6.3
5.1	110.3	19.5	50.4	9	5

*.9 signifies nine months

Calorie and Protein Intake Based
on 24-Hour Diet Recall of Vegan Children
Age One Through Five Years*

AGE OF SUBJECT	SEX	CALORIE	PROTEIN (grams)
1.10	M	2126	64.1
1.1	M	2130	89.7
2.11	M	3234	141.9
4.6	M	1482	50.7
1.7	M	1461	51.4
1.4	M	2802	73.3
5.9	M	2881	89.5
3.11	M	2547	77.9
2.10	M	2160	68.9
5.3	M	1630	48.8
1.2	M	3119	187.7
5.6	F	2596	99.8
1.8	F	2426	91.9
4.11	F	2516	99.7
1.6	F	1635	55.9
3.6	F	1328	41.8
3.3	F	1582	55.4
2.6	F	1679	62.7
4.11	F	4302	125.6
3.3	F	3416	98.3
1	F	1553	60

*Calorie and protein intakes were not calculated for infants under one year of age.

Calorie and Protein Intake Based
on 24-Hour Diet Recall of Traditional Children
Age One Through Five Years*

AGE OF SUBJECT	SEX	CALORIE	PROTEIN (grams)
3.6	M	1254	55.5
4.4	M	1655	56.7
1.11	M	1916	81.6
2.9	M	1511	49.3
4.9	M	3949	116.7
1.10	M	927	35.7
1	M	1450	70.1
1.6	M	1625	60.9
5.4	M	2111	84.7
1	F	897	40.6
5.2	F	1673	60.2
3.3	F	1347	50.9
1.6	F	2322	69.9
1.6	F	1421	65.9
1.6	F	1417	64.4
3	F	2217	75.7
2.6	F	2092	94.7
5.1	F	2161	130.9

*Calorie and protein intakes were not calculated for infants under one year of age.

Table 16

Numbered Responses to the Diet History
Questionnaire Administered to the Mothers of
Vegan and Traditional Children Age Birth Through Five Years

1. Relationship between guardian and child.

	VEGAN	TRADITIONAL
Mother	25*	26
Father	0	0
Guardian	0	0

2-3-4. Age of child.

YEARS	VEGAN	TRADITIONAL
<1	5	8
1-1.11	8	8
2-2.11	2	2
3-3.11	4	3
4-4.11	3	2
5-5.11	3	3

5-6. Age of mother**.

YEARS	VEGAN	TRADITIONAL
<20	0	1
20-24	5	7
25-29	6	10
30-34	2	2
35-39	0	2
40-44	0	1

*One vegan subject did not reply to the questionnaire

**Replies are not repeated for mothers with more than one child participating. Seven vegan mothers had more than one child in the study as compared to three traditional mothers.

7-8. Age of mother at birth of child.

YEARS	VEGAN	TRADITIONAL
<20	2	4
20-24	12	9
25-29	11	7
30-34	0	4
35-39	0	2

9-10-11-12. Birth weight of child.

LBS/OUNCES	VEGAN	TRADITIONAL
7.0; 8.0; 8.6; 6.7; 6.7; 9.9; 4.12;		8.7; 6.10; 6.12; 10.0;
6.7; 10.10; 8.11; 11.4; 6.11; 8.0;		6.4; 8.4; 3.12; 6.6; 6.4;
8.0; 6.3; 7.4; 7.7; 4.0; 8.1; 7.14;		6.13; 6.13; 7.6; 8.11;
7.9; 8.6; 6.1; 6.15; 8.6		7.14; 8.2; 7.14; 8.9;
		6.13; 7.12; 9.0; 9.0;
		6.9; 6.7; 9.6; 8.6; 6.10

13-14. Other children in family.

	VEGAN	TRADITIONAL
0	5	12
1	3	9
2	2	1
3	2	1
4	1	0

15. Babies weighing $5\frac{1}{2}$ lbs at birth.

	VEGAN	TRADITIONAL
No	10	20
Yes	3	2

16-17. How many?

	VEGAN	TRADITIONAL
0	0	0
1	3	2

18. (For mother) Are you breast feeding now?

	VEGAN	TRADITIONAL
Yes	12	2
No	13	24

19. If yes, how long?

LENGTH OF TIME	VEGAN	TRADITIONAL
Since birth	3	1
0-3 months	2	1
3-6 months	1	0
6-9 months	0	0
9-12 months	6	1
>1 year	0	0
No Answer	13	23

20. (For mother with babies 1 year and older) During infancy was baby breast fed, bottle fed or both?

	VEGAN	TRADITIONAL
Breast Fed	15	5
Bottle Fed	1	11
Both	4	3
Can't Remember	0	0
No Answer	5	7

21. If yes, for how long?

LENGTH OF TIME	VEGAN	TRADITIONAL
0-3 months	0	4
3-6 months	0	1
6-9 months	5	1
9-12 months	14	9
>1 year	1	4
No Answer	5	7

22. Child now receive supplemental vitamins or iron?

	VEGAN	TRADITIONAL
No	15	10
Yes, vitamin only	4	5
Yes, iron only	0	0
Yes, both vitamin and iron	5	5
Yes, but don't know composition	0	4
No answer	1	2

23. If yes, how often?

LENGTH OF TIME	VEGAN	TRADITIONAL
Once a month	2	0
Once every two weeks	1	0
Once a week	2	0
Three times a week	1	1
Daily	2	14
Not sure	0	0
No answer	17	11

24. (Mothers with children one year and older) During child's first year - did he/she receive supplemental vitamins or iron?

	VEGAN	TRADITIONAL
No	3	3
Can't remember	0	0
Yes, vitamin only	2	2
Yes, iron only	0	0
Yes, both vitamins and iron	14	11
Yes, but don't know composition	0	1
No answer	6	9

25. How often?

FREQUENCY	VEGAN	TRADITIONAL
Once a month	0	0
Once every two weeks	2	0
Once a week	1	0
Three times a week	3	2
Daily	10	12
Not sure	0	0
No answer	9	12

26. (For mother of child) Vitamin or iron during pregnancy?

	VEGAN	TRADITIONAL
No	0	3
Can't remember	0	0
Yes, vitamin only	1	0
Yes, iron only	0	7
Yes, both vitamin and iron	24	15
Yes, but don't know composition	0	1

No answer 0 0

27. What length of time?

LENGTH OF TIME	VEGAN	TRADITIONAL
Approximately 1 month	0	0
1-3 months	0	0
3-6 months	2	1
6-9 months	3	9
Whole term	20	13
Can't remember	0	0
No answer	0	3

28. Does parent eat foods with animal protein?

	VEGAN	TRADITIONAL
Yes	0	26
No	25	0

29. Length of time parent followed current diet.

LENGTH OF TIME	VEGAN	TRADITIONAL
One year or less	0	0
1-2 years	2	0
2-3 years	4	0
More than 3 years	5	0
More than 5 years	14	0
All my life	0	26

30. Does child eat foods with animal protein?

	VEGAN	TRADITIONAL
Yes	0	26
No	25	0

31. Length of time child has followed current diet?

LENGTH OF TIME	VEGAN	TRADITIONAL
Since birth	25	26
1 year	0	0
2 years	0	0
3 years	0	0
4 years	0	0
5 years or more	0	0

APPENDIX B

I have given permission for _____ to
 child's name
 participate in a study of anthropometric measurements on
 children. These measurements include: height, weight, head
 circumference, triceps skinfold thickness, and subscapular
 skinfold thickness. It has been explained that these
 measurements are neither painful nor harmful to the child.

