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Statistical Study of Child Growth: A Case Study of Rajshahi City

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STATISTICAL STUDY OF CHILD GROWTH: A CASE STUDY OF RAJSHAHI CITY

By

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A dissertation

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Declaration

I do hereby declare that the dissertation entitled "Statistical Study of Child Growth: A case study of Rajshahi City" submitted to the Department of Statistics, University of Rajshahi, Bangladesh, for the degree of Doctor of Philosophy. This study is an unique and original work of my own. No part of it, at any form, has been submitted to any other University or Institute for any degree, diploma or for other similar purposes.

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Certificate

Certified that this dissertation entitled "Statistical Study of Child Growth: A case study of Rajshahi City" is an original work from primary collected data done by Mst. Khurshida Pervin, Department of Statistics, University of Rajshahi, Bangladesh, for the degree of Doctor of Philosophy in Statistics under our supervision.

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It is also certified that we have gone through the draft and final version of the dissertation and approve it for submission.

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Dedicated

To

My Beloved Parents

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At first, I remember the Almighty Allah for His unlimited mercy to giving me the ability to complete this arduous task.

Research is a systematic effort of finding the truth. Every research work involves a lot of patience, devotion and endeavor of the researcher. It is not an easy task for an individual, particularly for a woman of a superstitious society to carry on a laborious work like research. In perspective of Bangladesh society I have badly felt that this was one of the hardest work among other research. However, despite all prevailing impediments it is matter of great joy that I have been able to complete the study. So at the end of the study I would like to heart full gratitude and thanks to all concerned persons and departments who had helped me at different stages of the study through various manner.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABSTRACT

Longitudinal data on 11 preselected variables of child growth was collected during the period of 25 May to 17 December, 2002 for a group of children from birth to 48 months of age from the study area. The study started with 296 children. There was about 38% loss of the study children during the 4 years of study. Finally, we have 169 children. Details of data collection and the underlines problems are given in Chapters 3 and 4. Chapter 5 of this dissertation is a contributory one which contains findings of the study. Fourteen tables and 14 charts are appended in this chapter. This tables and charts explain the growth patterns of children in study area. The most interesting of the findings are that growth patterns show two remarkable drifts, one just before the age of 1 year and the second just after the age of about 30 months which are absent in standard growth charts like that of CDC and WHO. There is another interesting finding, that is right and left wrist-elbow length differs by more than 2 cm among the children of the study area. There are some other variations in the growth velocities within and between the sexes. Chapter 6 is the concluding remarks where major findings, short coming of the study and scope for further research, specially the impact of varying sample size,socio-economic, environmental, nutritional variables, seasonality of birth, reproductive health, etc may be studied.

Chapter - One

Introduction

1.1 Prelude

The study of human growth and development is an integral part of the scientific study of human biological structure, function and diversity. Anthropometry as part of human biology has no restrictions concerning the anatomical parts of regions of the human body. Measurements such as, relationships between different parts of body, and proportional aspects can be established and compared for different sexes and ethnic groups.

The scientific study of human physical growth and maturation has a long illustrious history involving leading scientists from many countries. Although much has been learned, much remains to be achieved. It is dependent upon the recruitment of young scientists and the successful implementation of new studies, particularly in developing countries where the growth and maturation of many infant and children are retarded due to some causal factors and with their individual countries environment. Scientific interest in growth may have its origin in anthropology and medico biology.

Man shares the process of growth with all animals, but in one respect he is unique, the protracted period of infancy and childhood. Among all placental mammals we may speak of growth as taking place in two major periods: prenatal and postnatal, but the human time- rate ratio is extremely different from the rest.

Growth of the physical dimensions of the body is a highly regulated process. The pattern of post- natal growth is well documented, with a high growth rate immediately after birth, and rapid deceleration until 4 years of age.

A child's physical growth refers to the increases in height and weight and other body changes that occur as a child matures. Hair grows; teeth come in, come out, and come in again; and eventually puberty hits. It's all part of the growth process.

From the moment parents bring a new baby home from the hospital, they watch the baby's progress eagerly, anticipating every inch of growth and each new developmental milestone along the way. But how do parents know if their child is growing properly?

Physically, the child is not a man in miniature, nor it is the future adult already formed in the embryo, according to the "homunculus" theory of the seventeenth century physiologists, but has a special type of own.

At birth to during certain phases of the life cycle, age and sex "interact": the changes in body composition with age are divergent, not parallel, for the male and female of the human species.

Human growth of the physical dimensions of the body is a highly regulated process. The post natal growth is comparatively of higher rate immediately after birth, and rapid deceleration until four years of age. The infancy-childhood growth are additive in two components-infancy and childhood. Studies of child growth are conducted for reasons: to assess the environmental conditions in which the growth of a child occurs, and for the understanding of general patterns of physical development and their determinants. Patterns of growth have considerable impact on human biological diversity.

A major growth spurt occurs at the time of puberty. Usually kids enter puberty between age 8 to 13 years in girls and 10 to 15 years in boys. Puberty lasts about 2 to 5 years. This growth spurt is associated with sexual development, which includes the appearance of pubic and underarm hair, the growth and development of sex organs, and in girls, the onset of menstruation.

By the time girls reach age 15 and boys reach age 16 or 17, the growth associated with puberty will have ended for most teens and they will have reached physical maturity.

Maturation of a child is a "multi-track" process: it involves maturation of the skeleton, somatic growth, changes in body composition, etc. Accordingly, a variety of indices have been used to measure the rate of maturation of an individual.

Child growth is the result of the interaction of many regulatory factors, both hereditary and environmental. Optimal growth can be achieved only when all these factors work in harmony (Delemarre- van de Wall 1993).

1.2 Some important indicators of Child Growth

1.2.1 Growth curves: One of the fundamental approaches to the analysis of longitudinal data is curve fitting. Fitting curves to individual growth records permits the extraction of a maximum amount of information about an individual child's growth, and individual curves can, of course, be compared and contrasted. Further, when fitted growth- curve parameters are available for a large number of children, mean parameters and variation around them are a convenient way of summarizing a large amount of data for comparison of growth patterns between sexes or between populations (Thissen et al., '76). Thus, fitting curves provides a convenient means of characterizing individual or group differences in the pattern of growth.

1.2.2 Percentiles: The most widely used growth charts are constructed by measuring many boys and girls of all ages and breaking the range of their heights and weights into percentiles. These percentiles are represented on the growth charts. Age in years is marked along the bottom of the chart. Height in centimeter/inches is marked along the left side. The 50th percentile is the average height for any given age.

The normal range should be emphasized. The diagramed percentiles are generally P_3, P_5, P_{10}, P_{25}, P_{50}, P_{75}, P_{90}, P_{95}, P_{97} respectively.

