GROWTH PATTERNS OF HISPANIC AND CAUCASIAN CHILDREN

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September 27, 1999
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To the Associate Vice President for Research and Dean of the Graduate School:

I am submitting herewith a dissertation written by

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entitled Growth Patterns of Hispanic and Caucasian Children

I have examined the final copy of this dissertation for form and content and recommend that it be accepted in partial fulfillment of the requirement for the degree of Doctor of Philosophy with a major in Nursing.

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GROWTH PATTERNS OF HISPANIC AND CAUCASIAN CHILDREN

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Growth of children is a powerful indicator of general health used in clinical evaluations. No studies have examined the growth of Hispanic children under 2 years of age and compared the growth with Caucasian children of the same population. Breast-feeding and its impact on growth in children under 2 years of age are in question, and this study attempted to determine whether or not a difference in growth occurs in breast- and bottle-fed infants and children.

The label Hispanic is a classification that identifies ancestry from a Spanish-speaking country. Racial classification of Hispanics can include White, Asian, Black, and East Indian. In this study, Hispanics were defined as people whose ancestors were from Mexico. The label Caucasian defined the segment of the White race without ancestry from a Spanish-speaking country.

This study examined children from three similar clinics by weighing and measuring them and obtaining information concerning their heritage, family income, and whether they had been breast-fed. Additional data from their medical charts provided measurements on approximately 10% of the sample. A total of 1,026 sets of measurements was collected and analyzed. Over 50 sets of measurements of 2-, 4-, 6-, and 12-month-old children from each sex and origin were collected. Although 24-month-old children were in the study, it was not possible to collect large enough numbers to provide analysis to meet a power of .80.

Before analysis, body mass indexes were computed for each child in the study. Statistical analysis by t-test revealed a significant difference in height in only one age and sex category. Analysis of weight by *t*-test revealed that Hispanic children were significantly heavier in four categories and had higher body mass indexes in 2 categories. No significant differences were found in the breast- and bottle-fed children in analysis by *t*-test at the $p = .05$ level of significance.

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CHAPTER I

INTRODUCTION

More than any other measurement, growth provides the most informative evidence of healthy childhood. In check-ups for both well and sick children, nurses measure and assess growth. A child whose height or weight falls below or above the ag specific normal parameters is evaluated for possible illness, malnutrition, or parental neglect.

In the United States, the most widely used growth charts on which measurements are plotted are the National Center for Health Statistics' percentiles (Hamill et al.,1979). These growth charts were developed using data from the measurements of a randomized sample of 20,000 children of various racial, socioeconomic, and geographic groups throughout the United States between 1963 and 1975. These measurements contrasted with all previously available growth studies, which measured only White, middle- and upper-class children living in Boston, Massachusetts, and in Iowa.

The National Center for Health Statistics growth charts display the 5th, 10th, 25th, 50th, 75th, 90th, and 95th percentiles. Establishing where a child's growth falls on these percentiles is a screening measure, not a diagnostic one. A child whose growth falls outside of the normal parameters may have an illness that is interfering with growth, may not be provided with adequate nutrition, and/or may be demonstrating signs of parental neglect. As part of a health assessment, children who are small for their age or who are underweight in comparison to their length should undergo further evaluation. The health care personnel may then collect family history, birth measurements, illness history, information about dietary intake and physical activity, and observe for signs of gastrointestinal, renal, metabolic, or cardiac abnormalities. Other laboratory and radiological assessments may be ordered and evaluated (Hamill et al., 1979; Wong et al., 1999).

Growth is dependent on genetic heritage, nutrition, function of the endocrine glands, presence or absence of disease, and environmental factors such as climate, physical activity, social conditions, rearing style of the parents, sibling interaction, and cultural practices, such as breast-feeding (Malina & Bouchard, 1991). The significance of genetic contribution to growth is uncertain. Some scholars have argued that the environmental and socioeconomic differences account for racial and ethnic differences in stature (Dunn & Martorell, 1984; Habicht, Martorell, Yarborough, Malina, & Klein, 1974; Scholl, Karp, Theophano, & Decker, 1987). Others recognize that many factors influence growth, but argue that genetic differences are more significant than socioeconomic and environmental conditions (Martorell, Mendoza, & Castillo, 1989; Mendoza & Castillo, 1986).

In the United States, the adult Hispanic of Mexican origin is significantly shorter than the average Caucasian (Greaves, Puhl, Baranowski, Gruben, & Seale, 1989). Many studies have documented differences in the stature of Hispanic and Caucasian children (Dewey, Chavez, Gauthier, Jones, & Ramirez, 1983; Guinn, 1993; Kumanyika et al., 1990; Malina, Zavaleta, & Little, 1987a; 1987b; Martorell et al., 1989; Scholl et al., 1987). However, the researchers'conclusions conflict and often reflect the training of the authors. Nutritionists and social scientists have concluded that environmental influences, especially nutrition, account for the differences, and anthropologists and physicians have implicated a biological difference in populations. The largest Hispanic study, the National Center for Health Statistics' Hispanic Health and Nutrition Examination Survey (HHANES), recommended that the Hispanic population be studied 10 years from its data collection period (Hamill et al., 1979). This would determine whether or not the differences in stature between the Hispanic population and the Center for Health Statistics norms were decreasing due to improvement in socioeconomic conditions and national health programs that promote nutrition. In addition, no studies have measured children younger than 2 years of age. It is uncertain whether or not the growth of Hispanic children of Mexican origin differs from the growth of Caucasian children. This is important to learn so that this valuable health screening tool, growth, can be utilized appropriately for the Hispanic child.

It is widely accepted that nutrition intake impacts growth, both positively and negatively. Recently, scholars have questioned the effect of breast-feeding on growth (Dermer, 1996; Oski, 1993; Trahms & Powell, 1996). In infants who are formula-fed, birth weight is expected to double by the 4th or 5th month of age, and to triple by the first birthday. The formula-fed infant's birth length usually increases by 50% by the first birthday. These milestones are not known for breast-fed infants. Although it is recognized that breast-feeding provides the infant with immunities, contributes to maternal-infant bonding, and supplies the infant with nutrients custom-made for a human baby, a large-scale study of growth has not been undertaken (Anholm, 1986; Campton, 1993; Morrow-Tlucak, Haude, & Ernhart, 1988). It is important first to establish whether or not a difference exists in the growth of breast- and formula-fed infants in the same population.

Problem of the Study

A gap in the literature exists regarding the growth of children of Hispanic origin from 2 to 24 months of age. The research designs have been varied, with as few as 161 in one study and over 600,000 in another (Dunn & Martorell, 1984; Yip et al., 1992). The present study was designed to answer the following question: Is there a difference between the growth (height, weight, and body mass index) of Caucasian and Hispanic children from 2 months to 24 months of age?

Nutrition is the most important environmental influence on growth. Infancy is a period of rapid growth, requiring high amounts of protein and calories for energy (Parizkova, 1996). Health care providers are beginning to question whether or not breast-fed children grow differently from formula-fed children. Oski (1993) has suggested that new growth charts be developed and implemented so that breast-fed children are not incorrectly diagnosed as failure to thrive. This study compares the growth of breast-fed children and formula-fed children to answer the following question: Does the growth of bottle-fed and breast-fed infants differ?

Rationale for the Study

In health care, information about growth is used to assess the health of both the individual and the community. This information is an excellent determinant of the health and nutritional status of its citizens. It can also determine whether the child is showing the effects of long-term, chronic health problems or nutritional deficiencies. These are in contrast to short-term or single episodes of poor health or inadequate nutrition that are usually followed by catch-up growth. However, in all children, growth is episodic rather than consistent and normal children vary from one another in their growth patterns (Schulte, Price, & James, 1997). Persistent growth delay may be a strong indicator that other evaluations should be undertaken to determine whether a child who is small for his or her age, has health, nutrition, or parenting problems (Edwards & Morse, 1989).

The genetic and nutrition determinants of growth were selected for study in this research. This study design utilized one population and compared the growth of two different groups in regard to genetic heritage and nutrition. The growth of Hispanic children of Mexican origin was compared to the growth of Caucasian children, and the growth of breast-fed children was compared to the growth of formula-fed children.

Growth Reference Data

The Center for Health Statistics growth charts are the most widely used reference by nurses and other health care providers (Hamill et al., 1979) in the United States. A child whose growth plots are above the 97th or below the 5th percentile is appropriate for additional evaluation. However, if a large percentage of a particular group of infants and children is known to fall below the 5th percentile at specified ages, it would not be appropriate to recommend that all these children undergo laboratory or other diagnostic evaluations. The difficulty lies in determining just which children should be evaluated. A final clinical decision requires a judgment considering many factors, including parental size, birth weight, illness history, endocrine function, and known growth factors in that community and group (Edwards & Morse, 1989).

Edwards and Morse (1989) considered the question of the use of the National Center for Health Statistics charts as a reference for the growth of all children. They concluded that development of growth norms for each racial group would be the ideal solution, but one that may not be practical. Problems include insufficient numbers of children to study and selection of the sample from the total group to reflect population conditions such as poor nutrition. The measurements may have to be repeated over time to reflect changing economic conditions.

Racial and Ethnic Characteristics of the Population

People of Hispanic origin comprise 8.8% of the total population of the United States, and the Caucasian population comprises 75%. In Texas, Hispanics comprise 28% of the total, and Caucasians comprise 85%, according to the 1990 census. These numbers add to more than 100% because the U.S. Census defines Hispanic as a subset of White. The census does not classify Hispanic as a racial category. Guidelines for the classification of Hispanics include "persons born in Puerto Rico, Cuba, Mexico, or other Spanish-speaking countries, persons whose ancestors came from a Spanish-speaking country, and persons who identify themselves as Spanish-speaking or Spanish-surnamed" (Lavin, 1996, p. 136).

The racial classification of Hispanics can be varied, including White, Asian, Black, and East Indian. Most Hispanics in the United States are multiracial, including those with origins in Spain and the indigenous people of Mexico, Central and South America, and the Caribbean.

In the United States, Mexican Americans comprise the largest number of Hispanics, with those from Puerto Rico, Cuba and other countries of origin following in number. In Texas, most Hispanics (90.8 %) are of Mexican ancestry. The U. S. Census identified Hispanics as one of the fastest growing minorities, with a 53% increase in population from 1980 to 1990. Projections estimate that Hispanics may comprise 20% of the total United States population by year 2050 (Hispanic Databook, 1994; Lavin, 1996).

This study used the nomenclature Caucasian in referring to the non-Hispanic segment of the White racial category. The term Hispanic described a subset of White or other racial groups who have ancestry in Mexico. The assignment of the study participants to categories was based on a short interview with the participants' guardians. This is further described in chapter 3.

Growth of Caucasian Children

It is widely accepted that the National Center for Health Statistics percentiles accurately reflect the growth of the Caucasian child in the United States. These percentiles were developed from the data collected during the Health Examination Survey (HES), the Health and Nutrition Examination Survey (HANES), and data from the Fels Research Institute and Preschool Nutrition Survey, all completed between 1963 and 1975. The Committee on Nutrition Advisory to the Centers for Disease Control recommended its use for all children in the Unites States, "although appreciable anthropometric differences have been demonstrated among certain ethnic groups living under similar environmental conditions" (Hamill et al. 1979, p. 609).

Growth of Hispanic Children

Selected studies of the growth of Hispanic children in the United States are summarized in Table 1.

Table 1

Growth of Hispanic Children Studies

Authors	Location, year published	Number	Age	Conclusions
HHANES*	U.S., 1979	4,804	2-17	Small difference in height in years 2-12, with large difference in adolescence.
Greaves, Puhl, Baranowski, Gruben, & Seale	TX, 1989	568	3,4 years, adult	Hispanic adults shorter than Caucasian adults; number of children studied small.
Malina & Zavaleta**	Brownsville, TX, 1987	1,269	6-17 years	Growth similar to Mexican children.
Malina**	Brownsville, TX, 1987	868	6-17 years	Children have grown since 1928 and 1972 studies, but not as much as predicted based on European data.

Pediatric Nutrition Surveillance System***	37 states, 1992	633,972 records	1 month to 18 years	Low-income children had lower heights. Hispanic children had high prevalence of overweight.
Dewey, Chavez, Gauthier, Jones, &Ramirez	California, 1983	209	3-5 years	No difference in growth; findings cannot be generalized to Hispanic population due to small sample size.
Dunn & Martorell	California, 1984	161	2-16 years	Differences in growth are due to socioeconomic conditions.
Kumanyika, Huffman, Bradshaw, Waller, Ross, Serdula, & Paige	Washington, D.C., 1990	5,170	Kinder-garten	Hispanic boys were more often below the 5th percentile in height and had an increased weight for height.
Scholl, Karp, Theophano, & Decker	New Jersey & Washington, D.C., 1987	2,056	5-13 years	Within similar environments, children of different ethnic groups have similar heights.

The information in Table 1 shows that, in most studies of Hispanic children, small numbers of children were compared to other races in each category (Dewey et al.,1983; Dunn & Martorell, 1984; Greaves et al., 1989; *Hamill et al., 1979; **Malina et al, 1987a, 1987b; ***Yip et. al, 1992). Although the total numbers may seem large, they were composed of children of several races, many age categories, and both genders (Hamill et al., 1979; Malina et al., 1987a, 1987b; Kumanyika et al., 1990; Scholl et al.). All studies included all Hispanics, although origins could be from genetically dissimilar backgrounds, including Mexican, Puerto Rican, Cuban, Dominican, Central American and South American (Hispanic Databook, 1994). The Pediatric Nutrition Surveillance System was the only study that included children younger than 2 years of age. In the study, data were collected from over 5,000 centers. Hispanics of all origins were included, even though their genetic origins might be different. Reliability of measurement data would be difficult to achieve with such a large number of centers contributing information (Yip et al., 1992). A gap existed in the literature comparing the growth of Hispanics of Mexican origin children and of Caucasian children in the same clinic populations, from 2 to 24 months of age. If a difference was identified, more study would be necessary to establish growth curves. Then growth could accurately be evaluated in this large population of children.