I understand that this study is being performed to compare
 measurements of children following two different types of diets.
 I understand that this study is limited to that purpose. My
 name and my child's name will not appear anywhere in the final
 report.

It has been explained that I am free to withdraw from
 participation at any time. I understand that there is no cost
 involved.

Dr. Cameron Gundersen has offered to answer any question
 I might have about the purpose or procedure of this study.

I have read and fully understand the above information.

Date _____

 Parent/Guardian

 Witness

 Researcher

- ___1 What is the relationship between you and the child being measured?
1. Mother
 2. Father
 3. Guardian
- ___2-3-4 How old is your child? ___ years ___ months
- ___5-6 How old are you? ___ years
- ___7-8 How old were you when your child was born? ___ years
- ___9-10
- ___11-12 Birth weight of child? ___ lbs ___ oz
- ___13-14 How many other children do you have? _____
- ___15 Did any of your babies, including the one being measured, weigh less than $5\frac{1}{2}$ lbs (2500 gms) when they were born?
1. yes
 2. no
 3. can't remember
- ___16-17 How many? _____
- ___18 (For mother) Are you breast feeding now?
1. yes
 2. no
- ___19 If yes, how long have you been breast feeding?
- | | |
|----------------|----------------|
| 1. Since birth | 4. 6-9 months |
| 2. 0-3 months | 5. 9-12 months |
| 3. 3-6 months | 6. Over 1 year |
- ___20 (For mothers with babies one year and older) During infancy, was the baby breast fed, bottle-fed or both?
1. Breast fed only
 2. Bottle fed only
 3. Both
 4. Can't Remember
- ___21 If yes, for how long?
- | | |
|---------------|----------------|
| 1. 0-3 months | 4. 9-12 months |
| 2. 3-6 months | 5. Over 1 year |
| 3. 6-9 months | |

_____ 22 Does the child now receive supplemental vitamins or iron?

1. no
2. yes, vitamins only
3. yes, iron only
4. yes, both vitamins and iron
5. yes, but don't know composition

_____ 23 If yes, how often?

- | | |
|-------------------------|-------------------|
| 1. Once a month | 4. 3 times a week |
| 2. Once every two weeks | 5. Daily |
| 3. Once a week | 6. Not sure |

_____ 24 (For mothers with children 1 year and older)
During his/her first year did the child usually get supplemental vitamins or iron?

1. no
2. can't remember
3. yes, vitamins only
4. yes, iron only
5. yes, both vitamins and iron
6. yes, but don't know composition

_____ 25 If yes, during his/her first year, how often would the child receive vitamins?

- | | |
|-------------------------|-------------------|
| 1. Once a month | 4. 3 times a week |
| 2. Once every two weeks | 5. Daily |
| 3. Once a week | 6. Not sure |

_____ 26 (If mother of child)
During your pregnancy with this child, did you take vitamins or iron?

1. no
2. can't remember
3. yes, vitamins only
4. yes, iron only
5. yes, both vitamins and iron
6. yes, but don't know composition

_____ 27 If yes, for what length of time?

1. Approximately 1 month
2. 1-3 months before birth
3. 3-6 months before birth
4. 6-9 months
5. During the whole term
6. Can't remember

_____ 28 Do you (parent/guardian) eat eggs, cheese, meat, fish, or drink milk?

- | | |
|--------|-------|
| 1. yes | 2. no |
|--------|-------|

____29 How long have you followed this diet?

1. 1 year or less
2. 1-2 years
3. 2-3 years
4. More than 3 years
5. More than 5 years
6. All my life

____30 Does your child eat eggs, cheese, meat, fish, or drink milk?

1. yes
2. no

____31 How long has your child followed this diet?

1. Since birth
2. 1 year
3. 2 years
4. 3 years
5. 4 years
6. 5 years or more

24 HOUR FOOD RECALL

NAME: _____

DATE: _____

Tell me everything you (your child) ate and drank from the time you (your child) got up in the morning until you (your child) went to bed at night and what you (your child) ate during the night. Be sure to mention everything you (your child) ate or drank at home, at work and away from home. Include snacks and drinks of all kinds and everything else you (your child) put in mouth and swallow.

TIME	PLACE	FOOD EATEN	AMOUNT

Nutrition Section
W.I.C. Program
Wis. Div. Health
3/76

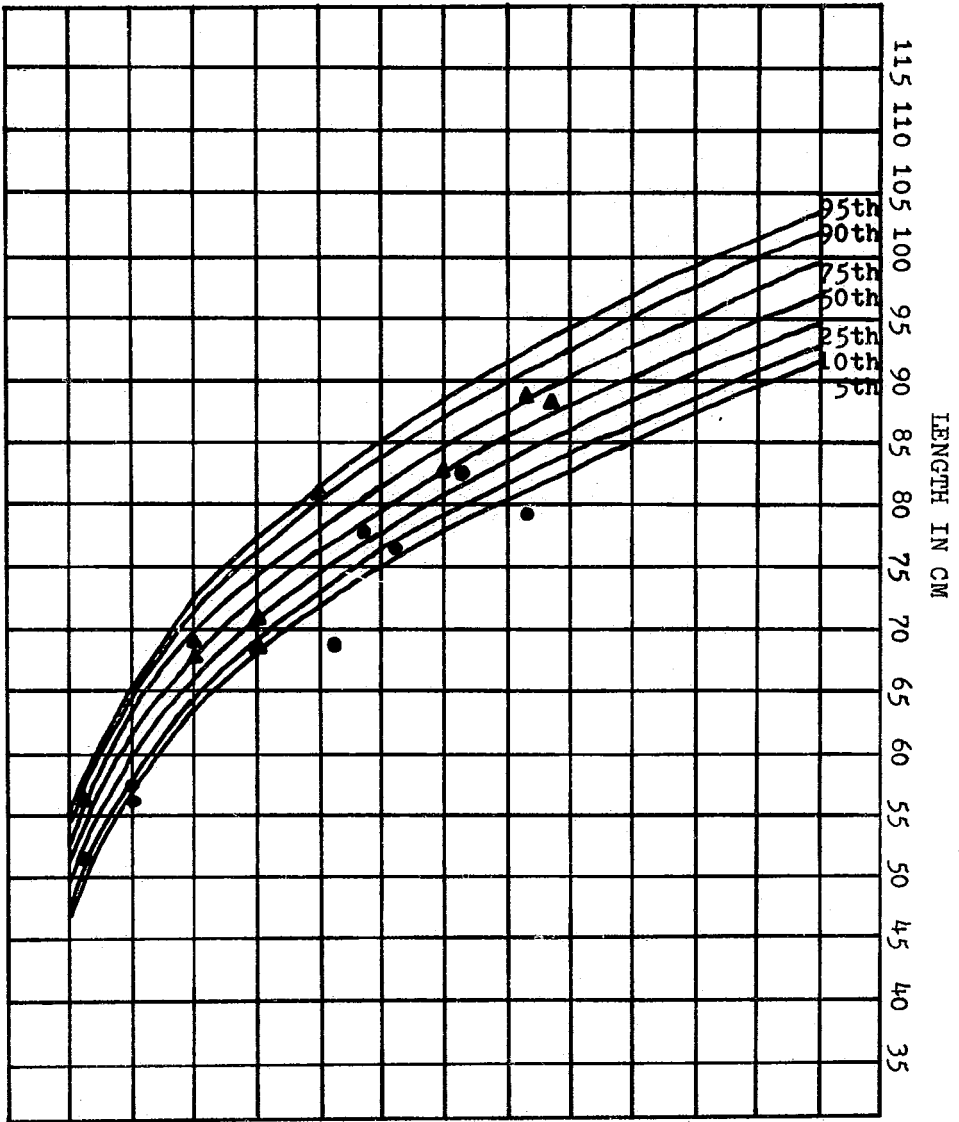
APPENDIX C

Figure 1

National Center for Health Statistics Growth Chart
 Comparison With Vegan and Traditional Males:
 Length by Age (0-36 months)