The 3^{rd} and 97^{th} percentiles added to specific charts the limits for length and height are considered as lowest and highest percentile growth.

1.2.3 Body composition: The investigations of total body composition like different areas of adipose tissue, skin fold thickness at Fels will be considered in relation to weight and weight/ stature, which are indices of total body composition. Percent body fat, total body fat, and fat–free mass, are basic components of body composition. The composition of body is influenced by environmental factors, nutrition, physical activity and disease.

1.2.4 Adipose tissue: This is a specialized type of connected tissue in which the cells rather than the intercellular material are most abundant. Fat cells are found scattered through or in groups in loose connective tissues, but the term "adipose" tissue is reserved for those tissues containing large deposits of fat (Lilian Hoagland Meyer)?

Body Proportion: Measurements of stature, sitting height and indirectly leg length (stature minus sitting height) together is called body proportion.

1.2.5 Skin fold: In man about one –half of the total fat deposits is present as the subcutaneous adipose tissue. In various parts of the body surface is loosely attached to the underlying structure (skin), together with the subcutaneous layer can be readily lifted (folded) which can be satisfactorily measured by applying a "constant pressure" caliper. The measurement of skin folds is the most commonly used indicator of fatness. It can be measured at many sites on the body.

1.2.6 Total body fat: Total body fat calculated from body density which predicted from trochanteric adipose tissue thickness. Total body fat increases in women than in man with their age, but not in infancy and childhood.

1.2.7 Fat-free mass: Fat free mass means that mass which never contain fat among the body composition. As for example, cranium of head is a fat free mass. Muscle mass is an important part of fat- free mass which changes with age.

1.2.8 Body mass index: In order to assess secular growth changes in height, weight, and weight for height as expressed by BMI= weight/ stature^2.

1.2.9 Increment of growth: Increment means progress. Increments can provide more sensitive information about the normality of growth progress than status at an age or at a series of ages. The Increments should be calculated for 1- month interval during the year after birth.

1.2.10 Upper-lower ratio: The upper lower ratio (ULR) was calculated as height divided by sitting height of children's individual age groups from 0-48 months. This calculation provides us individual's leg length.

1.2.11 Z-Score: The deviation of an individual's value from the mean value of a reference population, divided by the standard deviation of the reference population (or transformed to normal distribution).

1.2.12 Growth factor: There are various types of growth factors role in human body, such as genetical, hormonal, nutritional, physiological, environmental, seasonal effect etc.

1.2.13 Types of growth: Infant and children's growth are normal and abnormal. Abnormal growth means catch–up or catch down growth in the growing period of children.

1.3 Importance of the Study

Physical growth and maturation are important partly because they are normal physiological processes that are essential for the well being of the human organism. Aspects of growth and maturation can be used as "indicators" of genetically determined variation, environmental factors or pathological processes.

Physical growth is measured, in general, in four dimensions-Weight, height, head circumference and skeletal growth. Patterns of growth in head circumference is an important index of brain size, particularly during infancy when cranium is thin. It is also an important predictor of fat free mass.

Weight and weight gain (loss) are important, particularly during infancy and childhood, because their association with disease and mortality. Skeletal growth is responsible for accumulation of adipose tissue-a risk factor for cardiovascular disease and diabetes. Recumbent length (height) is also important during infancy and childhood because slow growth in recumbent length indicates the presence of an influence that is retarding the physiological process of normal growth. In addition it assists the interpretation of weight, particularly as a ratio weight/height^2, popularly known as BMI (Body mass Index). Some other measures like arm circumference, chest circumference, wrist circumference etc. are also in use to asses the nutritional status while measures of different limbs and their relative growth are in use to asses the over all balanced growth of human body.

According to (Dr. Hill; 2008) Normal development growth charts are part of the normal ongoing monitoring of the new born infant development is the simple measurement of weight, length/height and simple motor skills compared to large data sets of clinically normal infants. The original standards difference between countries. New International child growth standards 2006 for infant and young child released (27 April, 2006) by the WHO provide evidence and guidance for the first time about how every child in the World should grow.

The new standards prove that difference in children's growth to age five are more influenced by nutritional status, feeding practice, environment and health care than genetics or ethnicity.

Earlier growth charts had been prepared independently for children of different countries and nationalities using large numbers of clinically normal American children who tend to be taller and heavier than many other countries. The physician and people all over the world use that growth chart of WHO which is not symmetrical growth reference for the children of each and every country. So, every nation should have standard growth charts of their own.

There are two factors that causes the gradual growth of human infants after birth. One is genetical and other is environmental. Human growth study is meaningful for two reasons. Firstly, Mongolian population such as China, Japan, Korea-countries are too much shorter in comparison to the western and the American populations. So to develop the average height population Ergonomics study started institutionally in Japan. Secondly, usually to ascertain the dose of medicine to children, age is supposed to be standard. But when same dose of medicine is put on equal aged infants or childs whose growth are catch up or catch down or abnormal growth then the dose of medicine may react in those infants or childs body or may not work at all. So nowadays, practice of prescription of medicinal dose according to the growth of children has already been started in developed countries.

1.4 Statement of the Problem

Animal birth and gradually pre-natal and post-natal growth is a super natural event. Just like that human infant born and gradually grows day by day. We all know that infant or children grow, but accurate and quantitative study of this growth began very late in the history of natural science. So our knowledge about the child growth depends on our idea by observing external experience. In this field, as in all others areas the concepts of time and magnitude play a primary part but the simple methods of qualitative observation do not provide decisive results. Advances in our knowledge with centauries it have come through the introduction of precision by put up short techniques in the collection and measurement of observations, and the application of graphic, numerical, statistical analyzing methods.

Pediatrics in our country use the CDC growth charts. They are simple grids that allow parents to plot a child's height, according to his or her age. First of all, parents' will learn and have concept about how to read growth charts. Then, they'll have the opportunity to enter a child's age and height to find out how their child's height compares with sample heights of other children of the same age. But it is specially mentioned that Pediatric growth charts are not perfect/suitable for Bangladeshi infants and children.

It is important to the people of Bangladesh to understand the growth charts of ours which follow our child's growth over time or to find a pattern of our child growth. By using the charts they will be plotting their child's weight and height at different ages and seeing if he/she follows a growth curve at any one time. Even if their child is at the 5th percentile for his/her weight, which means that 95% of kids of his/her age weight more than he/she does. If he/she has always been at the 5th percentile, then he/she is likely growing normally. Though the child growth is consistently supposed to be in the normal range (between the 10^{th} and 90^{th} percentile). It would be concerning and it might mean there was a problem with his/her growth if he/she had previously been at the 50th or 75th percentile and had now fallen down to the 5th percentile.