Theoretical Framework

Malina and Bouchard's theory of growth, first published in 1975 by Malina and revised with Bouchard in 1991, is the most widely accepted, comprehensive explanation of the phenomenon (Malina & Bouchard, 1991). Although scholars may differ in their opinion of the importance of each of the determinants of growth, most agree with Malina and Bouchard's selection. The authors theorized that growth is dependent on a complex interplay of biologic and environmental factors. The biologic factors include genetics, endocrine gland function, nutrition, presence or absence of disease, and physical activity. Environmental factors include climate, social conditions, rearing style, sibling interactions and cultural practices.

The Malina and Bouchard (1991) theoretical framework was adopted for this study due to its comprehensive overview of determinants,of growth. This study examined two determinants, genetic factors and nutrition factors, in a clinic population. Both of these determinants are included in the Malina and Bouchard framework.

This framework is consistent with the genetic model of multifactorial inheritance. The multifactorial model explains that many human characteristics are caused by the products of various numbers of genes from both parents and the effect of several environmental factors working together (Jorde, Carey, Bamshad & White, 1999). The genetic influences in Malina and Bouchard's framework (1991) include genes for growth, genes that contribute to the functioning of the endocrine glands, genes that involve the metabolism and the utilization of nutrition, and genes that contribute to the occurrence or nonoccurrence of disease (due to immune function). The environmental influences in Malina and Bouchard's framework include outside influences on endocrine function such as sleep and adequate vitamin intake; availability of nutrition; physical activity; exposure to infectious organisms and treatment of disease; climate; social conditions; rearing style; sibling interactions; and cultural practices.

Assumptions

The following are the assumptions for this study:

1. Hispanics of Mexican origin have genes that code for growth that are more similar within their group than with others outside of their group due to generations of heritage. Due to these genes, characteristics such as growth or body stature may be more similar to those of similar heritage, than to the general population. In other words, genetic diversity exists among people of different origin.

2. Caucasian and Hispanic children who are served by the same clinic have access to the same federal nutrition programs. All three clinics in this study employ nurses and social workers who educate their patients about the availability and eligibility of nutrition programs.

3. The climate, air quality, purity of the water, and exposure to soil contaminants would be the same in Caucasian and Hispanic children served by the same clinics.

Hypotheses

The following were the hypotheses for the study:

1. At age 2 months, Hispanic boys will be shorter in length, heavier in weight, and have higher body mass indexes than Caucasian boys.

2. At age 2 months, Hispanic girls will be shorter in length, heavier in weight, and have higher body mass indexes than Caucasian girls.

3. At age 4 months, Hispanic boys will be shorter in length, heavier in weight, and have higher body mass indexes than Caucasian boys.

4. At age 4 months, Hispanic girls will be shorter in length, heavier in weight, and have higher body mass indexes than Caucasian girls.

5. At age 6 months, Hispanic boys will be shorter in length, heavier in weight, and have higher body mass indexes than Caucasian boys.

6. At age 6 months, Hispanic girls will be shorter in length, heavier in weight, and have higher body mass indexes than Caucasian girls.

7. At age 12 months, Hispanic boys will be shorter in length, heavier in weight, and have higher body mass indexes than Caucasian boys.

8. At age 12 months, Hispanic girls will be shorter in length, heavier in weight, and have higher body mass indexes than Caucasian girls.

9. At age 24 months, Hispanic boys will be shorter in length, heavier in weight, and have higher body mass indexes than Caucasian boys.

10. At age 24 months, Hispanic girls will be shorter in length, heavier in weight, and have higher body mass indexes than Caucasian girls.

11. At ages 2, 4, 6, and 12 months, breast-fed children will have different heights and weights than bottle-fed children.

Definitions

Study concepts have been defined for clarification. Height, weight, Caucasian, Hispanic, and body mass index are conceptually and operationally defined.

Height is defined as the distance or measurement from the base or foot to the top (New Webster's Dictionary, 1993) and in this study was the distance from the bottom of the foot of the child to the top of the head in feet and inches.

The conceptual definition of weight in the New Webster's Dictionary (1993) is the "force acting on a body in a gravitational field equal to the product of its mass and the acceleration of the body produced by the field." In this study it was measured in pounds and ounces on standard balance beam scales.

The conceptual definition of Caucasian is a member of the predominantly White-skinned race (New Webster's Dictionary, 1993). It was operationalized as White race defined by the report of the study participants.

The definition of Hispanic is an American of Spanish or Portuguese descent or of Latin American origin, especially one who speaks Spanish or Portuguese (New Webster's Dictionary, 1993). This study defined Hispanic as a person of Mexican descent, who may or may not be Spanish speaking.

Body mass index is defined as a measure of body stature determined by dividing the weight in kilograms by the height in meters squared, both conceptually and operationally.

Limitations

The purpose of this study was to compare the growth of children of Hispanic and Caucasian origins and to compare the growth of breast- and bottle-fed children. Therefore, limitations of the study included possible inaccuracies in measurement and inaccuracies in assignment of children into the different categories being compared. Limitations include the following:

1. Researchers may have measured children inaccurately by not following established protocols or by having difficulties in positioning infants and children.

2. The participants may have inaccurately reported their heritage.

3. There may have been a difference in the growth of recent immigrants from Mexico and those who were descendants of several generations of American Hispanics.

4. Children who were served by different clinics may have differed from each because of differences in the availability of services.

Delimitations

Delimitations of the study include the following:

1. Children who attend selected community health clinics in the North Texas area were invited to participate in the study.

2. The study requested participation of healthy children without underlying chronic or genetic disease or prematurity.

3. The study included children whose parents and grandparents were all Hispanic of Mexican origin or parents and grandparents who were all Caucasian.

4. Children aged 2, 4, 6, 12, and 24 months were included.

Summary

This chapter has presented an introduction to a cross-sectional study that compared the growth of Hispanic children of Mexican origin and Caucasian children at ages 2, 4, 6, 12, and 24 months of age. It also compared the growth of breast- and formula-fed children at 2, 4, 6, and 12 months of age.

Growth is an important parameter to examine, because it is a valuable indicator of good or poor health in children. If groups of children in good health are identified who have different growth patterns, this information could be utilized to develop a set of growth percentiles for their population. This has been accomplished in countries throughout the world (Delgado, Palma, & Fischer, 1991; Edwards & Morse, 1989 Stephenson, Latham, & Jansen, 1983).

The theoretical framework for growth used by this study was Malina and Bouchard's (1991) theory of growth, which identified many biological and environmental contributors to growth. From their framework, two factors of growth, genetics and nutrition, were selected to be examined. Genetic parameters included Hispanics of Mexican origin and Caucasian children. The nutrition parameters selected for this study were breast- and formula-feeding. Therefore, this study provided information to determine whether or not a difference existed in growth between several groups: (a) Hispanic children and Caucasian children in the same clinic population, and (b) breast- and formula-fed children in the same clinic population.

CHAPTER II

REVIEW OF LITERATURE

The growth of Hispanic children as addressed in the literature originates from two different perspectives: anthropology and nutrition. Although all pediatric nurses assess growth routinely, the nursing literature reveals few articles on the subject. The purpose of this study was to address the need for Hispanic early childhood growth data.

The review of the literature was approached by examining existing data in the anthropological and nutritional fields concerning Hispanic childhood growth. Topics reviewed included: background information about the Hispanic and Caucasian populations, determinants of growth of all children in general, effect of breast-feeding on growth, and the use of the body-mass index to assess growth, and the present state of knowledge about the growth of Hispanic children.

Hispanic and Caucasian Population

According to the 1990 census, persons of Hispanic origin comprise 8.8% of the total U.S. population and 28% of the Texas population. Overall, Hispanics have mixed ancestry, including Mexican, Puerto Rican, Cuban, Dominican, Central American, and South American. In Texas the majority (90.8 %) is of Mexican ancestry (Hispanic Databook, 1994). Caucasians also have mixed ancestry, with England, Germany, and Ireland making up the most common countries of origin (Lavin, 1996). In the United

States, Hispanics are a predominantly young population (average age 23.3 as compared to 31.9 in non-Hispanic) experiencing high fertility rates of 93 per 1,000 women aged 15-44 years compared to 68.5 per 1,000 of all other origins combined (Reddy, 1993). The numbers of Hispanics in the U.S. increased 53 % between the 1980 census and the 1990 census, much higher than the 7.4 % increase in the total population (Schick & Schick, 1991). Several large Texas cities report significant Hispanic numbers: El Paso, 69.6%; San Antonio, 47%; Austin, 20.9%; Houston, 20.7%; and Dallas, 13% (Honnon, 1994; Schick & Schick, 1991).

It is important to remember that American Hispanics are a heterogeneous group. "They represent all shades of acculturation, education, income, and citizenship status" (Balcazar, Aoyoma & Xi, 1991, p.420). Some of the studies previously described include Hispanics of Puerto Rican or Cuban origin, mixed in with those of Mexican origin. Data from each group must be compared to determine whether or not differences exist among the subgroups.

The division of the world's people into classifications has traditionally been completed by physical characteristics: color of skin, color and the texture of the hair, body stature, and facial features. Physical anthropologists have used three to nine categories and continue to have difficulties assigning people to classifications (Lavin, 1996). Some biologists are using DNA polymorphisms to determine origins of groups of people (Weaver & Hedrick, 1997). People are difficult to classify into racial categories due to the wide variation of characteristics within races. The interbreeding of racial groups results in the blending of populations. Modern scientists usually use the classification of race as a social grouping, not a biological one. Although racial grouping is important in the United States in how people relate to one another, many other countries place more emphasis on differences in religion or language.

According to the guidelines of the U.S. Census Bureau, the term Hispanic refers to "persons born in Puerto Rico, Cuba, Mexico, or other Spanish-speaking countries, persons whose ancestors came from a Spanish-speaking country, and persons who identify themselves as Spanish-speaking or Spanish-surnamed" (Lavin, 1996, p. 136).

Hispanic people may be of any race. The majority are White, with Black, American Indian, and Asian following in descending order. The U.S. Census Bureau racial categories include White; Black; American Indian, Eskimo, or Aleut; Asian or Pacific Islander; and Other Race. The bureau instructs Hispanics to select White unless they identify with one of the other racial categories. Because many Hispanics do not see themselves as White, they chose Other Race and wrote classifications such as "Latino," Puerto Rican," and "Brown" (Lavin, 1996).

The term Caucasian refers to people of the White-skinned race (New Webster's Dictionary, 1993). Although the Census Bureau includes people of Hispanic origin and of Middle-Eastern ancestry in this category, in this study, the classification Caucasian was used to describe non-Hispanic Whites.

Determinants of Growth

Robert M. Malina's theory of the regulatory and influencing factors of growth provides a comprehensive, clear framework for understanding the mechanisms involved in this complex process. His theory proposed that growth is determined by the interplay of the following factors: genetics, endocrine glands, nutrition, and environmental factors such as climate and presence or absence of disease. Malina and Bouchard (1991) later expanded the category of environment by adding physical activity, social conditions, rearing style, sibling interactions, and cultural practices.

Malina and Bouchard (1991) regard the individual's genotype, or genetic endowment, as the potential a person has for growth. If the person receives optimum nutrition and other environmental influences during infancy and childhood, the growth potential will be achieved. The child's phenotype, or observable characteristics, will match the child's genotype.

The endocrine hormones, which are regulated by genetic programming, are important in obtaining optimum growth potential. Some growth will occur without them, but it will be impaired. Nutrition makes the largest environmental contribution to growth. The person's nutritional requirements are unique due to the genetic influence, and this factor interacts with endocrine influence and the basic genetic potential for growth. The other environmental determinants of growth, such as physical activity, socioeconomic conditions, rearing style, sibling interactions, and cultural practices are difficult to quantify and document; therefore, growth is a complex concept with many factors involved in the time between conception and maturity (Malina & Bouchard, 1991).

Genetic Determinants of Growth

The human genome consists of approximately 100,000 genes on 46 chromosomes that come in pairs. The genetic material is located in the nucleus of every cell of the body. Through a complicated series of steps, spermatocytes and oocytes undergo meiosis, in which the resulting cells only have 23 chromosomes. Therefore, when the sperm and the egg unite to form the zygote in conception, the offspring receive 46 chromosomes, 23 from each parent. Human genetic material (deoxyribonucleic acid) is organized into 22 pairs of autosomal chromosomes and 1 pair of sex chromosomes. The male,s sex chromosomes consist of an X and a Y chromosome, and the female's sex chromosomes consist of two X chromosomes (Cummings, 1997). Human chromosomes can be visualized during mitosis, which is the process of normal cell division in which the resulting cells contain the same number of chromosomes as the parent cells. Cells are stimulated to "grow", using agents and nutrients that encourage division, and are "frozen" by utilizing another agent that stops the cell division at that immediate moment in the cell cycle. The chromosomes are visible after staining. A variety of stains is used to illuminate the specific areas of the chromosomes that the cytogeneticist chooses to study. The chromosomes are then photographed and arranged in an internationally accepted placement, generally from the largest to the smallest, which is called a karyotype.

Chromosomes are actually long strings of genes. Each gene is made up of two long strands of the four DNA bases: adenine (A), cytosine (C), guanine (G), and thymine (T). The strands, held together with hydrogen bonds, twist together in the form of a double helix. The strands complement each other by the pairing of specific bases together: adenine with thymine and cytosine with guanine. The approximately 2 billion pairs of bases of the human genome are being sequenced in the Human Genome Project, coordinated by the National Institute of Health and the Department of Energy (Lea, Jenkins, & Francomano, 1998; Lewis, 1997).

The millions of base pairs code for amino acids that are incorporated into polypeptides and eventually synthesized into proteins. Each triplet of base pairs codes for a specific amino acid or for the end or beginning of a gene. The information is taken from the gene to the working parts of the cell by ribonucleic acid (RNA). The messenger RNA produces a copy of the complement base pairs of the DNA strand and translates this to the cell, which builds proteins according to the DNA "recipe" (Lea et al., 1998; Lewis, 1997).