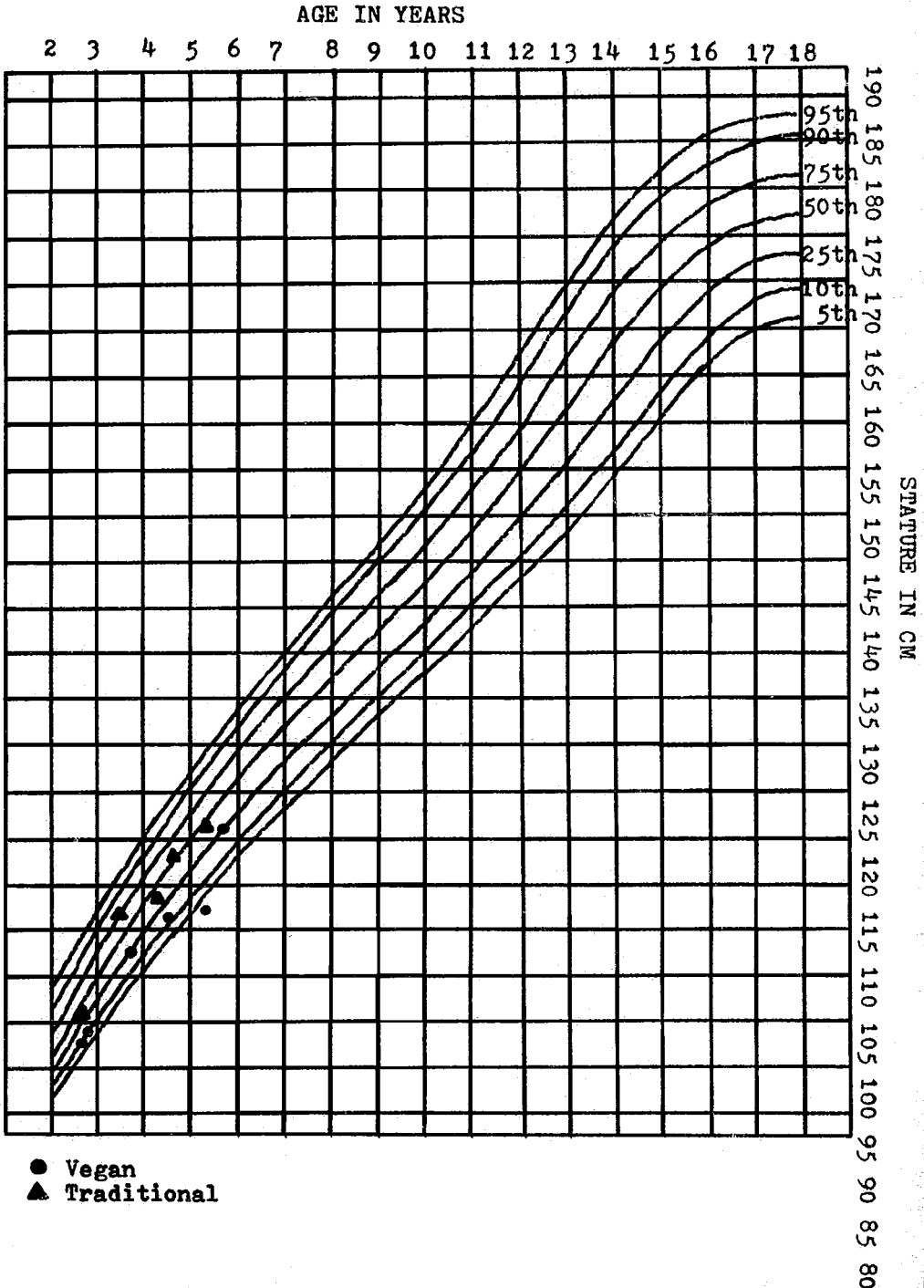
AGE IN MONTHS

0 3 6 9 12 15 18 21 24 27 30 33 36

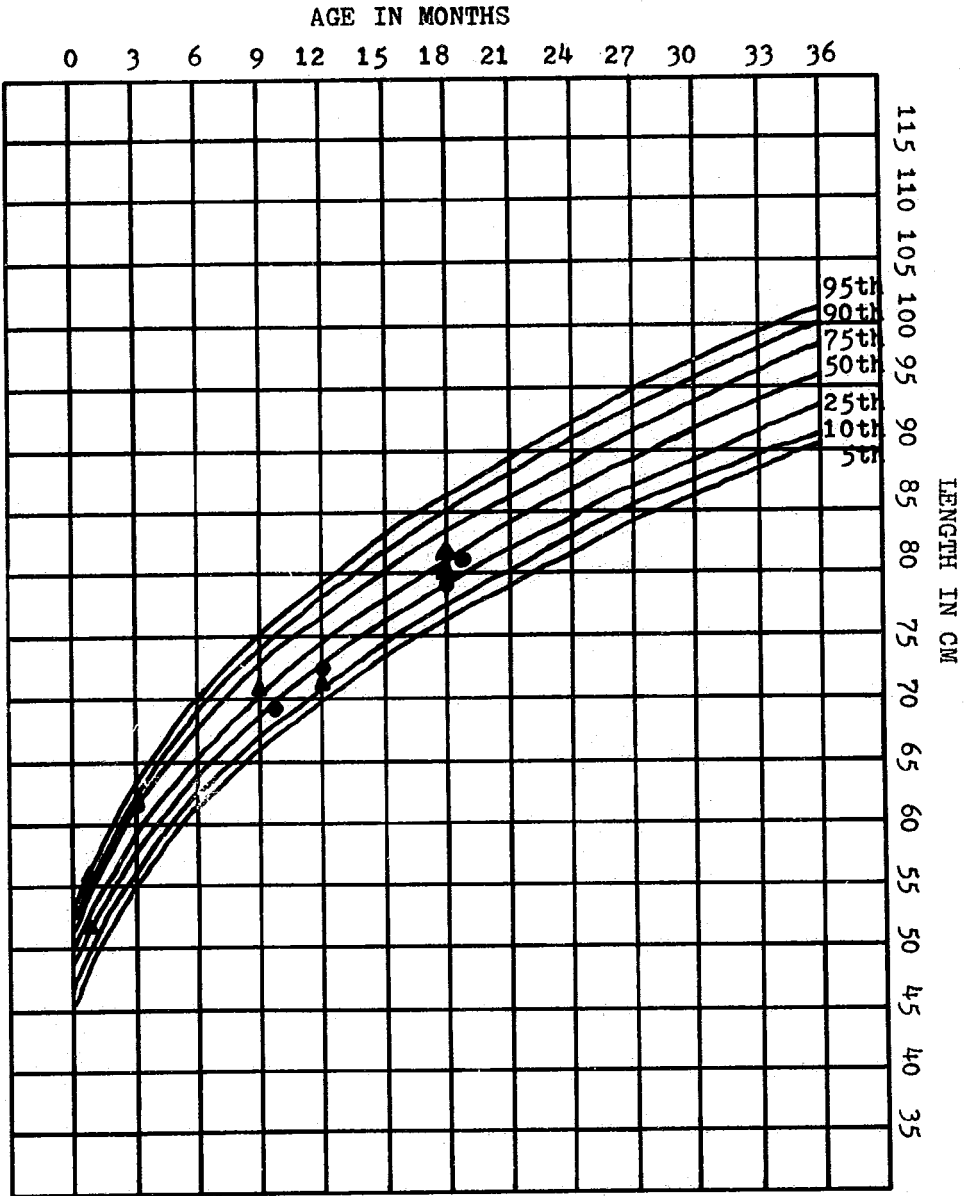


● Vegan
 ▲ Traditional

National Center for Health Statistics Growth Chart