Also remember that children between the ages of 6 and 18 months can normally move up or down on their percentiles, but older children should follow their growth curve fairly closely. But sorry to say that we have no such growth charts at our disposal.

- Height, weight and changes of various organs parameters are more important for significant growth and sexual development to the physician who observes and wishes to control individual growth and physical development. To establish a medical judgment of an individual's state of health, if they compare their measurements with reference data or standard curve values of growth in our country. Suitable standards must be based on surveys of height, weight, and sex characteristics of the population to which the child belongs.
- Secular changes in growth patterns are important indicators of the health status of a population. Influence by hygienic, cultural, and economic conditions, they are related to changes in morbidity and mortality in our country. Because Secular changes are clearly perceptible in variables such as height, weight, chest circumference, head circumference etc and sexual maturity which provide the biometric data for studies of growth trend shifts.
- Longitudinal growth and maturation have important social implications. A logical concomitant of changes in stature is, for example, that clothing, furniture, and

tools have to be redesigned, and that the architecture of homes, schools, and workshops has to be adapted. An earlier development of maturation characteristics, accompanied by an earlier onset of biological adulthood, will undoubtedly affect legislation, jurisdiction, and education.

Chapter - Two

Genesis of the Study

2.1 Review of Literature

The history of child growth and development study is not very old. In between 1927-32, several research center, and institutes were developed on the multidisciplinary study of child growth of which Fells Research Institute (1929), Institute of Human Development, Berkeley The Child Research Council (Denever), Harvard Scholl of Public Health Growth Study Center (Boston) are important. White House conference (1933) on Child Health and Protection recommended the need for such studies. The idea behind such studies was partly to shield children from the worst effects of the Great Depression and partly to acquire further knowledge to determine the effects of the Great Depression and the possible remedial measures to mitigate these effects.

There are various kinds of research on the growth of human body and organs

In the developed countries like America, Europe, German, Russia, Cuba, England, Span etc. Comas Juan (1960), in his famous book Physical Anthropology has discussed the growth of various organs of human body at age 0-18 years.

Ali and Ohtsuki (2002) estimated the maximum increment age (MIA) in height and weight of Japanese boys and girls during the birth years 1893-1990 using the published data of the Ministry of Education, science, sports and culture in Japan. They found that the estimated MIA shows an overall declining trend, except in birth year cohorts in 1934-1951.

S. chin et. al. (1989) had studied of secular trend in height by using the data of Primary School Children from schools participating in the National Study of Health and Growth in 1972, 1979 and 1986.About 50% of the trends from 1972-1979 for English and Scottish boys and girls were accounted for by changes in family size, with some contribution from increase in parental height and from birth weight, but almost none from changes in social class distribution. Estimates for 1979-1986 showed that the trend towards increased height in five to eleven years old children.

Tsuzaki et al., (1990) studied the difference in head circumference between Japanese and Caucasian Children. The subjects consisted of a total of 42,392 Japanese children between zero and four years of age surveyed from 1940 to 1980, and those data were compared with those of American and British children. They found that, there was a significant ethnic difference in head circumference, as large as one channel of usual percentiles, between Japanese and Caucasian children. The results indicated that smaller head circumference in Japanese children primarily reflects smaller stature of the Japanese.

Lindgren G.W and Hauspie R.C.,(1989) have conducted a longitudinal study of physical growth of Swedish School Children, born in 1955 and aged 10 to18 years. They have shown the secular changes in height, weight and weight- for- height as expressed in BMI.

From the samples of Swedish School Children born in 1955 and 1967 they have compared average heights and weights over 10-15 years. The main findings were that both boys and girls had been gaining more weight than height, especially around the ages at which peak velocity generally occurs. Since the increasing height of children born in 1967 gradually diminishes after age at peak height velocity, it seems that the height difference during puberty mainly reflects an earlier maturation of these child's, compared to the child's born in 1955.

Henneber G.M and Louw J.G (1998) have discussed on the patterns of physical growth (height, weight, length of body segments, circumference, widths and functions of (grip strength, reflexes and pulse rates) "Cape Coloured" School children. Data were collected on selected urban and rural groups with maximum contrasting socio-economic status (SES).The heights and weights of pre-pubertal urban children match American reference data, but post-pubertally they decline some what, whereas these measurements of the rural children consistently lie~1 standard deviation below the urban group. Skin fold thickness of urban children match or exceed the American reference, implying that their nutritional needs are being met well. Functional indicators of rural children are much poorer than those of urban children.

Bacallao, J; Molina, J.R et. al. (1992) studied on multivariate allometry model fitted to Morphometric Harmony of four skinfold in a sample of 250 newborns. Harmony is identified with the attribute of small variability of a function of morphometric dimensions. The chosen function defines allometry if it is linear in the natural logarithms of the variables. The existence of a harmonic relationship among the skin folds which is independent of weight, total body mass index, and several other maternal variables is indicated. However that, some evidence suggesting a possible correlation with the nutritional condition of the mother. The analysis showed that the multiple allometry model adequately describes the harmonic relationship among four skin folds in the newborn.

Rosique and Rebato (1995) had studied on regional differences in the growth of Spanish Children by fitting the Preece-Baines Model I to cross sectional stature data. The function parameters and derived biological variables were used to compare children from seven different studies. Regional differences in growth are interpreted as a result of a geographic variation among Spanish provinces in demographic, public health and nutritional conditions. There are differences between urban samples depending on region. Adult stature (h1) and the pattern of growth differ between urban and rural populations from the interior lands. Males from urban Extremadura, Barcelona and the Basque country show the tallest adult statures. Adult statures of males from Segovia, Extremadura emigrants and Cuenca are not only the lowest but the growth pattern shows delay in estimated ages at take-off and PHV compared to the other populations. Estimated age at PHV is later for all male samples compared to Vizcaya, except for the sample of Barcelona-I. Females from Barcelona-II, Segovia and the Basque Country show the tallest adult statures (h1). All of the female samples, except that of urban Extremadura, have an earlier estimated age at PHV compared to the sample from Vizcaya.

William Walter Greulich (1960) analyzed on three hundred and sixteen (35%) of the American –born Japanese children whose height , weight, and skeletal age were recorded in 1956-57 were reexamined as young adults between 1968 and 1974, when they were found taller, heavier and shorter legged than men and women in Japan who were born in the same years as they. These differences between the American-born and the native Japanese adults were relatively smaller than they had been during childhood, due to both an acceleration in the growth rate of the native Japanese and a concomitant decline in that of the American-born Japanese during the intervening years. A comparison of our 1956-57 data with Kondo and Eto's findings in Los Angeles in 1971 shows that there has been very little increase in the size of California- Japanese children between 6 to 20 years of age, at 10-year intervals from 1900 to 1970, disclosed the changing rate at which they grew during different decades of that period. Those curves and other data discussed in this paper provide additional evidence of the biological superiority of the human female as compared with the male.