How the gene expresses itself is an active area of research. It is not well understood how some genes in differentiated cells become active and others repressed. Some genes, such as those that code for glycolysis, essential for metabolic activity in all cells, are present in almost all cells. The understanding of this process may help develop treatments for the abnormal growth of cancer and allow for slowing the process of aging. In some tissues, the genes turn on and off, according to the needs of the body. Activation may be stimulated by neural or hormonal agents (Malina & Bouchard, 1991).

In spite of the uniqueness of each human being, it is estimated that only about .3% of the genome varies from individual to individual. This small percentage of the genome is responsible for the variation in people. When a gene has been identified to have multiple forms, or alleles, in at least 1% of the population, it is called a polymorphism. Genetic polymorphisms exist for red blood cell antigens, tissue antigens, serum proteins, and red blood cell enzymes (Jorde et al., 1999).

Genetic textbooks have long used height as an illustration of multifactorial inheritance. This type of inheritance recognizes the interaction of multiple genes (genotype) from both parents and from the environment that result in the physical characteristics of individuals (phenotype). The genotype is the genetic blueprint of a person that is present at the moment of conception and does not change throughout life (with the exception of malignant cells). The phenotype of a person is the total of characteristics that can be seen and measured, which can change throughout the lifetime. One particular gene's environment includes all the other genes in the person's make-up in addition to physical and social influences on the person (Cummings, 1997). These disorders and traits caused by multifactorial inheritance tend to follow bell curve patterns of distribution in the population (Jorde et al., 1999).

Multifactorially caused disorders include neural tube defects, cleft lip and/or palate, diabetes, hypertension, clubbed foot, and many other common diseases. Some characteristics that are inherited in this manner include weight, talents such as music and athletics, and abilities such as intelligence. Factors that influence growth include genes, nutrition, psychosocial conditions, environmental physical conditions, and overall health (Cummings, 1997; Jorde et al., 1999; Lea et al., 1998; Lewis, 1997).

Studies of twins are often used to determine the genetic and environmental origins of charactersitics. Because monozygotic twins have identical genomes, similarity that is greater than that observed in dizygotic twins, who only have half their genes in common, is attributed more to genetic than environmental influence. In contrast, if monozygotic twins are no more similar than dizygotic twins, the trait is attributed to the environment (Cummings, 1997). The strong convergence of growth curves for monozygotic twins suggests a strong genetic determinant in a large study of twin pairs in which zygosity was determined by blood type. If any of 22 antigens were different in any twin pair, they were classified as dizygotic. At birth, the monozygotic pairs' heights were correlated at r=.66 and by 4 years of age had become correlated to r=.94, which remained constant thereafter (±0.1). Weight correlated at r=.64 at birth and .86 to .89 from 3 years of age and older. By contrast, the dizygotic twins' height correlated at birth at r=.77, regressed to r=.59 at 2 years, and regressed to r=.49 at 9 years (Lewis, 1997).

The digygotic twins were more concordant than the monozygotic twins at birth and moved in divergent directions after birth. The similarity in size at birth may be due to common prenatal environment and gestational age. After birth, different environments interacted with the twins' different genetic potential to produce dissimilar heights. The similar heights of the monozygotic twins confirm a profound genetic influence on height but not much on weight (Lewis, 1997).

A Swedish study of twins observed children through adolescent years. Monozygotic correlations for height were .93-.97, and the dizygotic correlations were in the mid-.60s. For weight, the monozygotic girls were slightly more concordant (.88-.92) than the boys (.82-.88), but dizygotic girls showed a large difference as they grew older (.69 at age 12 and .23 at age 16 years). Digygotic twin boys' correlations ranged from .54-.68 This study is consistent with the previous study of twins in that the high correlation in monozygotic twins for height suggests strong genetic influence. Even though the correlation for weight is less than height in both monozygotic and dizygotic twin pairs, the consistently higher correlation in monozygotic than in dizygotic twin pairs suggests that a genetic influence is present (Lewis, 1997).

Studies of twins indicate a genetic factor in growth potential. Similar to many other phenomena of the human, the multifactorial model of inheritance can be applied to growth. The genetic plan for an individual can be realized only if the endocrine system functions well, adequate nutrition is ingested, and environmental factors are conducive to growth.

Endocrine Determinants of Growth

Endocrine glands are sometimes called the ductless glands, or glands of internal secretion. They produce hormones that are delivered directly into the bloodstream. Through bloodstream distribution, all body cells come into contact with the hormones, but not all respond to them. Specific hormones are recognized and utilized by specific tissues, and hormones vary in chemical structure. The pituitary, parathyroid, and pancreas hormones are proteins or derivatives of proteins. The hormones produced by the testes, ovaries, and adrenal cortex are steroids that are derivatives of cholesterol. Adrenal medulla and thyroid hormones are amines derived from amino acid substances (Malina & Bouchard, 1991).

Actions of hormones. Hormones basically regulate function and fall into three main categories: morphogenesis, integration, and maintenance. In morphogenesis, hormones determine the physical growth and maturation of the body. The rate of childhood growth is not constant. Children gain rapidly in both height and weight in infancy and early childhood, have a steady gain in middle childhood, a rapid gain during adolescence, and then a slow increase until adult size is attained. The growth rate is at its lowest point just before the adolescent spurt. Hormones are necessary for the full expression of the genetic potential of the body tissues (Gracey & Falkner, 1985; Malina & Bouchard, 1991).

Hormones help to integrate tissues so that the body responds in a coordinated fashion to stimuli. Stressful situations require responses from multiple tissues. Because hormones are circulated through all parts of the body by the bloodstream, they aid in the communication of stimuli and coordination of adaptive mechanisms. Hormones also help in the everyday maintenance of the body. The balance of minerals, chemicals, water, and substrates, such as glucose, is accomplished with the aid of circulating hormones (Gracey & Falkner, 1985; Malina & Bouchard, 1991).

Pituitary gland. The pituitary gland, which is sometimes called the master gland of the body, is the most important producer of hormones for growth. The pituitary is in the sella turcica of the sphenoid bone at the base of the brain. It is connected to the pituitary stalk, which connects to the hypothalamus, a part of the brain. The pituitary gland is made up of two lobes, the anterior and the posterior. The anterior pituitary produces six hormones: somatotropin (growth hormone), corticotropin (adrenocorticotropic hormone), thyrotropin (thyroid-stimulating hormone), and three gonadotropins (follicle-stimulating hormone, luteinizing hormone, and luteotropic hormone). In all of the hormones except the somatrotropin, or growth hormone (which generally affects the whole body,) the anterior pituitary hormones stimulate and maintain the production of other endocrine glands. The thyrotropin regulates the secretion of thyroid hormone; corticotropin stimulates the production of several adrenal cortex hormones, and the gonadotropin hormones; regulate the hormones of the ovaries and testes. If the pituitary gland fails to produce enough of these tropin hormones, the gland that it stimulates will produce a small amount, but not enough to fulfill its function (Reeves, Roux, & Lockhart, 1999; Wong et al., 1999).

Growth hormone, which is essential for normal growth, has both direct and indirect effects. The direct effects can be observed on the metabolic rate of carbohydrate and fat metabolism. Growth hormone decreases carbohydrate metabolism and increases burning of fat to meet energy needs. Indirect effects are produced by the somatomedins secreted by the liver in response to growth hormone. Somadomedins encourage protein synthesis and the proliferation of cells. Specific types of somadomedins, such as somadomedin C, stimulate the cell multiplication of specific tissues, which stimulates bone growth (Falkner & Tanner, 1978; Malina & Bouchard, 1991).

Growth hormone is distributed in pulse-like bursts during a 24-hour period. Children have more bursts than adults, and the peak is at the time of the adolescent growth spurt. The largest occur in the early part of deep sleep; therefore, it is difficult to measure growth hormone levels. Insufficiency of growth hormone can result in pituitary dwarfism. The child will have normal body proportions, such as upper body to lower body segment ratios, but the height is at least two standard deviations below the mean. Treatment with growth hormone can result in catch-up growth if the hormone is initiated prior to the cessation of bone growth due to closure of the epiphyses.

The posterior lobe of the pituitary gland affects various body functions. It produces hormones such as the antidiuretic hormone, which regulates water excretion and oxytocin, which helps prepare the uterus for contractions and stimulates lactation. The posterior lobe of the pituitary is not directly involved in growth (Reeves et al., 1999; Wong et al., 1999).

Thyroid gland. The thyroid gland is responsible for regulating metabolism. It is located in the neck in front of and on both sides of the trachea below the larynx. This two-lobed gland grows through childhood, with most of its growth in adolescence. Thyoxine is stimulated by the anterior pituitary's hormone thyrotropin. It and another hormone, thyrocalcitonin (which affects the amount of calcium in circulation) stimulate the use of oxygen and the expenditure of calories. The thyroid must function normally for growth to occur. Children with hypothyroidism are small, immature, and may have mental retardation. Due to the low cost of screening for this disorder, the dramatic effects of treatment, and the severe effects of the disease, newborn screening for hypothyroidism is in effect in most states (Reeves et al., 1999; Wong et al., 1999).

Parathyroid glands. The parathyroid glands consist of four to six glands located on the front of the thyroid gland. They produce parathormone, which regulates calcium and phosphate metabolism by stimulating an increase in calcium by decreasing calcium excretion in the urine, and thyrocalcitonin, which does the opposite of parathormone by increasing calcium bone deposition. The two hormones work together to maintain a proper level of calcium necessary for bone growth and the development of dentition (Wong et al., 1999).

Pancreas gland. The pancreas gland is located next to the duodenum of the small intestine, and its primary function is to aid in digestion by producing digestive enzymes. A small section of the pancreas, the Islets of Langerhans, produces insulin and glucagon, which regulate blood sugar. Because of the effect of insulin and glucagon on carbohydrate metabolism, they are important in normal growth. In addition, insulin is essential for the body's effective use of growth hormone (Wong et al., 1999).

Adrenal Glands. The adrenal glands located above the kidneys, are made up of two glands, the outer one which is the adrenal cortex, and the inner gland, the adrenal medulla. The adrenal medulla produces epinephrine in response to stimulation by the nervous system. Epinephrine is responsible for the physical responses to stress. The adrenal cortex produces steroid hormones that regulate growth and maturation in addition to other body functions. Excess production of hormones by the adrenal cortex results in growth stunting by increased protein catabolism in the bone and other tissues of the body (Wong et al., 1999).

Gonads. The hormone- and gonad-producing functions of the ovaries and testes are regulated by the follicle-stimulating hormone and luteinizing hormone produced by the anterior pituitary. The androgens and estrogens are responsible for a multitude of maturational changes in the adolescent years. In addition to the development of primary and secondary sexual characteristics in both males and females, the hormones promote nitrogen retention and tissue build-up. This results in the dramatic spurt in muscle mass, especially in males. Androgens (testosterone more than estrogen) also contribute to the growth of the skeleton in length and thickness. Estrogens promote the accumulation of fat on the hips, buttocks and breasts (Malina & Bouchard, 1991).

Nutritional Determinants of Growth

Nutrition is the most important environmental factor that is necessary for growth. Nutrition concerns the overall process of food intake in the human and includes the physiological dimensions such as digestion, absorption, adequate supply of essential elements and transformation to energy; and the social and cultural aspects, which include economics and attitudes and beliefs about food (Gracey & Falkner, 1985; Malina & Bouchard, 1991; Parizkova, 1996; Pediatric Nutrition Handbook, 1985). A comprehensive discussion of nutrition and its relation to growth is beyond the scope of this chapter. The following topics are summarized below: nutrients, nutritional requirements, energy requirements, protein requirements, and vitamin and mineral requirements.

Nutrients. Nutrients are the building blocks of food and are ingested and utilized by the body in combination with other nutrients, enzymes, and hormones. The way the body uses one nutrient depends on adequate amounts of other nutrients and other substances and on effective digestion and metabolism. For example, the body must have insulin, glucagon and other hormones, B complex vitamins, a well-functioning gastrointestinal system, and efficient metabolic pathways to utilize carbohydrates.

Nutrients are consumed in food, and eating is a culturally influenced activity. The foods a child may eat are established by the practices of the culture in which he or she lives. Some foods eaten in some cultures are not considered edible in others. In addition, the foods a young child may eat are determined by the family in which that child lives, and teenagers' foods are influenced by their peers' choices. In Western culture, advertisements, movies, television, and convenience influence the food choices of children and adolescents (Lifshitz, Finch & Lifshitz, 1991).

The six classes of nutrients are water, carbohydrates, fats, proteins, vitamins, and minerals. Water is an important nutrient that helps regulate the temperature of the individual and provides a solvent for the body. It constitutes about 75% of the body weight at birth and decreases to about 62% in adulthood (Malina & Bouchard, 1991).

Carbohydrates are the primary energy suppliers for the body. In childhood, only about 4%.5% of the body weight is comprised of carbohydrate stores. Carbohydrates are stored in the form of glycogen in the liver, and skeletal muscles and glucose molecules, in the blood (Malina & Bouchard, 1991).

Fat is an energy source that is stored in the form of tricylglycerols in adipose tissue. It constitutes about 15% of the body weight during infancy, and in young adulthood it constitutes about 25 to 30% of the body weight in females and 12 to 16% in males. It varies a great deal among individuals in childhood. Some polyunsaturated fatty acids, such as linoleic acid and arachidonic acid, are important during growth due to the requirements of cell membrane production (Malina & Bouchard, 1991).