 Comparison With Vegan and Traditional Males:
 Stature by Age (2-18 years)

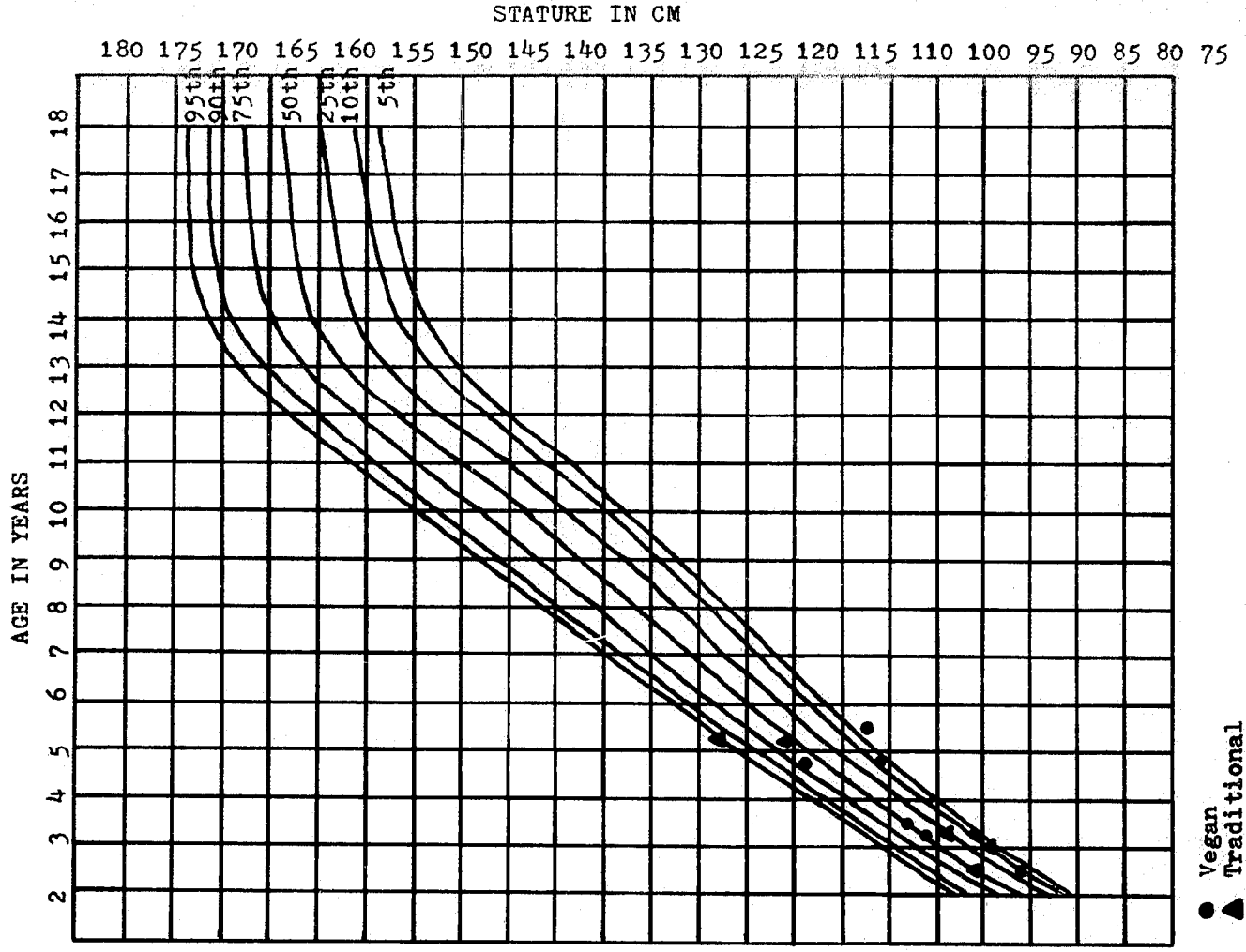


National Center for Health Statistics Growth Chart
 Comparison With Vegan and Traditional Females:
 Length by Age (0-36 months)