K. Mohammad et al (1999) have investigated BMI from weight and height data obtained from the 1990-1992 National Health Survey, a random cluster sample survey of 1 in 1000 families in Iran. Weight- for- height percentiles of children and adolescents aged 2 to 18 in Tehran have been computed from relationships between weight for age and height for age Z-score. The resulting percentiles are compared to weight-for-height percentiles based on BMI (weight/height^2) charts. From the investigation of the data points age by age revealed that the normal range of BMI for age is effectively equivalent to the normal range of weight-for-height by age.

Ashizawa et. al. (1993), estimated the diversity of adolescent growth, spline-smoothed individual velocity curves of stature, body weight and chest circumference of 44 girls in Tokyo, of which menarche was recorded correctly. Additionally, 25 variables of ages at peak velocity, intensities, sizes and weight at the peak and at menarche, and terminal height were obtained.

Billewic and Mcgregor (1982) described of heights and weights for more than 25 years for two neighboring Gambian villages have been used t0 the pattern of growth. Height growth curves from the age of 5 to 23-25 years were fitted for 55 boys and 62 girls. The curves indicate that puberty is much delayed in Gambian adolescents in comparison to British and West Bengal data.

Norgan et. al. (1982), anthropometrically measured 105 coastal and 115 highland 17-48 year old New Guinean men and women. The two groups experienced different physical, biological and social environments, the highland group being less exposed to new influences. Highland men had greater body weights and fat-free masses than coastal men but stature, body density, skin fold thickness and fat mass were similar in the two groups. n the women, there were significant negative correlations of age with body weight, skin fold thickness and fat-free mass and fat mass which contrasts with the changes seen in European populations.

Malina, R.M. et. al. (1984), had calculated relationships among ages at attaining 17 or 21 indices of maturity were considered in a longitudinal sample of 177 Polish boys examined at annual intervals from 1961 to 1972.Maturity indicators included ages at peak velocity for stature, sitting height, leg length and weight. All inter correlations among the developmental indicators were positive.

Rao and Reddy (2000) made a cross- sectional study on 1565 Sugali children (854 boys and 711 girls), aged 1 to 20 years. Anthropometric measurements included height, weight, skinfold measurements at triceps etc. They had found that the Sugali boys and girls are shorter and lighter than well-to-do Indian standards. The median heights and weights of Sugali boys and girls fall below the 5^{th} percentile of NCHS standards. Finally, the results were discussed with a comparative view point.

Robert M. Malina (1979) had broadly examined and discussed about the children of today are taller and heavier and mature earlier than children of same chronological ages several generations ago. The secular trend, however, is not universal. Data showing a secular trend in growth and maturation are derived largely from Europe, Australia, Canada, and the United States and from Japan. His review considers secular changes in growth, maturation, and physical performance.

Hauspie, R. et. al. (2000) studied 681 Israeli boys and girls, including 355 regular siblings(SB), 112 pairs of dizygotic (DZ) and 51 pairs of monozygotic (MZ) twins, was measured for body weight, length and head circumference at birth and during the first year of life. Variance decomposition analysis was used to simultaneously assess the contribution of gender, gestational age, additive genetic factor, common sibs common intrauterine environmental effects on total variance of each studied trait separately. All these sources of variation were statistically significant.

Garlie and Hoppa. (1998) estimated between a comparison of measurements of height from the late 19th to mid 20th century in Toronto School children. Comparison of the Toronto growth profiles to other published 18th and 19th century growth data demonstrates that the secular trend in the Canadian children is a reflection of the continued global trend towards increased height. The implications of this changing pattern over time are discussed in the context of changing urban health and nutrition in the greater Toronto area.

Togo M. and Togo, T. (1982) had conducted a research on stature and body weight in five siblings based on monthly measurement data. Time-series analysis of stature, body weight and their increments per month was made by the program of Census

Method IIX11 resulting in three components a trend- and-cycle factor, a seasonal factor and an irregular factor.

Significant seasonal variation was found in both stature and body weight. Trend factor in increment indicates that growth rate of stature or body weight are fluctuating, instead of being smooth, suggesting that from birth to maturity acceleration and deceleration occur alternatively, like repeated retardations and sub sequent catch-ups.

Cameron, N. et. al. (1994) had conducted a study on adolescent growth in height, fatness, and fat patterning was investigated in sample of 79 rural South African black children studied longitudinally from 6-18 years. Data were analyzed relative to peak height velocity (PHV) to identify the phenomenon of "compensatory" growth in height during adolescence and to describe changes in fatness and fat patterning. Statistically significant differences in fatness and centralization between males and females did not occur until about 2 years after.

Kasai et al. (1995) had studied on changes in the stature, weight, and peak at maximum increments in Chinese urban girls 7-17 years of age between the 1950 and 1985 in Chinese cities. An overall increasing trend is apparent for stature and weight. Girls in 1985 attained peak growth earlier, by 1.08 years and 0.40 year per decade, than girls in the generation 30 years earlier.

Beunen.G, Ostin. M. et al. (1981) had estimated the relative importance of skeletal age and chronological age in explaining body measurements and the relative importance of skeletal age, chronological age, height, weight, and their interactions in explaining motor fitness components are reported. The interaction between skeletal age and chronological age as such or in combination with height/weight have the highest predictive value except for trunk strength (leg lifting) and functional strength (bent arm hang).

Wales, J. K. H (1998) had shown that short-term human growth is non-linear unpredictable. It is therefore not possible in clinical practice to predict future growth from short-term measurements although it is valid to compare dose and efficacy of growth suppressing and promoting therapies in carefully designed studies. Longitudinal studies of increasing intensity and the use of new and as yet undiscovered techniques of measurement and analysis are still required to look deeper and deeper into the biology of the growth process.

Pia, G.G. and Marisa F. M. , (1980) had presented the average values for height, weight, arm circumference for 2,115 Somalis aged from birth to 18 years. Height and weight means are plotted on American Standard Charts. The circumference are compared with variables in Americans and European descent. The difference of the Somali means when compared with the International Growth Standard Charts suggested the construction of local growth charts to use in Somalia.

Ali and Ohtsuki (2000) had discussed the longitudinal growth in stature for 509 males and 311 females characterized from early childhood to adulthood. A triphasic generalized logistic (BTT) model was used through the AUXAL software program. Growth parameters were derived from the estimated distance and velocity curves for each individual. A set of estimated growth parameters, including adult stature, was selected to develop equations, through the forward stepwise regression method, for the prediction of adult stature for Japanese boys and girls.