Proteins can also be an energy source, but the most important functions in childhood are in the growth, maintenance, and repair of body tissues and in becoming the building materials for a variety of enzymes, hormones, antibodies, carrier molecules, contractile units, structural elements, and other substances (Malina & Bouchard, 1991). Protein makes up about 11% of the body weight at birth and increases throughout childhood to about 16% at young adulthood. When protein is digested, amino acids are released. Twenty amino acids are obtained from the diet, 9 of which cannot be produced by the body. These 9 are called essential amino acids because they must be obtained in the diet to support growth. The 11 other amino acids (nonessential) can be produced by the body if nutritional intake is inadequate. All of the amino acids are necessary for growth.

Vitamins function as regulators and often take part in chemical reactions. Vitamins must be in the diet daily because they cannot be produced by the body in necessary quantities to support growth. A deficiency of many different vitamins may have detrimental effects on growth. These include among others, vitamin D (rickets), B1-thaiamine (beriberi), folic acid (anemia), cobalamine (anemia), and vitamin C (scurvy). Minerals are also required by the body, probably for transport functions and chemical reactions in metabolism. At birth, minerals constitute about 2% of the body weight, and they gradually increase to about 6% by young adulthood. Among the minerals that affect growth are calcium and phosphorus (bone and tooth structure); sulfur (s-amino acids, coenzymes and connective tissue); potassium (osmotic pressure, membrane potential, nerve impulses); sodium (osmotic pressure, membrane potential, fluid volume); chlorine (osmotic pressure, fluid volume); and magnesium (bone and enzyme reactions) (Pediatric Nutrition Handbook, 1985).

Nutritional requirements. Nutrients in childhood are needed for the following: maintenance of resting metabolism, provision of elements necessary for growth, repair of injured tissues, provision of energy for physical activities, and provision of elements for energy and repair when the body is stressed by illness.

Nutritional requirements change as the child grows. They are also influenced by environmental factors, such as the altitude in which the child lives, infections and parasites to which the child may be exposed, and cultural dietary practices such as vegetarian preferences or other unusual practices. In addition, the genetic make-up of the child, in combination with the environment and types of nutrients, affects nutritional requirements. Individuals vary in the way they metabolize foods and utilize nutrients, according to their genetic structure. Therefore, because the needs of individuals vary from one to another and their needs vary due to age and other influences, it is difficult to establish nutritional requirements (Falkner & Tanner, 1978; Gracey & Falkner, 1985; Lifshitz, 1982; Lifshitz et al., 1991; Pediatric Nutrition Handbook, 1985).

Energy requirements. Calories are ingested in the form of fats, carbohydrates, and proteins to meet the energy needs of children. The energy value of fats is twice that of the other two nutrients. Lipids supply the body with about 9 kcal/g, and protein and carbohydrates supply about 4 kcal/g. Protein supplies both calories for energy and essential amino acids. If the child ingests too few calories for his or her energy needs, protein will be used for energy and will not be available for growth (Lifshitz et al., 1991).

The balance of the calories eaten in foods and the energy expended by the child must be positive (more intake than expenditure) for a child to grow. When the balance is positive, energy can be transformed into components necessary for cell division and growth of tissues. If the caloric intake is higher than the energy expenditure, the body stores the energy in triglycerides in adipose tissue. This energy can be accessed when needed for growth. Most of the caloric intake (about 95%) is used for the basic metabolic needs of the organs and tissues of the body. The following are components of energy expenditure of children: basal metabolic rate; resting metabolic rate; digestion, storage, or utilization of food; adjustments to hot or cold environments; energy used in physical activity; and energy used in growth. Basically, energy requirements are greatest in infancy and adolescence. After the age of 2, boys require more calories than girls. Because there is no significant difference in muscle mass at this age, the difference must be attributed to variation in the level of physical activity (Lifshitz et al., 1991).

The energy cost of growth is estimated to constitute about 24% of the intake in the 1st month of life. Because this time is transitional from fetal to postnatal life, the baby often loses body weight. During the 2nd month, the energy costs of growth increase to about 30% of calories ingested. It then declines during the remainder of the 1st year through the 2nd year of life. It represents about 7% of the energy intake from ages 4 through 12 months, 1.5% between 12 and 24 months, and about 1% of the intake between 24 and 36 months (Lifshitz et al., 1991).

Protein requirements. Protein provides the body with essential amino acids and nitrogen, both necessary for the proliferation of cells in growth. All amino acids are necessary for growth, but nine of them are called essential, because the body cannot make them. They must be ingested in the diet. Because the body does not store protein for long periods, the amount that is not used for the synthesis of other proteins or body tissues is used for energy. After it is converted to glucose it can be used as energy or stored as glycogen and triacylglycerol (Gracey & Falkner, 1985; Lifshitz et al., 1991; Pediatric Nutrition Handbook, 1985).

The World Health Organization has established minimum requirements of protein intake necessary for growth throughout childhood (Lifshitz et al., 1991). The requirements of protein per unit of body weight are highest in early infancy. Most of the protein eaten is used for growth in the first 2 years of life. As the rate of growth declines in childhood, the amount of protein necessary in the diet decreases. In older children, most of the growth is used for maintenance of the body tissue. The greatest difference in requirements between boys and girls is at the time of the boys' growth spurt (Lifshitz, et al., 1991).

Vitamin and mineral requirements. Vitamins are required by the body in childhood in small amounts and are primarily used for maintenance of body tissues, metabolism of nutrients, the production of red blood cells, and other functions. The necessity of vitamins is apparent in children who have severe deficiencies. For example, children who have deficiencies of vitamins A and D have abnormal bone growth and show stunted growth (Lifshitz et al., 1991).

Minerals contribute to the regulation of metabolic pathways and the structure of tissues. Calcium and phosphorus are necessary for bone growth. Magnesium aids in cell metabolism; sodium, potassium, and chlorine help maintain the fluid and electrolyte balance of the body, and potassium and sulfur aid in the synthesis and storage of protein. Inadequate intake of zinc is associated with growth stunting, and inadequate copper is associated with problems in ossification of the bone. Other minerals that influence growth include silicon, vanadium, manganese, iron, cobalt, nickel, zinc, and arsenic (Lifshitz et al., 1991).

Environmental Determinants of Growth

The environment affects childhood growth in multiple ways that are complex to study. The environmental factors include physical activity, socioeconomic status of the family, presence of illness, family size, and climate. These factors interact with the child's genetic composition, hormone activity, and nutrition intake to affect growth of the body (Gracey & Falkner, 1988; Lifshitz, 1982; Lifshitz et al., 1991; Pediatric Nutrition Handbook, 1985).

Indicators of socioeconomic status used in the Western cultures include annual family income, per-capita income, occupation and education of the head of the household, and place of residence. These criteria vary in different parts of the world. In general, children from higher socioeconomically-rated households are taller and heavier than are those from lower socioeconomically-rated rated households (Malina & Bouchard, 1991). Scientists agree that socioeconomic factors affect growth by influencing nutritive intake and the presence of infections.

Habicht et al. (1974) theorized that the pathways that lowered socioeconomic level affect growth. The socioeconomic status of a community, defined as wealth and education, impacts the use of land, income, infant-feeding practices, health practices and environmental sanitation. Land and income affect food resources, which impact nutrient intake, which ultimately affects growth. Infant-feeding practices directly determine nutrient intake and indirectly affect the child's vulnerability to infection, both of which have impact on growth. The health practices of a population and the sanitation of a community affect the number of episodes of infection, especially diarrhea, which can alter growth.

Socioeconomic status affects the family's ability to obtain high-quality food, health care to limit illnesses, and environmental cleanliness, and to practice good infant and childhood dietary habits. Because infants have such high nutritional needs and vulnerability to infections, they are especially at risk for slow growth in low socioeconomic households (Habicht et al., 1974).

Breast-feeding Effect on Growth

The benefits of breast-feeding range from a decreased incidence of minor illnesses such as ear infections, to decreased numbers of catastrophic occurrences of sudden infant death syndrome. They range from immediate benefits, such as fewer digestive disturbances, to later-in-life benefits, such as decreased incidences of multiple sclerosis, breast cancer (Dermer, 1996), and even high cholesterol (Anholm, 1986). A review of the breast-feeding literature is clearly beyond the scope of this review. However, Trahms and Powell (1996) raised the question as to whether the accepted growth rate of infants' doubling their birth weights at 5 months of age, and tripling it at 1 year, and increasing birth length 50% in 1 year (Pipes, 1993) is based on data on formula-fed infants. These authors, who were advocating the achievement of the Healthy People 2000 (U. S. Public Health Service, 1994) goals of increased numbers of breast-fed infants, asked if breast- fed children have different growth curves. Oski (1993) reported that, in general, breast-fed infants grow more rapidly than bottle-fed infants in the first few months of life and then grow more slowly than the National Center for Health Statistics standards.

A search of the literature reveals conflicting opinions as to the answer to this question. Wang (1996) found in her study of 145 Chinese infants, that at age 4 months, exclusively breast-fed infants had a significantly higher mean weight than formula-fed infants. (One would question whether infant formula available in China is similar to the quality here in the U.S.) Retrospective growth data of infants of enthusiastic breast-feeding mothers indicated that weight and length are above the 50th percentile up to 6 months of age.

A prospective study of 242 exclusively breast-fed infants demonstrated that 59 % grew satisfactorily up to 6 months. Thereafter, the percentage of infants whose growth remained adequate continued to drop to 15 % at the age of 1 year. All other infants required supplementary foods to maintain growth (Bergmann & Bergmann, 1986). Other authors have suggested that formula-fed babies are more susceptible to obesity because the mother may prompt the infant to finish the bottle, whereas breast-fed babies will stop when full. Studies have shown that formula-fed babies are often introduced to solid foods earlier than the breast-fed baby, which may result in overfeeding (Anholm, 1986). A question remains whether breast- or bottle-fed infants gain weight differently, and if so, how?

Body Mass Index

The most commonly used measure of body stature is the body mass index. This index, which is computed by dividing the weight (kg.) by the height (m) squared, was first described by Lambert Adolphe Jacques Quetelet in the 18th century. Sometimes called the Quetelet Index, it has been used as a measurement of obesity (Daniels, Khoury, & Morrison, 1997; Guo, Roche, Chumlea, Gardner, & Sierrogel, 1994).

Researchers are working to predict obesity in adulthood so that preventive measures can be developed in childhood before serious health complications occur. Long-term consequences of obesity can include cardiovascular disease, hypertension, and diabetes mellitus. Guo et al. (1994) found a correlation between high body mass index values from ages 1 to 11 to high body mass index values in adulthood. In contrast, they found that the body mass indexes of infants (children younger than 1 year of age) do not correlate with adult body mass indexes. Therefore, the identification of high body mass indexes in childhood could alert health care personnel to work with families to reduce body mass indexes by adopting healthy nutrition and exercise patterns. Infants younger than the age of 1 year with high body mass index values are not at an increased risk of maintaining it into adulthood.

In a study of 377 pairs of preschool-aged children (3-5 years) and their mothers, researchers compared many factors, such as Caucasian and Hispanic feeding practices, acculturation in the U.S., socioeconomic status, maternal nutrition knowledge, personal control over body weight, and demographic factors, with obesity as measured by high body mass index. Major risk factors for obesity in the Hispanic population identified were male sex, high body mass index of the mother, lower socioeconomic level of the family, bottle-feeding, use of the bottle to comfort the child, and more persons involved in feeding the child. In Caucasian families, obesity was associated with high birth weight, high body mass index of the mother, mother unmarried, lower socioeconomic level, and mother's external locus of control of body weight, bottle-feeding, use of bottle to comfort child, and number of persons involved in feeding the child (Alexander, Sherman, & Clark, 1991; Sherman, Alexander, Dean, & Kim, 1995).

Other studies have identified an increased incidence of obesity in the Hispanic population. A study of 2,241 Hispanic children in Arizona revealed that 13.3 % of the children aged 2 to 5 years were overweight, as compared with 8.9% of other ethnic groups (Yanochik-Owen & White, 1977). Social factors that contribute to obesity in Hispanic children include more bottle-than breast-feeding, and the belief that weight gain in infants is an indication of good health. Obesity in infancy was associated positively with the value that fat babies are healthy babies when drawings were used to assess mothers' concepts of ideal babies. In addition, obesity was associated with overweight in the mother and lower socioeconomic status (Alexander et al., 1991).

A study of 1,851 low-income Hispanic children aged 10 to 14 years in Edinburg, Texas, revealed that the boys and girls were significantly heavier and shorter than the means established by the National Center for Health Statistics (NCHS). The body mass index values were also greater than the NCHS values. The authors concluded that the high body mass index values can alert health care personnel to develop programs to reduce the obesity that predisposes this population to diabetes (Guinn, 1993).

Growth of Hispanic Children

The largest study of growth of Hispanic children analyzed measurements of 3,232 Mexican-American, 1,183 Puerto Rican, and 389 Cuban-American children (total 4,804). Sixty-eight to 126 children were measured in each gender category of each year from 2 to

17 years (National Center for Health Statistics Plan and Operation of the Hispanic Health and Nutrition Examination Survey, 1985). This can be compared to the total population growth curves based on 20,000 children (Hamill et al., 1979). The HHANES study revealed a "small" difference in height (2 cm. or less) from ages 2 to 12 years, with large differences of 5.7 cm. in boys and 4.4 cm in girls in adolescence (Martorell et al, 1989). A difference of 2 cm. may be meaningful to a nurse in a child health clinic who is determining whether a child is growing normally or if testing is necessary to look for malnutrition, underlying disease, or neglect.

Anthropometric measurements of Caucasian, African American, and Hispanic men, women, and children found that short stature in the Hispanic continues into adulthood. Both Hispanic women and men were significantly shorter than Caucasian and African American women and men, although no significant differences were found in weight. The numbers of study child participants were too small to determine differences (Greaves et al. 1989). This study confirms that the difference exists in adulthood, but leaves open the question of when the difference in growth occurs.