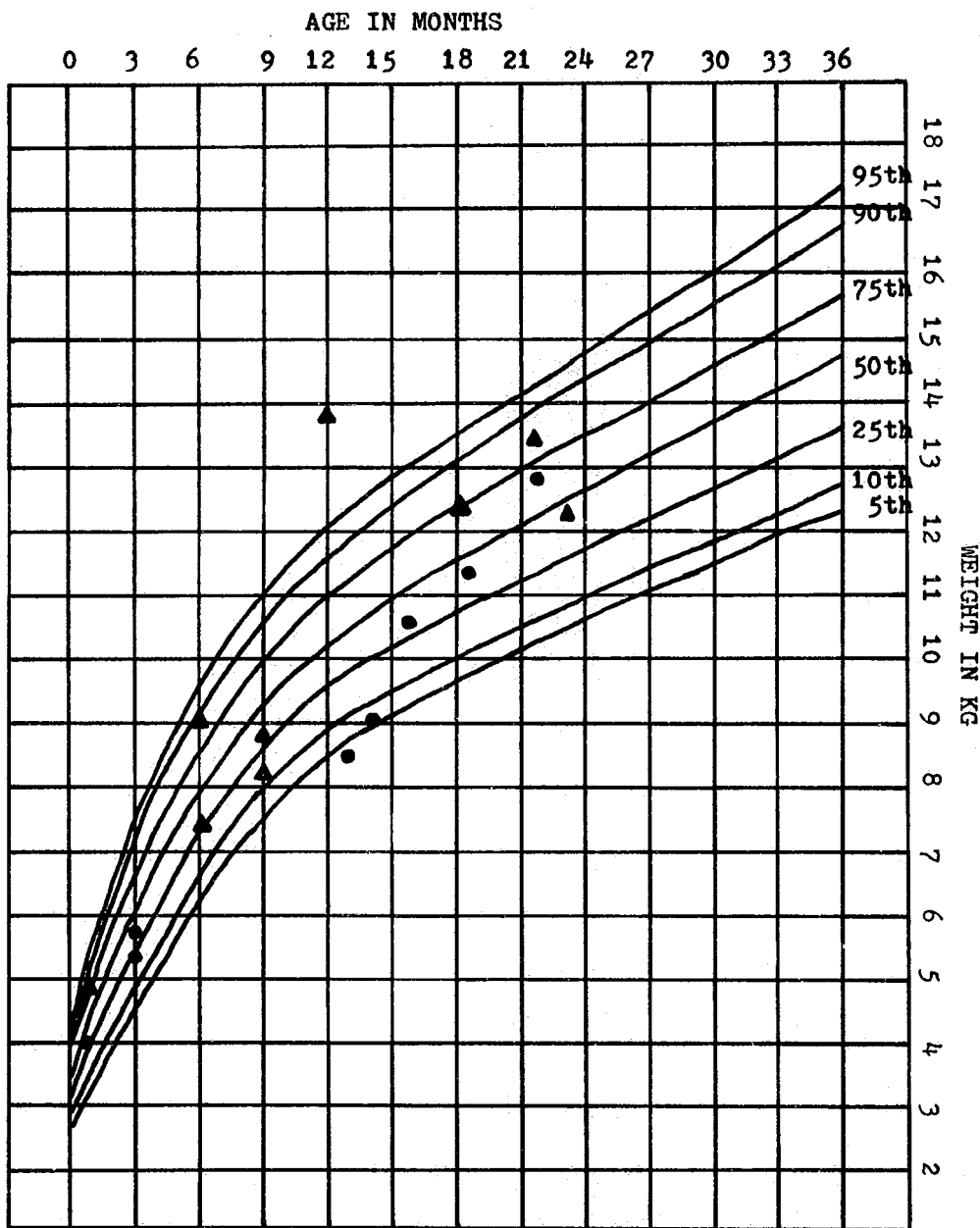


● Vegan
 ▲ Traditional

National Center for Health Statistics Growth Chart
Comparison With Vegan and Traditional Females:
Stature by Age (2-18 years)

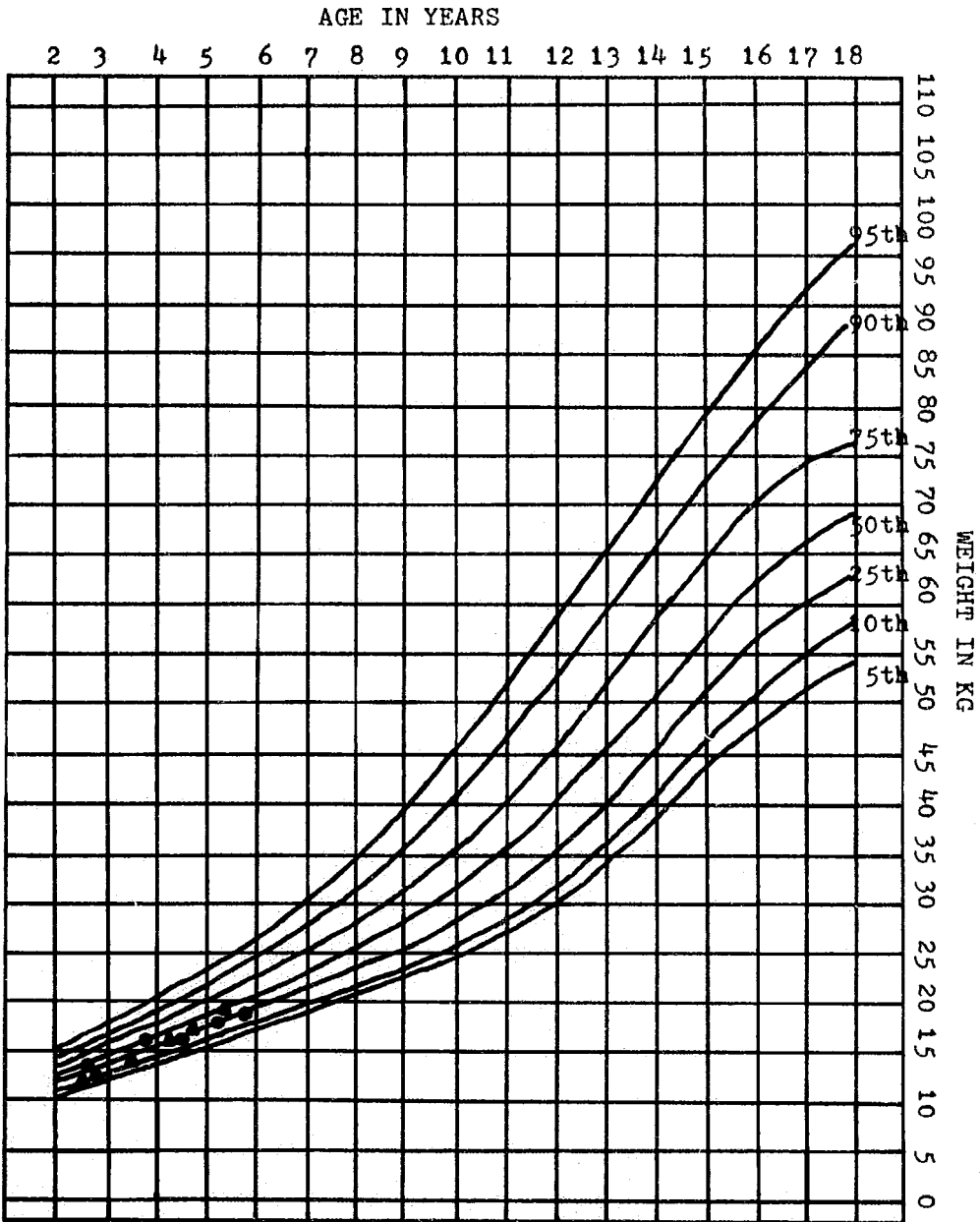


National Center for Health Statistics Growth Chart
 Comparison With Vegan and Traditional Males:
 Weight by Age (0-36 months)