Cole, T. J and Roede, M .J (1999) was found the distribution of body mass index (BMI) in Holland from the nationally representative growth survey in 1980, when obesity was uncommon. Forty- one- thousand boys and girls age 0-20 years. BMI percentiles based on the original height and weight data were derived using the LMS method. They had shown, median BMI the familiar pattern of a rise in the first year, followed by a fall, then a second rise after 6 years.

Kumi Ashizawa, Sumiyo Kato et al. (1994) estimated to make clear the diversity of adolescent growth, spline- smoothed individual velocity curves of stature, body weight and chest circumference of 44 girls in Tokyo, of which menarche was recorded correctly, were provided. Additionally, 25 variables of ages at peak velocity, intensities, sizes and weight at the peak and at menarche, and terminal height were obtained. On an average, take –off for height occurs at age 8.5, then that for weight at 8.8, for chest circumference at 9.1.

Shinkichi Nagamine and Shinjiro Suzuki, (1994) had studied on 96 Japanese college men and women for the criteria of body composition, skin fold thickness and body density, to apply these to the evaluation of the nutritional status in young Japanese men and women, and to compare them between races. They had found the correlations between body density and skin folds are highest in the abnormal region for men and in the sub scapular region for women. Of the correlations between body weight, body surface area and fat-free mass has the highest coefficient with density.

Matsuo et al. (1990) studied on controversy exists regarding possible international and interracial differences in head circumference of children. They wanted to see if there was a difference in head circumference between Japanese and Caucasian children. They concluded that there is a significant ethnic difference in head circumference, as large as one- channel of usual percentiles, between Japanese and Caucasian children. The results indicate that smaller head circumference in Japanese children primarily reflects smaller stature of the Japanese.

Kaplowitz et al. (1991) had discussed on longitudinal Principal components (LPC) analysis was used to assess growth patterns in children from rural Guatemala in order to determine their methodology regarding correlates of growth compared to more traditionally used methods based on attained size and increments. Component indices representing percentile level and percentile shift, attained size, and 3 to 36 month increments of growth was calculated multiple regression. They found from regression results were similar, higher nutritional intakes associated with more rapid growth.

Gyenis (1997) had shown his study that a positive secular trend had been continuing in University students in Hungary between 1986 and 1990.There was another socioeconomic characteristic of the analyzed measurements in the sample: students who were born elsewhere in the country had lower values, both in height and weight, than those students born in Budapest in the15 successive classes studied.

Shani et al. (1994) studied on weights of apparently normal hearts were obtained from 1,344 male and 313 female adults from the Chandigarh region of Northwest India. On whom a medico-legal autopsy was performed. Partial correlation between heart, weight and supine length were significant.

Kim (1982) had discussed in the growth status of 845 (boys 403, girls 442) Korean schoolchildren born and raised in Japan aged between 6 and 17 years in 1978. Height, weight, wt/ht, chest circumference/ht and sitting height of Korean schoolchildren in Japan were compared with those of Japanese children. Korean schoolchildren in Japan were slightly taller at every age. for a more favorable environment in Japan.

Tanaka et al. (2004) they studied and construct a chart of body proportion of girls and boys in Japan from Nationwide student population in Japan. They have found that, Japanese boys (13.5-17.5 years old) were taller and have relatively longer legs than Japanese girls in the same age group. In boys, the percentile values reached the lowest at

13.5 years, then increased slightly. In girls, the percentile values remained constant after 11.5 years, which is different in boys.

Gualdi- Russo et al. (2005); studied on the growth of human migrant populations. They have studied on the growth pattern from birth to 24 months and the body composition of Chinese infants born and living in Bologona. Weight and height values are higher in Chinese children than in Italians. So, they have found the supporting hypothesis that Chinese children born and living in Italy grow in an appropriate environment to achieve their growth potential

Already it has accomplished research on infant growth in various countries in the world. Probably most of the works have been executed on this topic in Japan. On the other hand, the principal purpose or target was on the basis of such kind of work in the developed countries to detect the nutritional status of both the babies and the mothers. By this time, two reports in Bangladesh have been recently published which have been observed and directed by NGO's in Bangladesh.

The first report was published in the American Journal of Clinical Nutrition in 1985 which title was 'Nutrition and Fertility in Bangladesh- Nutritional Status of non pregnant women', Authors -Huffman, S.L and others. The second report was published in 1993 edited by Professor Mascie Taylor, C.G.N. jointly as a report of NGO and BIRPHERTS research in Dhaka. Both Dr. E Karim and Professor Mascie Taylor of Bangladesh Institute of Epidemiology Diseases Center had taken the work of second follow up and had accomplished research work on it. After the accomplishment of the research work they had published two articles in 1997 and 2001 in the ANNALS OF HUMAN BIOLOGY. The title of the first article was 'The Association between Birth Weight, Socio Demographic Variables and Maternal Anthropology in an urban sample from Dhaka, Bangladesh'. The title of the second one was 'Longitudinal Growth of Bangladeshi Infants During the First year of Life'. Their study area was the three slums at Mirpur in Dhaka. They had started their work in June 1993 with 253 mothers and Children. When the ending time of the project in 1995 there was only 91 specimen remaining. The rest were lost. The researchers frankly agreed that there were many kinds of short comings in that collected data. Specially it is mentioned that though the duration of time of observation and taking measurement every after one month but many times it was too late. Such as 5-10 days late from due time and it was mostly occurs for infants at birth to first observation measurement. According to their opinion, the reliability of their collected data was only 0.85 to a maximum. For all of these causes, they have used both of actual and predicted data in the text.

2.2 Research Gap

It is evident from literature review that there is limited research to support a prescribed frequency for performing anthropometric measurements in order to identify children with physical growth disorders in general. In particular, there have no such research which is related to growth monitoring of Bangladeshi infant and children. So, Serial measurements data of height, weight, and head circumference, etc as part of scheduled well-baby and well-child health visits are required for the purpose. It is to be mentioned that the ideal number of health maintenance visits either by NGO's or Government initiatives has not been established till now for the Bangladeshi children. In Canada, their current recommendations are that they be organized according to the immunization schedule with additional visits within the first month and followed by additional observations at regular intervals upto 2-6 years of age. For the early identification and referral of a child whose abnormal stature or rate of weight gain may indicate a problem that might require treatment. In cases where a growth problem is suspected, or a child's response to therapy is being monitored, more frequent measurements may be required.