Martorell, et al.(1989) compared data from the HHANES study with a study in which measurements of children were collected 15 years earlier (Centers for Disease Control, 1972). A trend of increased size in the Hispanic children is apparent. Martorell et al. concluded that the increase in stature can be attributed to an increase in the quality of nutrition, and the small remaining difference in stature between the standard growth charts and the Hispanic sample can still be attributed to nutritional status. It was theorized that the larger difference in height in adolescents of Hispanic origin with the standardized growth charts may mean that the children may have had inadequate nutrition in early childhood that could not be overcome. It was predicted that a study conducted 10 years after the HHANES study would find no difference in height of Hispanic children and the standardized growth charts. From a genetics point of view, the differences in studies may reflect the true contribution of adequate nutrition. The differences found in 1985 in the HHANES study are remaining, probably due to the genetic contribution to growth. A difference will exist as long as ethnic groups remain identifiable.

Martorell et al. (1989) also analyzed the HHANES data by using regression analysis, using the factors of poverty and ethnic groups on the growth of the Hispanics. Analysis showed that poverty was the more significant predictor of stature in ages 2 to 11. From ages 12 to 17, ethnicity was a strong predictor, and poverty was not a significant predictor of growth. A study in which Caucasian and Hispanic children of similar economic backgrounds are compared would answer the question of whether a difference exists in a clear manner.

Findings of three studies of school-aged Hispanic children in Brownsville, Texas, in 1928, 1972, and 1983 revealed an increase in stature over the years, especially between 7 and 14 years of age. Although significant, the increase was not as large as those observed for children of North America and Europe between 1880 and 1950, who showed a gain of 1 cm and .5 kg. per decade from ages 5-7 years, 2.5 cm and .7 kg per decade in adolescence and 1 cm. per decade in adults. The researchers concluded that the gains were due to increased socioeconomic conditions and the availability of federal assistance programs. The researchers postulated that the insufficient gain (as compared with North

American and European children) of the older children may be due to the fact that the improved environment in the 1970s was not enough to overcome the low socioeconomic conditions of the 1960s (Malina et al., 1987a, & 1987b). The genetic viewpoint is much more consistent with the data; that is, although the children increased in stature due to an increased quality of nutrition, they nonetheless reached maximum potential based on their genetic endowment.

From 1980 to 1991, the Pediatric Nutrition Surveillance System reported information collected at public health programs in 37 states and the District of Columbia, Puerto Rico, the Intertribal Council of Arizona, and the Navaho Nation. Overall, children in lower socioeconomic groups were smaller than the growth norms. In this sample, which did not include measurements of children in Texas, the largest group of Hispanics was from Puerto Rico, a population with genetic background probably different from that of the Mexican American Hispanics (Yip et al., 1992).

A small California sample (209) of Hispanic preschool-aged children of Mexican American ancestry was studied in 1981. Most of the children were in families of migrant farm workers. The weight, height, and weight-for-height distributions were similar to the National Center for Health Statistics percentiles. Only 8 percent of the children were below the 5th percentile for height. Because the sample of children came from a state-run migrant camp, the authors concluded that the findings cannot be generalized to the Hispanic population as a whole. Despite the limitations of the study, the authors supported the idea that with adequate nutrition, Hispanic children may, in height and weight, be similar to the American norm (Dewey et al., 1983). Similar findings were discovered at a health fair screening of 161 Hispanic children of migrant workers in Redwood City, California. The authors of this study stated that “short stature and higher weight for height values are not ‘genetic’ traits as some have suggested but rather reflections of the socioeconomic conditions of the Mexican-American migrant population” (Dunn & Martorell, 1984, p.344). Both studies had sample sizes much too small to make these conclusions. In addition, a comparison to other children of similar socioeconomic conditions was not made.

Studies of school-aged children in New Jersey and the District of Columbia had conflicting results. In the New Jersey study of Hispanics of Puerto Rican origin, the boys were .5 cm. shorter and the girls were .9 cm. taller than Caucasian children. Although the sample size was small (10-86 in each category), the authors concluded that, within similar environments, the children of different ethnic groups have similar heights. This finding led the researchers to conclude that the differences found in some previous studies were due to environment, not genetics (Scholl et al., 1987). With the small sample size and the unexplainable data (shorter in males and taller in females), the conclusions are illogical and inconsistent. The studies were inconclusive.

In a Washington, D. C., study of 5,170 kindergarten children, Hispanic boys had an increased incidence of stature below the 5th percentile. More than one third were in the lowest 2 deciles of the standardized growth charts. Other observations include a high weight-for-height percentile, which may indicate an early development of overweight, muscularity, or overall maturational status (Kumanyika et al., 1990). This would support a hypothesis that Hispanic growth is different than others at age five. The origins of the Hispanics were not revealed in the description of the study.

Growth of Caucasian Children

As was discussed in the previous chapter, the growth of Caucasian children was well documented in the National Center for Health Statisitics' (NCHS) growth charts. Based on measurements over time, a trend of increased height and weight has been documented and attributed to increased quality of nutrition. The growth of children was first investigated in 1833, to study children employed by factories. When it was found that these children were shorter than the average child of that time, laws were passed to prohibit children younger than 9 years of age from working (Edwards & Morse, 1989). The NCHS percentiles have been widely adopted in pediatric care in the United States and Canada. Some authors have urged the use of this standard throughout the world as an international standard regardless of genetic factors of specific populations (Demirjian, Bailey, DePena, Auger, & Jenicek, 1976; Goldstein & Tanner, 1980; Habicht et al., 1974).

Summary

This chapter has provided background information regarding the Hispanic population, determinants of growth, breast-feeding's effect on growth, body mass index, and a comprehensive review of research of growth of Hispanic children. The Hispanic people constitute a large growing population with health strengths and risks (Balcazar et al., 1991; Hispanic Databook, 1994; Markides & Coreil, 1986). Although many studies have measured the growth of Hispanic children, they were either completed over a decade ago, were performed on small samples, or had conflicting results (Centers for Disease

Control, 1972; Dewey et al., 1983; Dunn & Martorell, 1984; Greaves et al., 1989; Hamill et al.,1979; Kumanyika et al., 1990; Malina et al., 1987a; 1987b; Martorell et al., 1989; Scholl et al., 1987; Yip et al., 1992). None have been completed in children less than 2 years of age, comparing 2 races in the same population. The researchers of the HHANES study recommended that an additional study be completed about 10 years after it was published, which would have been 1995 (Hamill et al., 1979).

Studies of children from 2 to 14 years of age have indicated that Hispanic children have elevated body mass index values, which can be a risk factor in developing obesity in adulthood (Guinn, 1993; Guo et al., 1994; Sherman et al., 1995; Yanochik-Owen & White, 1977). Again, no studies have been completed that document the body mass index of Hispanic children younger than the age of 2 and compare them with children from the same clinic population who are of Caucasian background.

Whether an infant is bottle- or breast-fed may impact the child's growth. It appears that, ultimately, breast-fed infants are less likely to have high body mass index values than formula-fed infants (Anholm, 1986; Sherman et al., 1995; Alexander et al., 1991). The present researcher echoes the question asked by Trahms and Powell (1996) as to whether breast-fed infants have different growth rates than formula- fed ones and whether the U.S.-accepted standards for adequate infant growth are based on infants who are formula-fed.

As in any search for knowledge, this review of the literature has not answered all the questions as much as it has helped to identify additional ones. It is reassuring to read in Doing Naturalistic Inquiry (Erlandson, Harris, Skipper, & Allen, 1993) that "good researchers, representing every paradigmatic stance, are similarly awed by the depth and complexity of the fields they are investigating" (p. 20).

CHAPTER III

PROCEDURE FOR COLLECTION AND TREATMENT OF DATA

This chapter describes the design of the study, including the sample, population, data collection, and treatment. This study was non-experimental and cross-sectional and sought to compare several pairs of groups. Although basic and straightforward, the complexity was in its scale due to the large numbers required to achieve power.

Power

Power analysis was performed prior to establishing the number of participants who would be measured. This type of analysis allows the researcher to estimate the ability to reject the null hypothesis. First, the significance criterion was established at $p=.05$ because it is the most widely accepted standard in research. It sets the chance that a researcher would reject a null hypothesis that is true as 5 times out of 100 samples. The population effect size was set as medium, or .50. This was estimated based on the review of the literature and examination of the pilot data. An effect size of .50 estimates the relationship between genetic heritage and growth, as well as breast- and formula-feeding, and growth was estimated as medium strength. The power was set at .80, which is a scientific standard. This sets the chance that the researcher would accept a null hypothesis that is false as 20 times out of 100. For a one-tailed t-test (the Hispanic and Caucasian group comparisons), the power analysis indicated that a sample size of 50 subjects in each group was required. For a two-tailed t-test (the breast- and formula-feeding comparison), the power analysis indicated that a sample size of 63 in each group was required (Polit, 1996).

Setting

The data were collected in three community-based clinics in mid-sized cities in the North Texas area (Appendixes B, C, & D). The nonprofit clinics primarily serve indigent populations and services are offered on a fee-for-service basis. A sliding scale was used to determine clients' ability to pay. One of the clinics administers the federally funded Women, Infant and Children (WIC) Program. This program provides food supplements such as milk, cheese, peanut butter, eggs, beans, cereals, juice, and formula for pregnant women and their young children. In the WIC program, the children's growth is carefully monitored. A diverse population of Hispanic, Caucasian, and African American patients utilizes these services.

All three settings have waiting areas in which the potential participants for the study were approached and the study was described. The parent or guardian of the potential study participant was approached and asked if he or she would like to participate in a study of children's growth. The clinic clients were reassured that their clinic appointment would not be prolonged or affected in any way and that there was no cost to them. A consent form (Appendix E) was given to the client, and ample time to read it and answer questions allowed. Demographic, background, and feeding data were collected prior to measurement of the child. If the client spoke only Spanish, personnel who work for the clinics explained the information. The Spanish language consent form was given to the Spanish-speaking clients (Appendix F).

The weight scales were tested using a 5-pound sack of flour. Since all scales accurately registered 5 pounds, no adjustments were necessary. At all locations the scales were calibrated in both kilograms and pounds. The height scales were checked with a ruler and determined to be accurately placed. They were all marked in both centimeters and inches.

Population and Sample

The population was all of the clients seen in three clinics in mid-sized North Texas cities. In all, the three clinics serve approximately 4,837 Caucasian and Hispanic children.

The sample for this study included children who were free of any chronic health condition, prematurity, or genetic syndrome. They were at least 3/4 Hispanic of Mexican origin, or 3/4 Caucasian, based on self-report of the participants. The children were boys and girls of the following ages: 2 months, 4 months, 6 months, 12 months, and 24 months.

Protection of Human Subjects

The study was developed and undertaken as a pilot study in the fall of 1997. The Texas Woman's University Human Subjects Review Committee reviewed the application and first approved it August 22, 1997 (Appendix A). As the research progressed to a full study in the fall of 1998, the Human Subjects Review Committee approved the design (Appendix A).

When the potential study participants were invited to participate in the study, they were assured that participation would not affect their clinic appointment in any way. They were also informed that this study would probably not reveal information to help their children, but that the information may help other children in the future. They were told that participation was voluntary. A consent form that was also translated into Spanish (Appendix F) was signed, and a copy given to the parent. The parent stayed with the child during the measurement so that two adults (the parent and the researcher or nurse) were with the child at all times to prevent falls.

Instruments

In all three settings weights were taken of children younger than 2 years on electronic scales that gave a digital readout in pounds and ounces. The 2-year-olds were weighed on a balance beam scale that measured in pounds and ounces.

The validity was tested by placing a 5-pound sack of flour on the scales. At all three clinics, the scales accurately registered 5 pounds. Reliability was determined through working with trained research assistants. The research assistants were undergraduate students selected by the researcher after interviews to ascertain characteristics such as consistency and attention to detail. Preference was given to applicants of Hispanic descent who spoke Spanish. The students selected to be research assistants were trained in the clinic setting in which data were collected. After observing the researcher enroll several participants, then weigh and measure them, the research assistant performed the tasks with the researcher present before working independently.

In all three settings, heights were taken of children younger than 2 years recumbent on a measuring board with has a stationary headboard and a sliding vertical foot piece. At 2 years, the child was measured against a stadiometer, an instrument designed for height measurement. Validity was addressed by comparing the device on the wall with a hand-held ruler. Reliability was addressed in the same manner as in the weight scales, with well-trained research assistants.

Data were recorded on a tool developed for this study (Appendix G). It included items such as income, number of months breast-fed, age, and heritage of the child for purposes of analysis and assignment to groups.

Data Collection

Preliminary Data Collection

Demographic data, breast-feeding history, and heritage of the family were collected by the research assistant. Information regarding whether the child, the child's parents, and the child's grandparents were Hispanic of Mexican origin or were of Caucasian origin was documented on the data collection sheet (Appendix D). The research assistant verbally asked questions except for the annual income data. The guardian of the child was asked to mark the income category of the family at that time. This procedure was used to give the family privacy in disclosing income.

Height Measurements of the 2-month to 23-month-old Children

Recommendations of the American Academy of Family Physicians, the U.S. Preventive Services Task Force, and the American Academy of Pediatrics for body measurement were adopted (U.S. Public Health Service, 1995). Two people were present during measurement to ensure safety and accuracy. One of these was usually the researcher or her researcher assistant, and the other person present was the parent or guardian of the child. The child was placed in a supine position, facing the ceiling, on a measuring board, with the head held by the parent at the headboard. The knees were held so that the hips and legs were extended. The foot piece of the measuring board was then moved until it was against the child's heels. Height measurements were read and recorded to the nearest 1/4th inch.

Height Measurements of the 24-month-old Children

Standing height was measured on children 24 months of age. A stadiometer was used in all three clinics. The child was in bare feet or socks only. The child stood, with head, shoulder blades, buttocks, and heels touching the stadiometer. The knees were straight, and the child was asked to look straight ahead. The moveable headboard of the instrument was lowered until it touched the crown of the head, compressing the hair. After the child stepped away from the stadiometer, the height measurement was read and recorded to the nearest 1/4th inch.