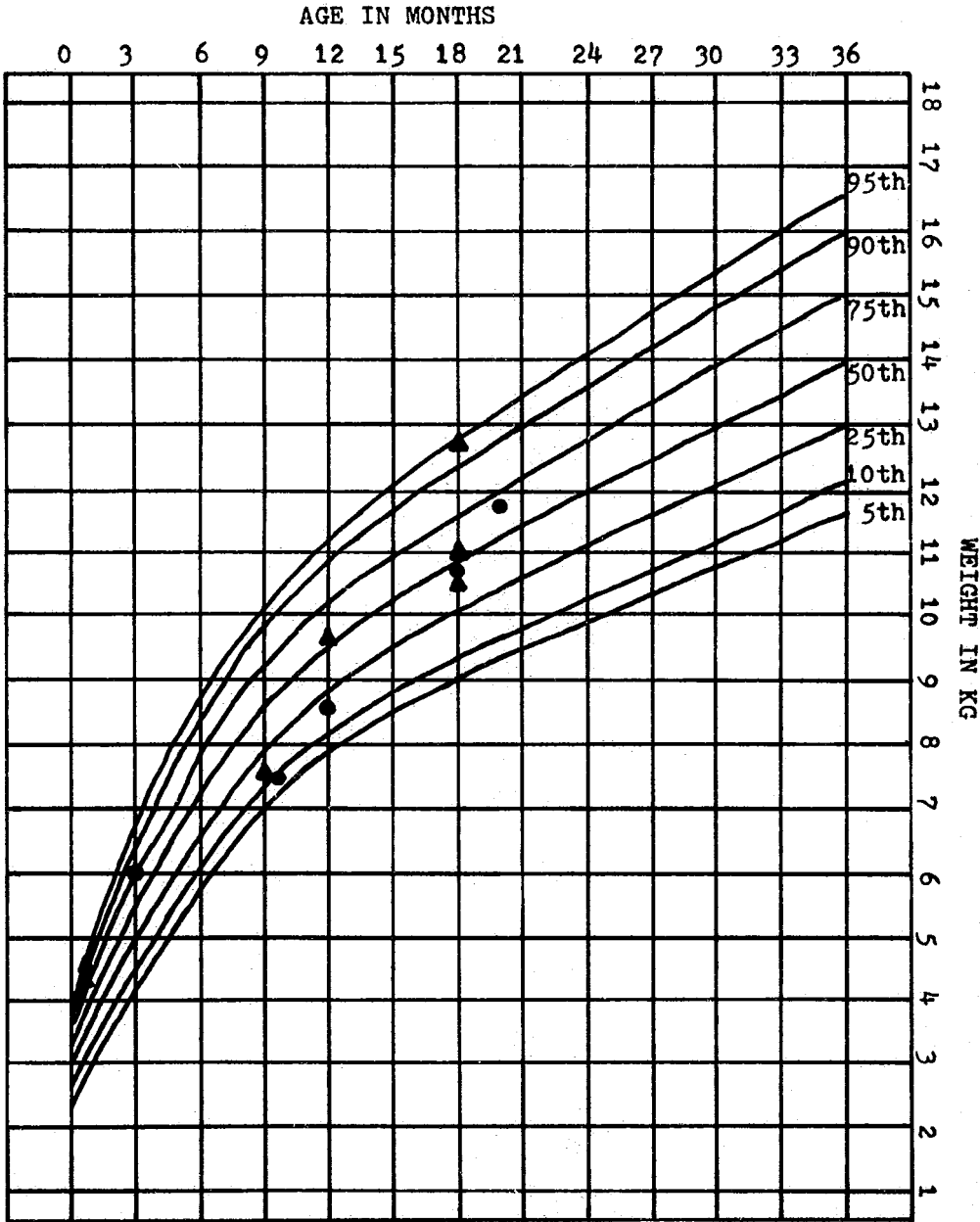


● Vegan
 ▲ Traditional

National Center for Health Statistics Growth Chart
 Comparison With Vegan and Traditional Males:
 Weight by Age (2-18 years)

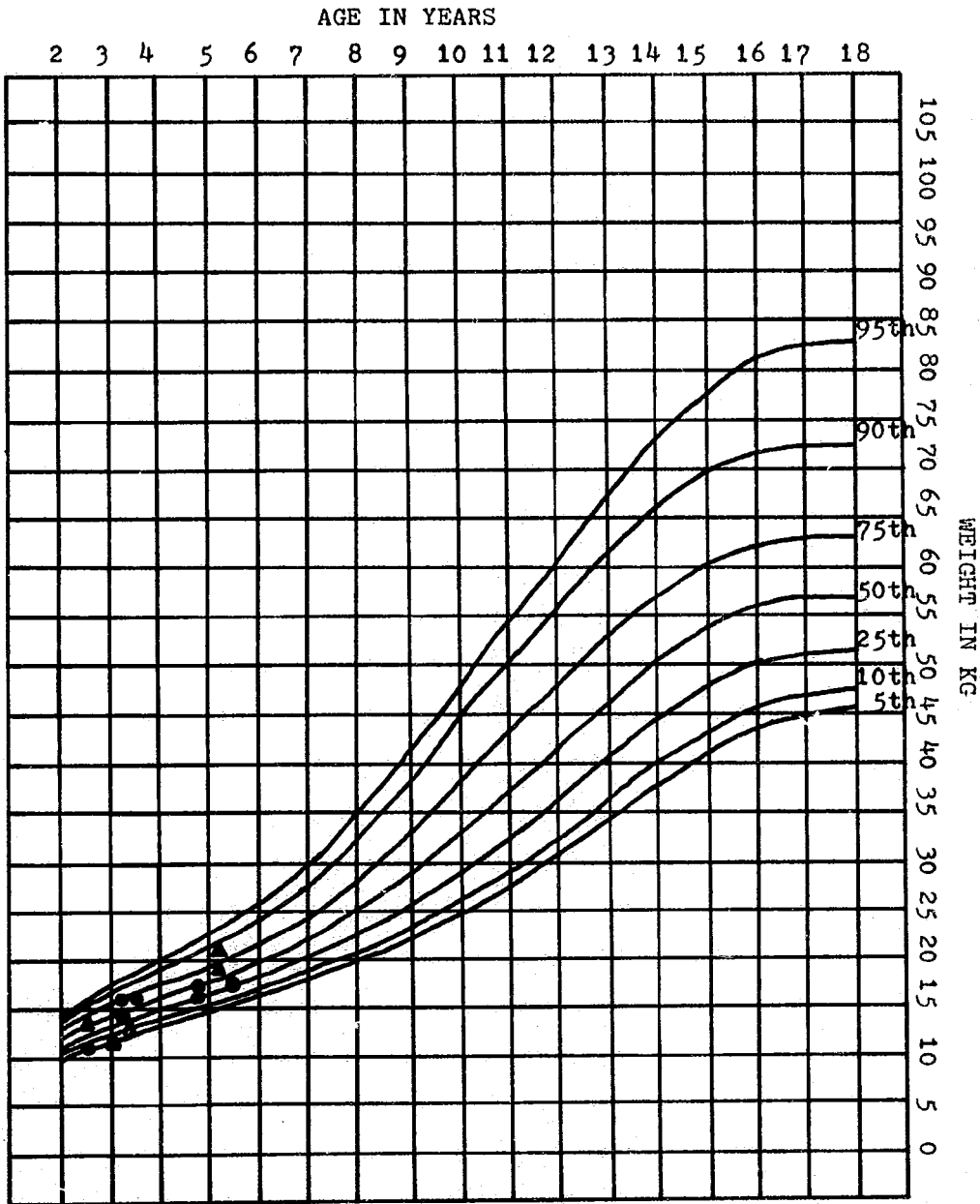


National Center for Health Statistics Growth Chart
 Comparison With Vegan and Traditional Females:
 Weight by Age (0-36 months)