Growth charts are a graphic presentation of body measurements that aid in the assessment of body size and shape, and in the observation of trends in growth performance. They are used in the assessment and monitoring of individual children and in screening whole population. Growth charts are not diagnostic and may be used in conjunction with other information when evaluating a child's general health. There is an important distinction between a growth reference and a growth standard. A reference simply describes its sample without making any claims about the health of its sample, where as a standard represents 'healthy' growth of a population and suggests a model or target to try and achieve the given charts. Growth charts currently in use describe existing growth patterns and are therefore references, not prescriptive standards.

The Government of Bangladesh (GOB) is committed to improving the health of its people, particularly for mothers and children. Health services are mainly provided here through public hospitals and private clinics, the nature of services being curative, preventive and promotional, especially health care for women, mother and children. Bangladesh does not have a national pediatric surveillance system for collecting anthropometric and nutritional data; therefore, national growth charts do not exist for Bangladeshi children.

2.3 Objectives of the Study

The main objective of this research is to study some differentials of longitudinal growth from (0-48) month interval, in general concerning growth velocity, interrelationships between variables such as height, weight, maturity, followed by construction of some important growth charts to monitor the growth of a child and that may be used to compare the growth standard of Bangladeshi children with other standard population.

Special Objectives:

Special Objectives of this study are

i) To study recumbent length age and sex, 0-48 month,

ii) To study weight by age and sex, 0-48 month,

iii) To study head circumference by age and sex, 0-48 month,

iv) To study growth differentials of sex, and

v) Construction of child growth reference tables and charts of :

a. Height for age,

b. Weight for age,

c. Sitting height,

d. Upper-lower ratio,

e. Body mass index (BMI),

f. Chest circumference,

g. Arm circumference,

h. Elbow-wrist length,

i. Shoulder-elbow length,

j. Head circumference,

k. Maximum head length,

l. Maximum head breadth, and

m. Maximum head height.

2.4 Organization of the study

There are six chapters in this study. Chapter 1 is Introduction which contains prelude, indicators of child growth, importance of the study and statement of the problem.

Chapter 2 is Genesis of the study that contains literature review, research gap, objectives of the study and organization of the study.

Chapter 3 is the methodology of the study. It contains statistical methodology of the study and measurement of variables.

Chapter 4 is the materials of the study. It contains sampling design, selection of study area, selection of variables, framing of the questionnaire, collection of data, and problems of data collection.

Chapter 5 is the core chapter of this study consisting of researching findings and discussion of results.

Chapter 6 is the concluding remarks consisting of overall findings, limitations of the study and scope for the further research.

A bibliography is appended at the end. The questionnaire of the study is affixed in the appendix.

Declarations, title page, acknowledgement, table of content, list of tables and figures are appended at the beginning of the thesis.

Chapter - Three

Methods of the Study

3.1 Statistical Methods

3.1.1 Statistics: Statistics is the Science of measurement of Social organism, regarded as a whole in all its manifestations. On the other words, "Statistics" are numerical statements of facts in any department of enquiry placed in relation to each other."

3.1.2 Data: The raw material of statistics consists of numbers or observations usually obtained by some process of counting or measurement. These are referred to collectively called as data. There are two general types of data.

a) Qualitative data b) Quantitative data.

Our research depend upon on these two kinds of data.

3.1.3 Qualitative data: In certain statistical investigations we are concerned only with the presence or absence of some characteristic in a set of objects or individuals. In this situation, we only count how many individuals do or do not possess the characteristics, is called qualitative or enumeration data. As for example, if we have record of births we may be concerned only as to whether the baby is male or not and the count the number of male babies.

3.1.4 Quantitative data: A variable is a measurable quantity which can assume any of a prescribed set of values, called the domain of variables. When we are interested in a variable, we either note or measure the actual magnitude of some character for each of the individuals or units under consideration is called quantitative data. Such as, the height of a person, the valid of a crop etc.

3.1.5 Variable: A characteristic which varies over time, place and individual is called a variable. When a variable can assume only isolated values, it is called a discrete variable. For example, if the number of children in a family is the variable of interest, it is obvious that it cannot assume fractional values and hence it is a discrete variable.

A variable is said to be continuous if it can theoretically assume any value within a given range or ranges.

3.1.6 Population: A population or universe is a very important concept in statistics. It is the aggregate of all possible values of a variable or all possible objects whose characteristics are of interest in any particular investigation or enquiry. If the income of the citizens of a country are of interest to us, the aggregate of all relevant incomes will constitute the population.

3.1.7 Classification: When the data have been collected in any statistical investigation, the first step is to introduce order in the raw material. But it is difficult to grasp the significance of a large mass of data unless they are arranged in a systematic way, and hence the need for classification. So, the process of arranging individuals in groups or classes according to their affinities is called classification.

3.1.8 Tabulation: It involves the orderly presentation of numerical facts in tabular form. Such as, the growth of population in Pakistan during the period 1901-1961 can be arranged in tabulated form.

3.1.9 Frequency Distribution: When observations, discrete or continuous, are available on a single characteristic of in large number and complicated often it becomes necessary to condense the data as far as possible without losing any information of interest. So, the most important tabulated form, a data from statistical point view is called frequency distribution.

3.1.10 Graphical representation of data: It is often useful to represent a frequency distribution or data with the help of a diagram which makes the unwidely data intelligible and conveys to the eye general run of the observations. Diagrammatic representation also facilitates the comparison of two or more frequency distributions. There are some important types of graphic representations, like:

Bar diagram: This diagram is drawn by erecting a series of blocks of equal width but with heights proportional to the values corresponding to different time periods or categories.

Pie diagram: The pie diagram is intended to components which together constitute a whole. The whole is represented by a circle of arbitrary radius and the segments of the circle represent the component parts.

Line diagram: If we are given the values of a variable at different points of time, the set of values is known as a time series. The line diagram is used to represent this type of data. In this diagram time is represented along the X-axis and the variable is plotted along the Y-axis.

Frequency polygon: In this diagram the mid-values of class intervals are plotted along the X-axis and corresponding frequencies are plotted along the Y-axis. These latter points are then joined by straight lines, thus forming with the X-axis a polygon called frequency polygon.

Histogram: In this diagram the horizontal axis is divided into segments corresponding to the class boundaries of the frequency distribution. On each segment a rectangle with area proportional to the frequency in the class erected. The set of adjacent rectangles so constructed, constitutes a histogram.

Cumulative frequency polygon: A graph showing the cumulative frequency less than any upper class boundary plotted against the upper class boundary is called a cumulative frequency polygon.

Scatter diagram: Sometimes the data consists of pairs values of two related variables, x and y, and the statistical problem is to investigate the inter-relationship between the variables. If x may represent the height and y, the weight of a university student then the given pairs of values are plotted on ordinary graph paper, we get a "dot diagram" or "scatter diagram".