Weight Measurements of 2-months to 23-month old Children

An electronic scale was used to weigh infants. It was zeroed before each measurement. The child's clothing was removed except for a dry diaper. The child was placed on the scale, with no hands touching the child. The weight was read and recorded to the nearest ounce.

Weight Measurements of 24-month-old Children

A balance beam scale was used to weigh toddlers. It was zeroed before each measurement. The child's clothing was removed except for light indoor garments, such as a cotton shirt and dry diaper or underwear, and child was placed on the scale with no hands touching the child. The weights were moved until the bar balanced. The markings on the scale were read and recorded to the nearest ounce.

Chart Review

The child's medical chart was then reviewed to determine whether or not heights and weights were recorded on previous visits. If so, the child's age, heights, and weights were documented on the data collection tool in the chart data grid. Only the charts of children who had been seen in person and enrolled in the study were examined.

Pilot Data

In the pilot, 125 children were measured by one research assistant and the researcher. Because none of the categories contained more than 10 children, the cells were too small to complete data analysis to determine differences. The pilot was used to work out methods of data collection that were efficient without being intrusive in busy community clinics. In addition, charts for compilation of data were developed, and data entry for statistical analysis devised.

Treatment of Data

Within gender, the data were analyzed with William Gosset's t test (Munro & Page, 1993). The following t tests were performed:

1. Height between Hispanic males and Caucasian males at 2 months, 4 months, 6

months, 12 months, and 24 months.

2. Weight between Hispanic males and Caucasian males at 2 months, 4 months, 6 months, 12 months, and 24 months.

3. Body mass index between Hispanic males and Caucasian males at 2 months, 4 months, 6 months, 12 months, and 24 months.

4. Height between Hispanic females and Caucasian females at 2 months, 4 months, 6 months, 12 months, and 24 months.

5. Weight between Hispanic females and Caucasian females at 2 months, 4 months, 6 months, 12 months, and 24 months.

6. Body mass index between Hispanic females and Caucasian females at 2 months, 4 months, 6 months, 12 months, and 24 months.

7. Breast-fed and bottle-fed infants at 2 months, 4 months, 6 months, and 12 months.

8. Income between Hispanic and Caucasian children's families.

In this study, the classic question of whether two groups were different was stated. The t test indicates whether the difference was greater than that which would have been found by chance alone. This study fulfilled the requirements of the following t test assumptions:

1. It requires interval level data.
2. Each subject can only belong to only one group.

In the process of data analysis, it was necessary to determine whether the data of each measure was distributed normally. In addition, it was necessary to determine whether the groups were similar in their variances. Meeting the homogeneity of variance ensured against the possibility of a Type II error due to the difficulty of finding significance if variances are not equal (Munro & Page, 1993).

The statistical analysis was completed using SPSS statistical software. The t test determined whether differences between the Hispanic and Caucasian children's growth existed and whether differences in breast- and formula-fed children's growth existed in this sample.

Summary

The research design was to measure 50 children of both genders and origins in the age categories 2, 4, 6, 12, and 24 months. The determination of 50 children in each gender, age, and origin group was established by applying power analysis. The collection of data occurred in three similar community clinics that serve diverse indigent populations. Following a thorough explanation of the research, the participants were enrolled in the study and the consent form was signed by the guardian of the child. Preliminary information regarding origin, socioeconomic factors, and breast-feeding or formula-feeding was collected prior to the weighing and measuring of the child according to protocol. The data were analyzed through the use of a t-test, using SPSS software.

CHAPTER IV

ANALYSIS OF DATA

This chapter contains a description of the data collected and a report of the results of the statistical analysis performed. The sample is explored, and the findings are presented.

Description of the Sample

The researcher and the research assistants measured a total of 936 children. After the children were measured, their medical charts were reviewed to determine whether any previous measurements had been recorded at the children's 2-, 4-, 6-, or 12-months-of-age clinic visit. An additional 90 sets of measurements were recorded from the charts and used in the analysis. The total number of sets of data, including research measurements and chart data was 1,026.

The goal of obtaining 50 sets of measurements in each category (sex, race, and age) was achieved except in the 2-year-old categories (Table 2). It appeared that those children were not regularly being seen in the clinics used for data collection in this study. It is recommended that children have a well-child check-up at this age, but no immunizations are planned if the child is up-to-date. Therefore, families probably save money and time by not bringing the children to the clinic.

In all the age categories except 24 months, the numbers of children were similar in the Hispanic and Caucasian groups. No categories revealed a large difference in number that required data transformation. Although collection of the 4-month age category was accomplished early in the data collection period, many more months of collection were required to reach the collection goals in the other categories. At all age levels, the collection of male data was completed before that of female data.

Table 2 lists the total number of sets of measurements by ethnic group, gender, and age.

Table 2

Sample Size

	Hispanic boys	Caucasian boys	Hispanic girls	Caucasian girls
2 months	75	68	53	59
4 months	63	60	51	56
6 months	54	50	50	53
12 months	56	56	58	50
24 months	34	29	31	20

The percentage of families on Medicaid was similar in the Hispanic and the Caucasian children in the study. It was assumed that the eligibility requirements of Medicaid for the maximum income related to family size would qualify children from similar socioeconomic backgrounds. Table 3 reveals the percentages of children in Medicaid in each age and ethnic category. Only in the girls aged 12 and 24 months and the boys aged 24 months, was a moderate difference (more than 10) found. However, it was inconsistent. More Caucasian girls and Hispanic boys were on Medicaid in these age categories.

Table 3

Percentage and Number of Children on Medicaid

	Hispanic girls		Caucasian girls		Hispanic boys		Caucasian boys	
	%	n	%	n	%	n	%	n
2 Months	84.6	44	83.1	49	90.7	67	79.4	54
4 Months	74.5	54	82.1	46	88.9	56	80.0	48
6 Months	90.0	45	90.6	48	85.2	46	78.0	39
12 Months	56.9	33	80.0	40	67.9	38	76.8	43
24 Months	67.7	21	90.0	18	88.2	30	65.6	19

The median incomes of families of children who did not have Medicaid were determined to ensure that a large difference did not exist between Hispanic and Caucasian children in this population. A difference of one category was identified in 6-month-old girls and boys and 24-month-old girls and boys. In theses categories, the sample of children with Caucasian background consistently showed a higher income. The numbers of families evaluated for median income were small. The incomes were similar enough to ensure that socioeconomic variability between the groups was not a factor in the families' ability to obtain adequate nutrition for their children. Table 4 illustrates the median income in dollars.

Table 4

Median Income

	Hispanic girls	Caucasian girls	Hispanic boys	Caucasian boys
2 Months	10,000-19,999	10,000-19,999	20,000-29,999	20,000-29,999
4 Months	10,000-19,000	10,000-19,999	20,000-29,000	20,000-29,000
6 Months	10,000-19,999	20,000-29,999	10,000-19,999	20,000-29,999
12 Months	10,000-19,999	10,000-19,999	10,000-19,999	10,000-19,999
24 Months	10,000-19,999	20,000-29,999	10,000-19,999	20,000-29,999

Findings

The findings of the study were organized according to the 11 hypotheses for the study.

Hypothesis 1: At age 2 months, Hispanic boys will be shorter in length, heavier in weight, and have higher body mass indexes than Caucasian boys. Analysis of the data by one-tailed t-test revealed that Hispanic boys were longer in length, heavier in weight, and had higher body mass indexes than Caucasian boys. Only the difference in weight was significant at the $p = .05$ level. The height revealed a mean difference of .2310 inches, which had a nonsignificant t-value of 1.11. The weight revealed a mean difference of 10.7871 ounces, which had a significant t-value of 1.59. The body mass index showed a mean difference of .5956, which had a nonsignificant t-value of 1.12. These data are illustrated in Table 5.

Table 5

Two-month Boys

	Hispanic mean	Caucasian mean	Mean difference	Equality of variance	t-value
Height	23.2200	22.989	.2310	Yes	1.11
Weight	208.2900	197.5029	10.7871	Yes	1.59*
BMI	16.9525	16.3569	.5956	Yes	1.12

df = 141, height in inches, weight in ounces; BMI = body mass index;

t-value* = significant.

Hypothesis 2: At age 2 months, Hispanic girls will be shorter in length, heavier in weight, and have higher body mass indexes than Caucasian girls. After analysis by one-tailed t-test, the findings of the study showed that the hypothesis was true, but only at the significant level of $p = .05$ for weight. All 6 groups (height, weight, body mass index for Hispanic and Caucasian) showed equality of variance. The mean difference in height was .2462 inches, which had a nonsignificant t-value of -.97. The mean difference of weight was 10.7871, which had a significant t-value of 1.59. The body mass indexes showed a mean difference of .5956, which had a nonsignificant t-value of 1.12. The findings are shown in the Table 6.

Table 6

Two-month Girls

	Hispanic mean	Caucasian mean	Mean difference	Equality of variance	t-value
Height	22.2877	22.5339	.2462	Yes	.97
Weight	208.2900	197.5029	10.787	Yes	1.59*
BMI	16.9525	16.3529	.5956	Yes	1.12

df = 141, height in inches, weight in ounces; BMI = body mass index;

t-value* = significant.

Hypothesis 3: At age 4 months, Hispanic boys will be shorter in length, heavier in weight, and have higher body mass indexes than Caucasian boys. After analysis by one-tailed t-test, the data revealed that, at 4 months, Hispanic boys were longer in length, heavier in weight, and had higher body mass indexes than Caucasian boys, but none of the differences are significant at the $p = .05$ level (Table 7). The mean difference of height was .0760 inches, which had a nonsignificant t-value of .31. The weight mean difference was 4.2944 ounces, which had a nonsignificant t-value of .71. The body mass indexes mean difference was .2817, which had a nonsignificant t-value of .84.

Table 7

Four-month Boys

	Hispanic mean	Caucasian mean	Mean difference	Equality of variance	t-value
Height	25.3968	25.3208	.0760	Yes	.31
Weight	261.1111	256.8167	4.2944	Yes	.71
BMI	17.7098	17.4282	.2817	Yes	.84

df = 121, height in inches, weight in ounces; BMI = body mass index;

t-value* = significant.

Hypothesis 4: At age 4 months, Hispanic girls will be shorter in length, heavier in weight, and have higher body mass indexes than Caucasian girls. After analysis by one-tailed t-test, the study findings showed that Hispanic girls were longer in height, heavier in weight, and had higher body mass indexes than Caucasian girls. Only the difference in weight was significant at the p = .05 level. The mean difference in height was .1809 inches, and the t-value was .75, which was not significant. The mean difference in weight was 8.6751 ounces, and the t-value 1.71, which was significant at the p=.05 level of significance. The difference in body mass indices was 1.47, and the t-value 1.47, which was not significant. The findings are shown in Table 8.

Table 8.

Four-month Girls

	Hispanic mean	Caucasian mean	Mean difference	Equality of variance	t-value
Height	24.4265	24.2455	.1809	Yes	.75
Weight	233.9608	225.2857	8.6751	Yes	1.71*
BMI	17.2862	16.6509	1.47	Yes	1.47

df = 105, height in inches, weight in ounces; BMI = body mass index;

t-value* = significant.

Hypothesis 5: At age 6 months, Hispanic boys will be shorter in length, heavier in weight, and have higher body mass indexes than Caucasian boys. After analysis by one-tailed t-test, the study showed the hypothesis to be true, however, not at the significant level of p = .05 (Table 9). The mean difference in height was .1294 inches, which had a nonsignificant t-value of -.56. The mean difference in weight was 9.0467 ounces, which was nonsignificant at a t-value of .99. The mean difference of the body mass index was .5436, which had a nonsignificant t-value of 1.06.

Table 9

Six-month Boys

	Hispanic mean	Caucasian mean	Mean difference	Equality of variance	t-value
Height	26.5556	26.6850	.1294	No	-.56
Weight	297.1667	288.1200	9.0467	Yes	.99
BMI	18.2252	17.6816	.5436	Yes	1.06

df = 102, Height in inches, weight in ounces; BMI = body mass index;

t-value* = significance.

Hypothesis 6: At age 6 months, Hispanic girls will be shorter in length, heavier in weight, and have higher body mass indexes than Caucasian girls. After analysis by one-tailed t-test, the study found Hispanic girls to be shorter in length, lighter in weight, and have higher body mass indexes than Caucasian girls (Table 10). The height and the body mass indexes differences were significant at the $p = .05$ level. The height computed to a mean difference of .4853, with a significant t-value of -2.39. The weight computed to a mean difference of 2.3370 ounces, with a nonsignificant t-value of -.34. The body mass index computed to a significant t-value of 2.

Table 10

Six-month Girls

	Hispanic mean	Caucasian mean	Mean difference	Equality of variance	t-value
Height	25.7600	26.2453	-.4853	Yes	-2.39*
Weight	260.3800	262.7170	-2.3370	Yes	-.34
BMI	17.3380	16.7206	.6174	Yes	2*

d.f. = 101, height in inches, weight in ounces; BMI = body mass index;

t-value* = significant.

Hypothesis 7: At age 12 months, Hispanic boys will be shorter in length, heavier in weight, and have higher body mass indexes than Caucasian boys. Analysis by one-tailed t-test revealed Hispanic boys to be shorter in length, lighter in weight, and demonstrating higher body mass indexes. None of these differences was significant at the p =.05 level (Table 11). The mean difference of the height was .3348 inches, which had a nonsignificant t-value of –1.5. The mean difference of the weight was 1.3393 ounces, which had a nonsignificant t-value of -.17. The mean difference of the body mass index was .0320, which had a nonsignificant t-value of .08.

Table 11

Twelve-month Boys

	Hispanic mean	Caucasian mean	Mean difference	Equality of variance	t-value
Height	29.5313	29.8661	-.3348	Yes	-1.5
Weight	364.0179	365.3571	-1.3393	Yes	-.17
BMI	17.8997	17.8677	.0320	Yes	.08

df = 110, height in inches, weight in ounces; BMI = body mass index;

t-value* = significant.