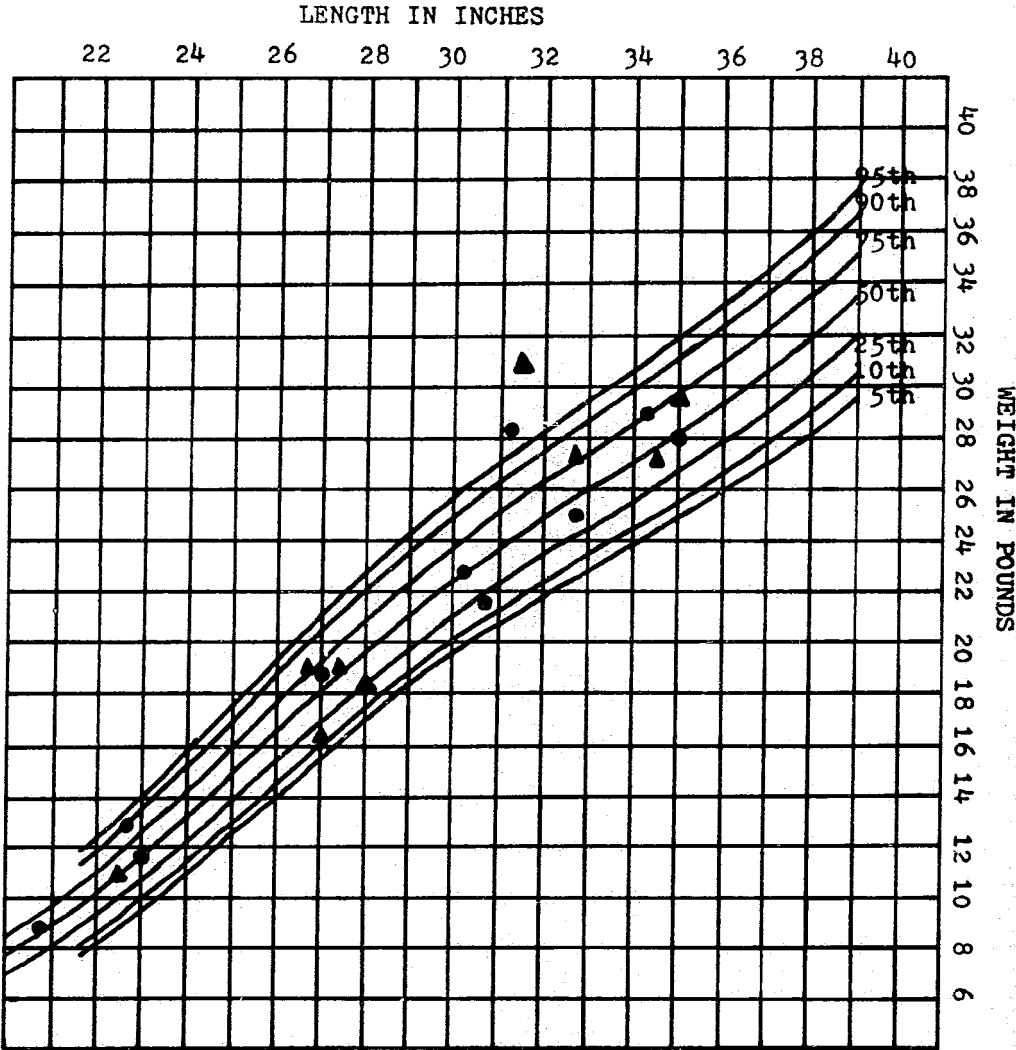


- Vegan
- ▲ Traditional

National Center for Health Statistics Growth Chart
 Comparison With Vegan and Traditional Females:
 Weight by Age (2-18 years)

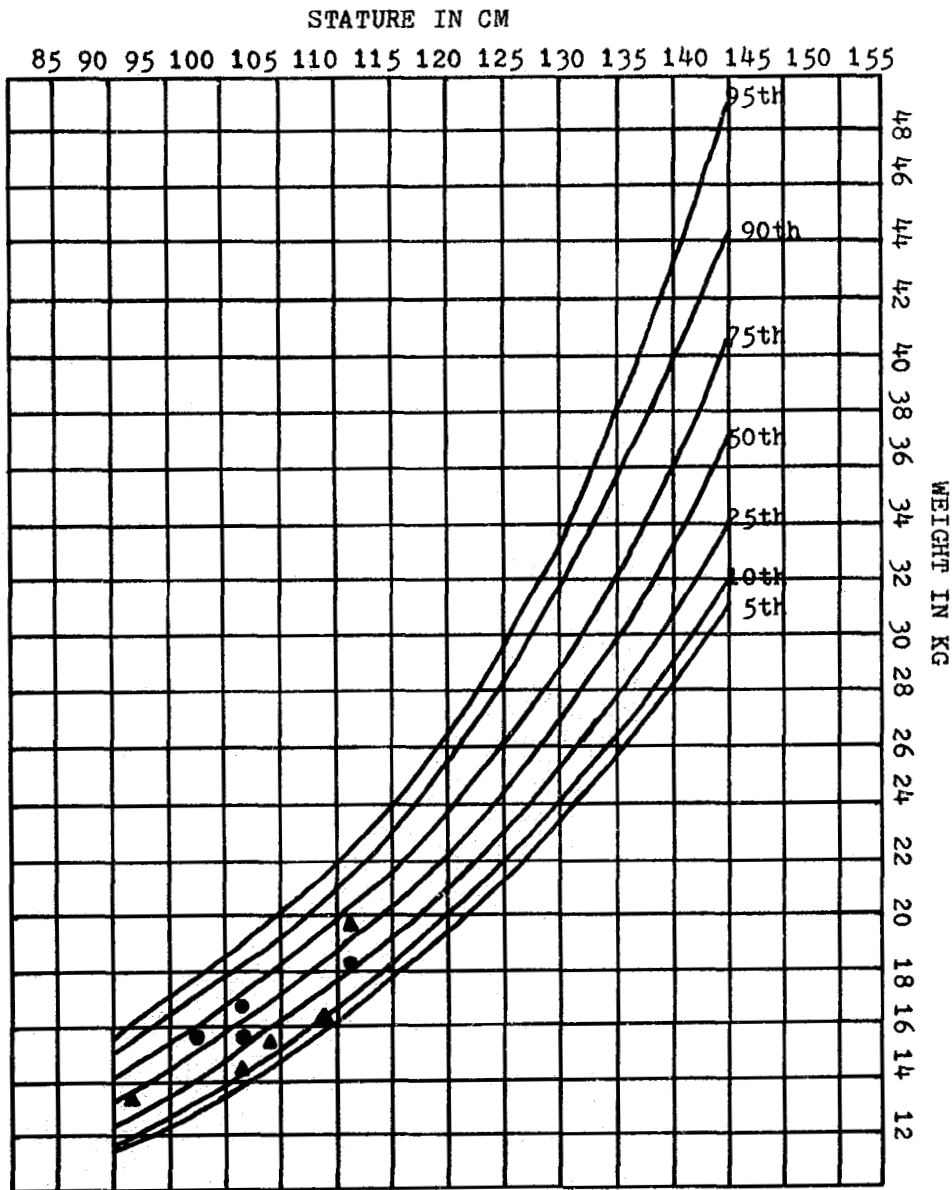


National Center for Health Statistics Growth Chart
Comparison With Vegan and Traditional Males:
Weight for Length (0-36 months)