3.1.11 Central tendency: In a representative sample the variables have a tendency to cluster around a certain point usually at the center of the series. This tendency of clustering the values around the center is called Central tendency. Its numerical measures are called measures of central tendency. Mean, Median etc. are the measures of central tendency.

3.1.12 Dispersion: Measures of central tendency give us an idea of the concentration of the observations about the central value of the distribution. It is equally important to know how the observations of the variety cluster around or dispersed away from the central value of the distribution. This characteristic of the observations of the distribution is called dispersion.

The statistical methods to measure the deviations of the observations from their central value are called measures of dispersion.

There are two types of dispersion- Absolute measures and Relative measure.

An absolute measure is performed from the raw data with the actual unit of measurement. Four types of such measures are available:

Range: Range is the difference between the largest and smallest values of the variate.

Mean deviation: The arithmetic mean of the absolute deviations of the observations from their central value (mean, median, mode) is called mean deviation about central location.

Mean deviation: The arithmetic mean of the absolute deviations of the observations from their central value (Mean, Medina, Mode) is called mean deviation about central location.

Standard deviation: The positive square root of the square of the deviations of the observations from their arithmetic mean divided by the total number of observations is called Standard deviation.

Mean deviation: The arithmetic mean of the absolute deviations of the observations from their central value (Mean, Median, Mode) is called mean deviation about central location.

Quartile deviation: If Q_1 and Q_3 be the first and 3^{rd} quartile of a series of data, the quartile deviation is defined as $Q: D=Q_{3}-Q_{1}/2$.

3.1.13 **Correlation:** In a bi-variate distribution we may be interested to find out if there is any correlation or covariate between the two variables under study. If the change in one variable effects a change, the variables are said to be correlated. The relationship between the two correlated variables is called Correlation.

3.1.14 Regression: Regression analysis is a mathematical measure of the average relationship between two or more variables in terms of the original units of the data.

Polynomial regression: The linear regression model $Y=X\beta+\varepsilon$ is a general model for fitting any relationship that is linear in the unknown parameters β. This includes the important class of polynomial regression models. For example: -

the second order polynomial in one variable

$$Y = \beta_0 + \beta_1 x + \beta_2 x^2 + \varepsilon.$$

3.2 Variables Selected:

In this research we have selected the following quantitative variables for this study:

- Arm Circumference (Right and Left),
- Chest Circumference,
- Elbow-Wrist/Fore-Arm Length (Right and Left),
- Head Circumference,
- Maximum Head Breadth,
- Maximum Head Height,
- Maximum Head Length,
- Recumbent Length or Full Length,
- Shoulder Elbow Length (Right and Left),
- Sitting Height, and
- Weight,

3.3 Measurement of Variables:

We have used in our research some instruments. Such as (a) Weight machine, (b) Spreading Caliper,(c) Sliding Caliper (d) Length Measurement Tap etc. The machine error in spreading caliper was .02cm and the .0025cm in sliding caliper. We have detected the machine errors of these instruments as below:

The number of strains of main scale of spreading caliper 5=1 cm

So, 1/5 = .2cm

5 strains of main scale=4 strains of vernier scale. So, vernier constant (error) = (5-4)×.2/5 = .04cm

For sliding caliper:

1 strains of venire scale=1/10=0.1cm.

Now the 10 strains of main scale has accurately adjusted to the 5 strains of vernier scale. So, (10-5) × .1/10= .05 cm.

Length = main scale reading + vernier scale reading × vernier constant.

3.3.1 Full length: We have taken full length of infant by measurement tap which is marking by cm and inch. By lying vertically situation touches a big scale with the top of the head and at the same time at the ending of the foot touching with a scale as a parallel way. Lightly pressure should be sufficient to compress the soft tissues of the foot but not enough to alter the length of the venier column. Now we have to measure the total distance between two scales. But when the child able to be stand without any kind of support then we have taken measurement between the distance from the highest point of the top of the head in the mid sagittal plan to the floor.

3.3.2 Weight: The birth weight we have recorded from Clinic/Hospital. The next every after 15 days to one years of age we have taken weight of infants by our weight machine to keep infant lying quietly or sitting position. During Infancy, a leveled pan scale with a beam and movable weight machine is used. The pan must be at least 100 cm long so that an infant can easily lying on it and it can support a two years of old infant at the 95th percentile for recumbent length. The Infant with or without a diaper, is placed on the scale so that the weight is distributed equally on each side of the center of the pan. When an infant is restless, it is possible to weight the mother when holding the infant then she stand on the plane weight machine. Then we have taken only the weight of mother. Now by subtract from the weight of mother with infant and only mothers weight we get the infant weight. After 2 years of age when child able to stand or sitting without support then it is weighted using a leveled platform scale with a movable weight machine. There is a general agreement that weight should be measured using a beam scale with movable weight machine and that a pan scale is needed for measurements made during infancy. Weight is a composite measure of total body size.

3.3.3 Sitting Height: The sitting height of new born infant is called Crown-rump length which has measured as subject (infant) lies in a supine position vertically upon a bed or recumbent length table or desk. The crown of the head touches the stationary, vertical headboard, with the long axis of the body coinciding with the long axis of the board. Usually in infants, we have given a scale horizontally and infants legs had kept at straight horizontally like 90°and in the position here also have a scale as a parallel to that head scale. Now the distance from the top of the head to last of feet have recorded. When infants able to sit then its need to measurement of sitting height requires a table and a base for the anthropometer. The table should be sufficiently high so that the subject's legs hang freely. The subject sits on the table with the legs hanging unsupported over the edge of the table and with hands resting on the thighs in a cross handed position. The knees are directed straight ahead. It is important that the subject and measurer so positioned, the subject is instructed to take a deep breath, and the measurement is made just before the subject exhales. Now the back peace has a movable horizontal headboard that can be brought in contact with the subjects head.

Now when the subject is seated properly the head board of the stadiometer is brought down on to the head as in the measurement stature and the reading is taken, we use for it a measurement tap and a table.

3.3.4 Chest Circumference: The measurement of chest circumference have taken below the armpit in a horizontal plane on the bust point at the time of a normal expiration standing in front of subject by measurement tap and that is written properly.

The measurer stands in front of the subject but slightly to one side. The tap using is held in the right hand while the free end of the tape is passed in front of the subject and retrieved by the measurer's left hand as it passes around the subjects back. The free end of the tap is taken positioned between the right axilla and the sternum. At this time, the measurer ensures that the tap is at the correct horizontal position, first at the back and then at the front the reserve end of the tap is then placed near the zero end.