Hypothesis 8: At age 12 months, Hispanic girls will be shorter in length, heavier in weight, and have higher body mass indexes than Caucasian girls. Analysis by one- tailed t-test showed this to be true, but the difference was not significant at the $p = .05$ level (Table 12). The mean difference of the height was .2866 inches, which had a nonsignificant t-value of –1.21. The mean difference of the weight was 1.3607 ounces, which had a nonsignificant t-value of .18. The mean difference of the body mass index was .4203, which had a nonsignificant t-value of 1.35.

Table 12

Twelve-month Girls

	Hispanic mean	Caucasian mean	Mean difference	Equality of variance	t-value
Height	29.2284	29.5150	-.2866	No	-1.21
Weight	342.6207	341.2600	1.3607	Yes	.18
BMI	17.4055	16.9852	.4203	Yes	1.35

df = 106, height in inches, weight in ounces; BMI = body mass index;

t-value* = significant.

Hypothesis 9: At age 24 months, Hispanic boys will be shorter in length, heavier in weight, and have higher body mass indexes than Caucasian boys. After analysis by one-tailed t-test, the study found Hispanic boys to be longer in length, heavier in weight, and have higher body mass indexes than Caucasian boys, but not at a significant level of p=.05 (Table 13). The mean difference of the height was .0859 inches, which had a nonsignificant t-value of .18. The mean difference of the weight was 12.2738 ounces, which had a non-significant t-value of .86. The mean difference of the body mass index was .5634, which had a nonsignificant t-value of 1.14.

Table 13

Twenty-four-month Boys

	Hispanic mean	Caucasian mean	Mean difference	Equality of variance	t-value
Height	34.0956	34.0097	.0859	Yes	.18
Weight	468.4118	456.1379	12.2738	Yes	.86
BMI	17.6524	17.0890	.5634	Yes	1.14

df = 61, height measured in inches, weight in ounces; BMI = body mass index; t-value* =significance.

Hypothesis 10: At age 24 months, Hispanic girls will be shorter in length, heavier in weight, and have higher body mass indexes than Caucasian girls. After analysis by one-tailed t-test, this study found the hypothesis to be true, and the weight and body mass index were different significantly at the $p = .05$ level (Table 14). The mean difference of the height was .3415 inches, which had a nonsignificant t-value of .70. The mean difference of the weight was 31.6177, which had a significant t-value of 2.06. The mean difference of the body mass index was .7980, which had a significant t-value of 2.00.

Table 14

Twenty-four-month Girls

	Hispanic mean	Caucasian mean	Mean difference	Equality of variance	t-value
Height	34.1290	33.7875	.3415	Yes	.70
Weight	458.9677	427.3500	31.6177	Yes	2.06*
BMI	17.1445	16.3465	.7980	Yes	2.00*

df = 49, height in inches, weight in ounces; BMI = body mass index;

t-value* = significant.

Hypothesis 11: At ages 2, 4, 6, and 12 months, breast-fed children will have different heights and weights than bottle-fed children. After analysis by two-tailed t-test, the study found no significant differences in breast-fed and bottle-fed children at the $p = .05$ level (Table 15). T-tests were performed for each sex and age category for height, weight, and body mass indexes to determine whether they were significantly different in breast-fed and bottle-fed children. Differences were small, inconsistent, and insignificant.

Table 15

Breast- and Formula-fed Growth

	Ht. mean difference	Ht. t-value	Wt. mean difference	Wt. t-value	BMI mean difference	BMI t-value
2-month boys	.1678	.71	5.6469	-.82	.4531	-1.04
2-month girls	.0973	-.36	3.7333	.74	.6679	1.52
4-month boys	.4850	-1.88	10.9649	-1.68	.2191	-.60
4-month girls	.0608	-.21	2.3890	-.38	41.775	-.99
6-month boys	.4548	-1.65	2.9588	.29	.4207	.77
6-month girls	.1477	.59	5.7121	.69	.0565	-.15
12-month boys	.2133	-.81	-8989	-.11	.0696	.16
12-month girls	.2841	-1.11	5.0000	.57	.6395	1.83

t-value* = significant at p = .05.

Summary of Findings

Height and weight measurements of 936 Hispanic and Caucasian children from 2 months to 24 months of age were collected, and the body mass indexes calculated. Data were collected concerning whether the infants were ever breast-fed. The groups were analyzed to determine whether there were growth (height, weight, and body mass index) differences. Significant differences in Hispanic and Caucasian were found in the height of 6-month-old girls, weight of 2-month-old-boys and girls, 4-and 24-month-old girls, and the body mass indexes of girls at ages 6 and 24 months (Table 16).

Table 16

t-Values in Comparison of Hispanic and Caucasian Growth

	Height	Weight	Body mass index
2-month boys	1.11	1.59*	1.12
2-month girls	.97	1.59*	1.12
4-month boys	.31	.71	.84
4-month girls	.75	1.71*	1.47
6-month boys	-.56	.99	1.06
6-month girls	-2.39*	-.34	2*
12-month boys	-1.5	-.17	.08
12-month girls	-1.21	.18	1.35
24-month boys	.18	.86	1.14
24-month girls	.70	2.06*	2.00*

Significance at the p = .05 level; t-value* = significant.

No significant differences were found in height, weight, or body mass index, at any age, between breast-fed and bottle-fed children.

CHAPTER V

SUMMARY OF THE STUDY

This study examined the growth of Hispanic children of Mexican origin and compared it with the growth of Caucasian children from the same socioeconomic background. Additional data were collected regarding the child's history of breast-feeding to determine if breast-fed children grow differently in these age ranges. Only seven significant differences in growth were found between Hispanic and Caucasian children, and no significant differences in growth were found between breast-fed and bottle-fed children.

This chapter provides a summary of the research, discussion of the findings, conclusions and implications of the findings, and recommendations for further studies.

Summary

The growth of children is a powerful indicator of general health when considered in clinical evaluations. Although Hispanic adults have been documented to be shorter than Caucasian adults, no studies have examined the growth of Hispanic children under 2 years of age and compared the growth with Caucasian children of the same population (Greaves et al., 1989). Breast-feeding and its impact on growth in children under 2 years of age is in question, (Oski, 1993; Pipes, 1993; Trahms & Powell, 1996), and this study provided an opportunity to determine whether or not a difference in growth occurs in breast-fed and bottle-fed infants and children.

In this study, children seen in three similar clinic settings were examined by weighing and measuring them and by obtaining information concerning their heritage, family income, and whether they had ever been breast-fed. Additional data from their medical charts provided measurements on approximately 10% of the sample. The medical chart data were equally distributed among clinic settings, ages, gender, and background categories. A total of 1,026 sets of measurements was collected and analyzed. Over 50 sets of measurements of 2-, 4-, 6-, and 12-month-old children from each sex and race were collected. Although 24-month-old children were included in the design of the study, it was not possible to collect large enough numbers to provide analysis to meet a power of .80, which ensures that if a difference exists, it will be found at the $\underline{p} = .05$ level of significance. A group size of 50 accomplishes this (Polit, 1993).

Before analysis, body mass indexes were computed for each child in the study. Statistical analysis of each group revealed a difference in height in only one age and sex category, differences in weight in four categories, and differences in body mass index in two categories. No differences were found in the growth of breast- and bottle-fed children in any group.

Discussion of the Findings

This study can conclude that, in the same population, Mexican Hispanic children grow the same in length as Caucasian children in the 1st year of life. Inadequate data were collected to make this conclusion for 24-month-old children in this study. This is the first study to examine Hispanics from only one origin, Mexico. The only published study that included children under 2 years of age (Yip et al. 1992) mixed Hispanics of all ancestry and included measurements from 5,000 collection sites from many states. In the present study, the numbers of sets of measurements were large in each category, compared to previously reported studies of older children (Dewey et al 1983; Hamill et al., 1979; Kumanyika et al., 1990; Malina et al., 1987a, 1987b; Scholl et al., 1987).

This study reveals that the difference in height between the adult Hispanic population of Mexican origin and the American Caucasian population does not start to occur before the age of 12 months. Several possibilities exist when considering the data interpretation. The children of the 2 populations may grow similarly, and then their growth may deviate from each other at a particular age. Ages that involve the most growth include infancy and puberty, and infancy growth differences have been ruled out by this study. Further study may reveal a difference in growth in adolescence. This conclusion is supported by Greaves and others' (1989) study in which Hispanics' adult height was found to be shorter than Caucasians' adult height. Although this study was conducted in 1989 and not repeated in recent years, qualitative observation of adult Hispanics of Mexican origin reveals that adult height remains shorter than Caucasians' adult height. It is also supported by Guinn who found in 1993 that adolescent Hispanics were shorter and had higher body mass indices than Caucasian adolescents. Martorell and others (1989) found that even with adequate nutrition, Hispanic children remained shorter than Caucasian children, and concluded that this was due to genetic influences on growth. In contrast, other authors, including Malina and others (1987a, 1987b), and Mendoza and Castillo (1986), predicted that with adequate nutrition in several generations, Hispanics would grow as tall as Caucasians. Genetic influence would be minimal. The HHANES study (National Center for Health Statistics, 1985) recommendations included a proposal that growth of Hispanic children be examined 10-15 years from the collection of data in that study to determine if improving nutrition would result in growth similar in Hispanic and Caucasian children. This has not been undertaken.

Authors in the nutrition field may argue that continued measurement of this study sample would show no differences between the growth of these children of different origins throughout life due to adequate nutrition, similar socioeconomic backgrounds, and similar environments. In interpretations of previous studies, many scientists with nutrition background have concluded that differences in height between samples of children are caused by inadequate nutrient intake because of lower socioeconomic level. They theorize that, when the children have access to healthy foods, their growth will not differ from the Caucasian population (Dunn & Martorell, 1984; Malina et al., 1987; Scholl et al., 1987). Genetic scientists may reply that the effect of genetic programming may not allow the Hispanic population to grow as tall as the Caucasian population, regardless of nutrition, socioeconomic conditions, or environment. The genetic heritage forms a recipe, or blueprint, for the individual, so that the potential height cannot surpass the plan established in the genetic code (Cummings, 1997).

Another interpretation of the data may suggest that a difference remains in the growth of Hispanics of Mexican origin and Caucasian children from 1 month to 24 months, but the influence of genetic contribution is small. Therefore, larger numbers of children evaluated would be necessary to provide enough power to show the difference. The power analysis assumed a medium effect size of the influence of genetics on growth, which required sample size of 50. If the effect size were small, power analysis would require sample size of 200 or more (Polit, 1996). A larger study may reveal a difference in height of these 2 populations studied.

This was the first study to compute the body mass index of many subjects to determine body structure differences between Hispanic and Caucasian children. Previous studies of smaller groups of older Hispanic individuals revealed obesity in the Hispanic children (Alexander et al., 1991; Guinn, 1993; Sherman et al., 1995; Yanochik-Owen & White, 1977). This study also found that Hispanic infants were significantly heavier in both girls and boys at age 2 months, and in girls at age 4 months. A significant increase in weight at age 24 months in Hispanic girls was identified, even though the numbers of children measured were small, and differences more difficult to detect in small sample sizes. With a sample size of 31 Hispanic girls and 20 Caucasian girls (at 24 months), a significance level of $p = .05$, and medium effect size, the power calculates at .90. A high power such as this indicates that it is unlikely that a false null hypothesis would be accepted. Hispanic girls were found to have significantly higher body mass indexes at ages 6 and 24 months.

Although weight was higher in Hispanic boys than in Caucasian boys, their body mass indexes were not significantly higher. This may be explained by the finding that the Hispanic infants were also longer than Caucasian boys, although the differences were not significant. The higher weight and body mass index are consistent in 24-month-old girls.

All the significant differences relate to infant intake of nutrients. The Caucasian infants, although smaller in weight, were well within healthy norms for their ages.

Conclusions and Implications

Based on the results of this study, health care providers can utilize the growth curves established by the National Center for Health Statistics to evaluate Hispanic (of Mexican origin) children's length in the 1st year of life. The numbers of children in the 2-year-old category are insufficient to make that conclusion. Hispanic girls and boys from 2 months to 12 months have growth that is similar to the Caucasian population. Any growth that deviates from the National Center for Health Statistics curves should be evaluated for disease, inadequate nutrition, or problems in parenting.

Although the weight was only significantly higher in the Hispanic sample than in the Caucasian samples in only four age and gender categories, it was consistently higher in all age and gender categories. Therefore, careful attention to early feeding practices in child health clinics may help prevent the development of obesity. Health care providers can teach the importance of comfort measures other than feeding, the use of water in bottles, and the appropriate amount of formula to feed a small infant.

Sherman and others (1995) found that in the Hispanic population as the socioeconomic status decreased, and as the mothers were less acculturated to the United States, the higher the body mass indexes the children had. Other variables which correlated with childhood obesity were: higher body mass indexes in the mothers, male gender, higher birth weight, bottle-feeding, use of the bottle to comfort the child, and a larger number of people who feed the child. Alexander and others (1991) also found obesity in Hispanic preschool-aged children. Variables identified were a maternal preference for chubby babies, overweight status of the mother, and lower socioeconomic status of the family. Keller and Stevens (1996) identified epidemiological factors of: parental obesity, siblings who are overweight, maternal preference for a chubby baby, high birth weight, lack of nutrition knowledge in the parents, bottle feeding and using food as comfort. Lifestyle factors identified were: lower socioeconomic status, single parenthood, several people who feed the baby, physical inactivity, and poor dietary habits in children and adolescents. All of the authors urge assessment at well-child clinics followed by nutrition counseling and health teaching to help prevent obesity. Sensitivity to cultural and socioeconomic factors in the health teaching is important to its success. A program that includes weight reduction in the mother in addition to the children may be more successful than one that only treats the child. Sherman and others (1995) stressed the importance of prevention, since obesity is such a difficult health condition to treat.