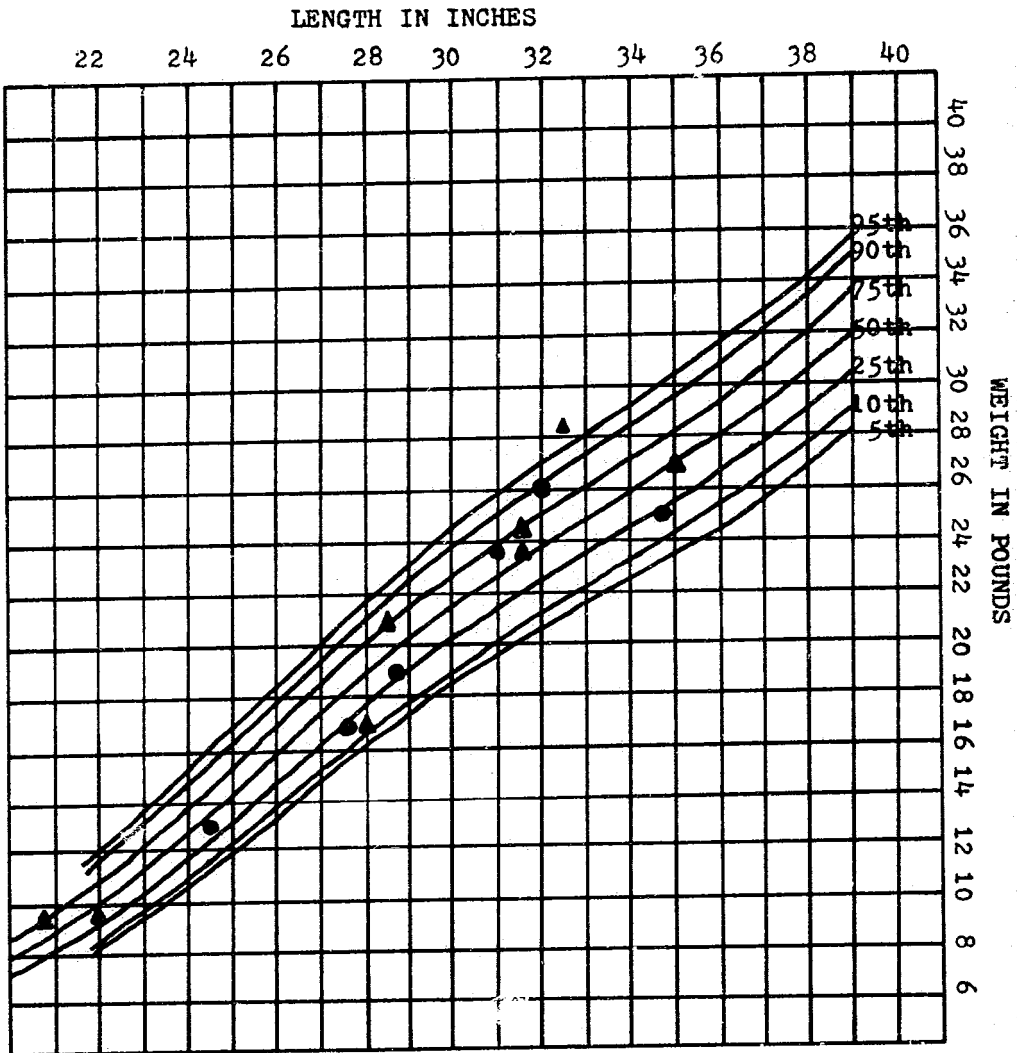
● Vegan
▲ Traditional

National Center for Health Statistics Growth Chart
 Comparison With Vegan and Traditional Males:
 Weight by Stature (Prepubertal)



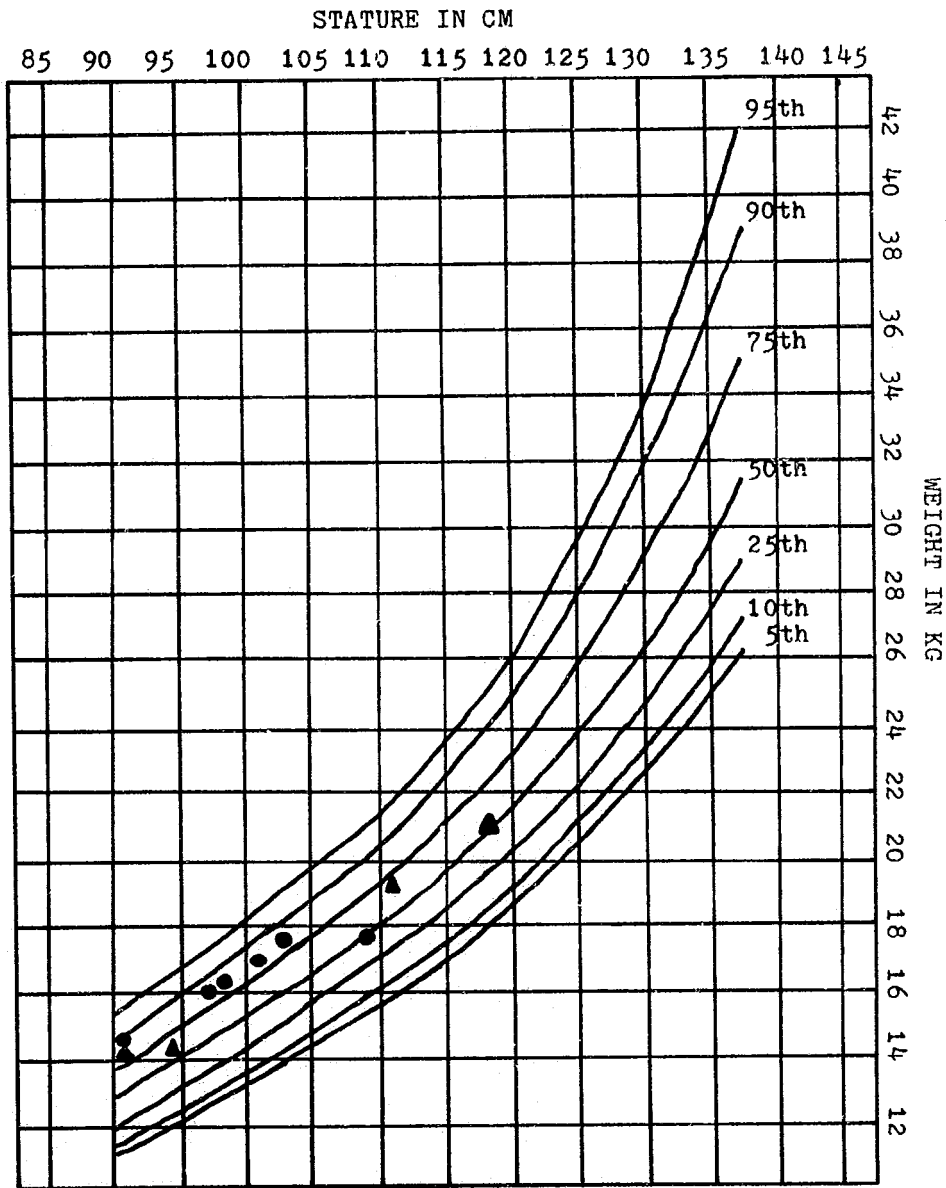
- Vegan
- ▲ Traditional

National Center for Health Statistics Growth Chart
 Comparison With Vegan and Traditional Females:
 Weight for Length (0-36 months)



● Vegan
 ▲ Traditional

National Center for Health Statistics Growth Chart
 Comparison With Vegan and Traditional Females;
 Weight by Stature (Prepubertal)



● Vegan
 ▲ Traditional