This study found no difference in the growth (height, weight, or body mass index) in breast- or bottle-fed children. However, the data analysis grouped all infants who had been breast-fed together, whether it was 1 week or up to 1 year. If breast-fed children were supplemented with formula, they were still coded in the breast-fed category. Therefore, caution is advised in concluding that breast-feeding does not affect growth on the basis of this finding. This study can provide information that growth is little changed, if any, and a researcher who focuses on this issue must obtain much more specific data regarding length of breast-feeding and use of supplementation and then group the data differently for analysis. In this population, totally breast-fed infants were not common.

Also, when the growth of breast-fed children was compared to that of the children who were totally bottle-fed, the groups were not usually similar in number (many more bottle-fed than breast-fed). This can affect analysis adversely.

Recommendations for Further Study

A continuation of this study to increase the sample size would determine if a difference exists due to a small influence of genetics. The sample size would require at least 200 children in each gender and age category.

It is logical to suggest that a similar study be performed on older children. It is suggested that the design continue to include Caucasians in addition to Hispanics from the same population for comparison and to compute body mass index in the analysis. Because the episodes of most intensive growth occur in infancy and in puberty, the next study should be proposed assessing the growth of children from ages 12 to 18 years. Adolescent health care centers or public schools may provide the sample for this research.

To assess the difference in growth of breast- and bottle-fed children, a differently designed study may provide more information. A group of exclusively breast-fed children and a control group of bottle-fed children could be followed for 6 months (until the introduction of solid foods). After that, a study would have to include documentation of the use of foods and amounts to make comparisons of breast- and bottle-fed children.

Additional research regarding the growth of different ethnic groups would provide health care personnel with valuable resources. Other large populations that should be studied include the African American, Native American, and specific Asian ethnic groups.

Summary

The present study found no significant difference in the heights of infants from 1 month to 12 months of age. This may mean that:

1. there is no difference in the growth of Hispanics at any age,
2. there is no difference from 1 to 12 months, but the difference occurs later, or
3. there is a difference, but due to the small influence of genetics, it would require larger numbers of children to study to reveal the difference.

The present study revealed significant differences in weight of the children in 4 age and gender categories, and was consistently higher in all age and gender categories. Body mass indexes were higher in 2 age and gender categories. Feeding practices, socioeconomic level, and other lifestyle factors may be responsible for the increase in weight.

The study revealed no differences in the growth of breast-fed and bottle-fed children at any age or gender category. A redesign of the study to determine differences in the breast and bottle-fed groups, and selection of a population in which a larger number of mothers who exclusively breast-feed their infants would answer this question more effectively. No conclusions about differences between breast- and bottle-fed infants can be made based on this study.

APPENDICES

APPENDIX A

Approval of Human Subjects Review Committee
Texas Woman's University, Denton, Texas

TEXAS WOMAN'S
UNIVERSITY
DENTON / DALLAS / HOUSTON

HUMAN SUBJECTS
REVIEW COMMITTEE
P.O. Box 425619
Denton, TX 76204-3619
Phone: 817/898-3377
Fax: 817/898-3416

August 22, 1996

Becky Althaus
1541 Parkside Trail
Lewisville, TX 75067

Dear Becky Althaus: Social Security #: 585-60-8726

Your study entitled "The Growth of Infants and Children of Hispanic and Caucasian Background" has been reviewed by a committee of the Human Subjects Review Committee and appears to meet our requirements in regard to protection of individuals' rights.

Be reminded that both the University and the Department of Health and Human Services (HHS) regulations typically require that agency approval letters and signatures indicating informed consent be obtained from all human subjects in your study. These are to be filed with the Human Subjects Review Committee. Any exception to this requirement is noted below. This approval is valid one year from the date of this letter. Furthermore, according to HHS regulations, another review by the Committee is required if your project changes.

Special provisions pertaining to your study are noted below:

____ The filing of signatures of subjects with the Human Subjects Review Committee is not required.

____ Other:

_X_ No special provisions apply.

Sincerely,

Chair
Human Subjects Review Committee - Denton

cc: Graduate School
Dr. Kashka, Nursing
Dr. Carolyn Gunning, Nursing

TEXAS WOMAN'S
UNIVERSITY

DENTON / DALLAS / HOUSTON

HUMAN SUBJECTS
REVIEW COMMITTEE
P.O. Box 425619
Denton, TX 76204-5619
Phone: 940/898-3377
Fax: 940/898-3416

August 13, 1998

Ms. Becky Althaus
1541 Parkside Trail
Lewisville, TX 75067

Dear Ms. Althaus: Social Security # 585-60-8726

The request for an extension of the approval for your study entitled "Growth Patterns of Caucasian Children and Hispanic of Mexican Origin Children" has been reviewed by a committee of the Human Subjects Review Committee and appears to meet our requirements in regard to protection of individuals' rights.

Be reminded that both the University and the Department of Health and Human Services (HHS) regulations typically require that agency approval letters and signatures indicating informed consent be obtained from all human subjects in your study. **These consent forms, agency approval letters, and an annual/final report are to be filed with the Human Subjects Review Committee at the completion of the study.**

This approval is valid one year from August 22, 1998. Furthermore, according to HHS regulations, another review by the Committee is required if your project changes. If you have any questions, please feel free to call the Human Subjects Review Committee at the phone number listed above.

Sincerely,

Jerry D Wilkerson
Chair
Human Subjects Review Committee

cc. Graduate School
Dr. Maisie Kashka, College of Nursing
Dr. Carolyn Gunning, College of Nursing

APPENDIX B

Agency Approval from North Texas Community Clinic's Pediatric Clinic

TEXAS WOMAN'S UNIVERSITY
COLLEGE OF NURSING

AGENCY PERMISSION FOR CONDUCTING STUDY

THE North Texas Community Clinics' Pediatric Clinic

GRANTS TO Becky Althaus, a student enrolled in a program of nursing leading to a doctoral degree at Texas Woman's University, the privilege of its facilities in order to study the following problem.

The Growth of Infants and Children of Hispanic and Caucasian Background

The conditions mutually agreed upon are as follows:

1. The agency (may) (may not) be identified in the final report.
2. The names of consultative or administrative personnel (may) (may not) be identified in the final report.
3. The agency (wants) (does not want) a conference with the student when the report is completed.
4. The agency is (willing) (unwilling) to allow the completed report to be circulated through interlibrary loan.
5. Other Agency personnel will not be responsible for collecting any data.

Date: 10-1-96

Mindy Mashburn CCN CPNP
Signature of Agency Personnel

Becky Althaus
Signature of Student

Maisie Kashka
Signature of Faculty Advisor

*Fill out and sign three copies to be distributed as follows: Original-Student; First copy-Agency; Second copy-TWU College of Nursing

APPENDIX C

Agency Approval from Women, Infants, and Children Program
Denton County Health Department

TEXAS WOMAN'S UNIVERSITY
COLLEGE OF NURSING

AGENCY PERMISSION FOR CONDUCTING STUDY*

THE Women, Infant and Children Program

GRANTS TO Becky Althaus

a student enrolled in a program of nursing leading to a Doctoral Degree at Texas Woman's University, the privilege of its facilities in order to study the following problem:

The comparison of growth of children of Hispanic (Mexican origin) and Caucasian children

The conditions mutually agreed upon are as follows:

1. The agency (may) (may not) be identified in the final report.
2. The names of consultative or administrative personnel in the agency (may) (may not) be identified in the final report.
3. The agency (wants) (does not want) a conference with the student when the report is completed.
4. The agency is (willing) (unwilling) to allow the completed report to be circulated through interlibrary loan.
5. Other

Date: 9/1/98

Signature of Agency Personnel

Becky Althaus
Signature of Student

Jeannette McGreevy
Signature of Faculty Advisor

*Fill out and sign three copies to be distributed as follows: Original - Student; First copy - Agency, Second copy - TWU College of Nursing.

APPENDIX D

Agency Approval from Pediplace
Lewisville, Texas

TEXAS WOMAN'S UNIVERSITY
COLLEGE OF NURSING

AGENCY PERMISSION FOR CONDUCTING STUDY*

THE Pedi Place

GRANTS TO Becky Althaus

a student enrolled in a program of nursing leading to a Doctoral Degree at Texas Woman's University, the privilege of its facilities in order to study the following problem:

the comparison of growth of children of Hispanic (Mexican origin) and Caucasian children.

The conditions mutually agreed upon are as follows:

1. The agency (may) (may not) be identified in the final report.
2. The names of consultative or administrative personnel in the agency (may) (may not) be identified in the final report.
3. The agency (wants) (does not want) a conference with the student when the report is completed.
4. The agency is (willing) (unwilling) to allow the completed report to be circulated through interlibrary loan.
5. Other

Date: 3/10/99

Sandra B. Thurman
Signature of Agency Personnel

Becky Althaus
Signature of Student

Joanette McGrady
Signature of Faculty Advisor

**Fill out and sign three copies to be distributed as follows: Original - Student; First copy - Agency, Second copy - TWU College of Nursing.*

APPENDIX E

English Consent Form

TEXAS WOMAN'S UNIVERSITY
SUBJECT CONSENT TO PARTICIPATE IN RESEARCH

The Growth of Infants and Children of Hispanic and Caucasian Background
Becky W. Althaus 565-3892

In this research study, the heights and weights of infants and children of Hispanic and Caucasian background will be compared to see if there is any difference from age 2 to 24 months. The heights and weights will be written down when they are being done normally at your child's clinic visit and your child's clinic chart will be reviewed. No additional time for your appointment will be taken.

Helping with this study will not require your child to do anything different from normal during the clinic visit. Your child's weight, height, name and ethnic group will be written on a card that will be studied along with the heights and weights of many other children. The cards will be stored in a locked file cabinet for 5 years, then shredded. Your child's name will not be used in any way on the description of the results. Your child will not personally benefit from helping in this study, but this knowledge can help other children, including yours in the future.

We will try to prevent any problem that could happen because of this research. Please let us know at once if there is a problem and we will help you. You should understand, however, that TWU does not provide medical services or financial assistance for injuries that might happen because you are taking part in this research.

If you have any question about the research or about your rights as a subject, we want you to ask us. Our phone number is at the top of the form. If you have questions later, or if you wish to report a problem, please call us or the Office of Research & Grants Administration at 940-898-3375.

I only want you to help with this research if you want to. You may quit any time. Your clinic visit will stay the same whether or not you help in the study.

I have offered to answer any questions you have. If you wish to speak with my advisor, her name is Dr. McGadney and her phone number is 214-689-6513. A copy of this signed consent form will be yours to keep. If you would like to have a summary of the results of this study, please call me at 565-3892.

Your signature below means you give consent for your child to participate in this research by allowing his or her height and weight to be measured and recorded and his or her chart to be reviewed.

______________________________ ____________
Signature of parent or guardian Date

____
Relationship to participant

APPENDIX F

Spanish Consent Form

TEXAS WOMAN'S UNIVERSITY
CONSENTIMIENTO DE LA PERSONA QUE PARTICIPA EN LA ENCUESTA

El crecimiento de bebes y ninos de origen hispano y caucasico
Becky W. Althaus

En este estudio se compararan las estaturas, los pesos de los bebes y de los ninos de origen hispano y caucasico para determinar si hay alguna diferencia entre las edades de 2 a 24 meses. Las estaturas y los pesos seran anotados cuando se tomen de rutina durante la visita de su nino en la clinica del doctor, y el expediente de su nino sera asimismo revisado. No se necesitara mas tiempo durante su cita.

Para ayudar con este estudio no se requiere que a su nino se la haga nada diferente a lo normal en su visita a la clinica. El peso, la estatura, el nombre y el grupo etnico de su nino se anotara en una tarjeta que se estudiara junto con las estaturas y los pesos de muchos otros ninos. Las tarjetas se guardaran en un archivo con llave durante 5 anos y despues se destruiran. El nombre de su nino no se mencionara de ninguna manera en la descripcion del los resultados. Su nino no se beneficiara personalmente por ayudar en este estudio, pero esta informacion podra en al futuro ayudar a otros ninos, incluyendo los suyos.

Trataremos de prevenir cualquier problema que se pudiera presentar por este estudio. Por favor diganos de inmediato si hay algun problema y nosotros le ayudaremos. Como usted comprendera. TWU no proporciona servicios medicos ni ayuda financiera por lesiones que pudieran resultar porque usted tome parte en el estudio.

Si tiene cualquier duda sobre el estudio o sobre sus derechos como participante, queremos que nos pregunte. Nuestro numero de telefono esta indicado arriba de esta forma. Si tiene preguntas despues, o si usted quiere reportar un problema llamenos por favor a nosotros, o a la Oficina de Research and Grants Administration al 940-898-3376.

Solamente quiero que usted ayude con este estudio si usted tambien quiere hacerlo. Puede renunciar en cualquier momento. Su visita a la clinica se mantendra sin cambios aunque usted no nos ayude con el estudio.

Me pongo a su disposicion para contestar cualquier pregunta que usted pueda tener. Si lo desas, puede hablar con mi consejera, su nombre es Dra.

McGadney y su numero de telefono es el 214-689-6513. Una copia firmada de esta forma de consentimiento se le entregara para que usted la guarde.

Si usted quiere tener un sumario de los resultados de este estudio, llame por favor al (940) 565-3892.

Su firma al calce, significa que usted da su consentimento para que su nino participe en este estudio permitiendo que su estatura y su peso le sea tomado y registrado, y su expedience pueda ser analizado.

Signature of parent or guardian Date

Relationship to participant

APPENDIX G

Data Collection Form

Growth Study
Texas Woman's University

Number______Sex___Breast-fed__________

D.O.B.___________Age: Years________Months________

Ethnic Group	Hispanic	Caucasian
Infant/Child		
Mother		
Grandmother		
Grandfather		
Father		
Grandmother		
Grandfather		

Income: <10,000____ 10-19,999____ 20-29,999____

30-39,999____>40,000_____Medicaid_____

Height______________________inches

Weight_________pounds__________ounces

Age	Height	Weight

Data Collector____________ Date____________

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