The tap should be in light contact with the skin, without indenting it, but the tap may be away from the skin near the vertebral column. The skin should be free of perspiration, because this may increase friction between the skin and the tap.

3.3.5 Arm Circumference (Right &Left): By keeping infant elbow is flexed 90°as normal we have taken the measurement of arm circumference. The midpoint between the distance of infants shoulder & elbow by measurement tape. Yet, when the subject had awakened after sleeping then we have messaged its soft tissue to turn into normal position. After then we have got the reading of arm circumference and note down. Because it has observed perfectly that when an infant or child was in sleeping turn a side then the amount of water in tissue and mussel of opposite side increases than the normal side. So the reading of sleeping side of infant always differ from normal side.

The subject wears loose clothing without sleeves to allow total exposure of the shoulder area. If the mid point of the upper arm has been marked for the measurement of triceps or biceps skin folds, this should be used as the level for the measurement of arm circumference. To locate the midpoint, the subjects elbow is flexed to 90°with the palm facing superiority. The measurers stands behind the subject and locates the lateral tip of the acromion by palpating laterally along the superior surface of the spinous process of the scapula. A small mark is made at the identified point. The most distal point on the acromial process is located and marked. A type is placed so that it passes over these two marks, and the midpoint between them is marked.

With the arm relaxed and the elbow extended and hanging just away from the side of the trunk and the palm facing the thigh, place the tape around the arm so that it is touching the skin, but not compressing the soft tissues. The tape axis the arm at the marked midpoint.

3.3.6 Shoulder Elbow Length (Right & Left): By keeping infants both hands horizontal and vertical position like as 90°angle and both hands are parallel, we put one scale upon the shoulder and other has kept at the ending point of the elbow as parallel then the distance between the two scales we have taken reading or measurement by measurement tap. This reading is note down as shoulder elbow length. We have taken measurement such way both of hands of Infant.

The shoulders and upper arms are relaxed, with the shoulders drawn back and the upper arms hanging loosely at the subjects sides, weight is distributed equally between the feet. Both elbows are flexed to place the total surfaces of the forearms and the hands in the horizontal plane and parallel to each other. The infant takes breath normally. Measurement of shoulder elbow length was made with the infants laying, sitting or standing position.

3.3.7. Elbow-Wrist Length: By keeping infants both hands horizontal and vertical position like as 90°angle and both hands are parallel, now one scale has kept to touch the ending point of elbow and other has kept at the ending point of the wrist as parallel. The distance between the two scales we have taken reading or measurement by measurement tap. This reading is note down as elbow wrist length. We have taken measurement such way both of hands of Infant.

Elbow-wrist length is measured with a measurement tap .The subject wears clothing that permits body positioning to be observed. The arms and shoulders are bare. The subject, unsupported by a wall or similar structure, stands erect on a flat horizontal surface with heels together, weight equally distributed between both feet, and the shoulders drawn back. The subject breathes normally with the head in the Frankfort Plane.

The subject's arms hang by the sides. The elbows are flexed to 90° and the palms face medially, with the fingers extended in the direction of the long axes of the forearms.

3.3.8. Head Circumference: To measure head circumference it is necessary with the round over the head comparatively highest sloping place and upon just upper of the ears, glabella or eye brows by measurement tape. The plane of the tape must be the same on both sides of the head. The tape is pulled tightly to compress hair and obtain a measure that approximates cranial circumference. We have taken measurement by this technique.

An infant is measured when seated on the lap of the mother or caretaker. At older ages head circumference is measured with the subject standing, but few children less than 36 months old will stand still for this purpose. The measurer stands facing the left side of the infant and positions the tape so that the zero end is on the lateral aspect of the head. This involves passing the tape around the head and then transferring the ends of the tape from one hand to other so that the zero mark on the tape is inferior to the value to be recorded. The tape is positioned so that large amounts of cranial hair (braids) are excluded. Interiorly, the tape is placed just superior to the eyebrows and posteriorly it is placed so that the maximum circumference is measured.

3.3.9. Maximum Head Breadth: The greatest transverse diameter of the head of an infant is called maximum head breadth. This is usually found at a point over each parietal bone (each point is turmed the euryon). That forms the sides and top of the skull? The measurement of maximum head breadth requires a spreading caliper which contains a main scale with a venire scale. To determine maximum head breadth the measurer stands in front of subject. Then the spreading caliper is placed lightly/flippantly both on the top point of parietal bones. After taking measurement, the record of main scale, venire scale have observed carefully and have note down. After then, the constant of vernire scale of multiply with venire reading. Now the reading of venire scale add with main scale we have got the perfect reading of maximum head breadth.

3.3.10. Maximum Head Height: Maximum head length is determined the front part of infants face from below of chin to just upon the arched part of forehead. It is mention that the measurement has taken and recorded by the sliding caliper.

3.3.11. Maximum Head Length: The distance between the glabella and the farthest projecting point in the mid saggital plane, on the back of the head (occiput). The later point is turmed the opisthocranion. It has measured and recorded by sliding caliper.

3.4 Processing and Presentation of Data:

Collected data has been processed after necessary checking, editing and then they have been arranged in the tabular form. Accuracy of data has been looked very carefully. The collected raw data has been tabulated and processing done by the computer. Collected data and findings are presented in tabulated and in graphical form.

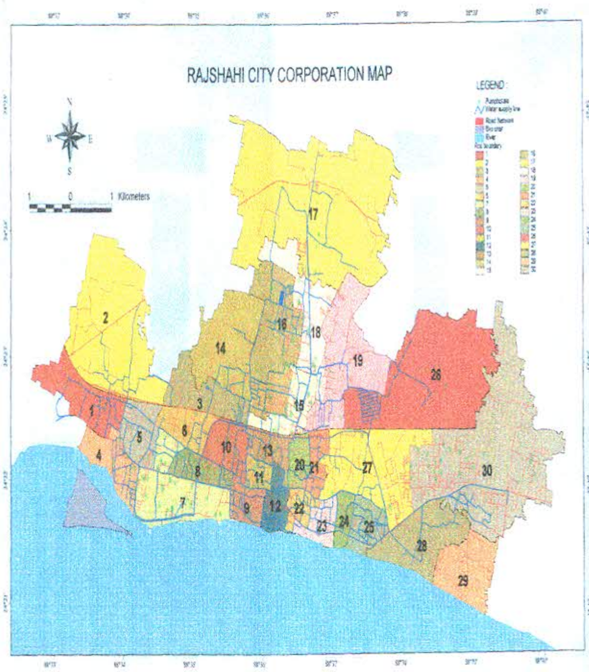
Chapter - Four

Materials of the Study

4.1 Selection of the Study Area:

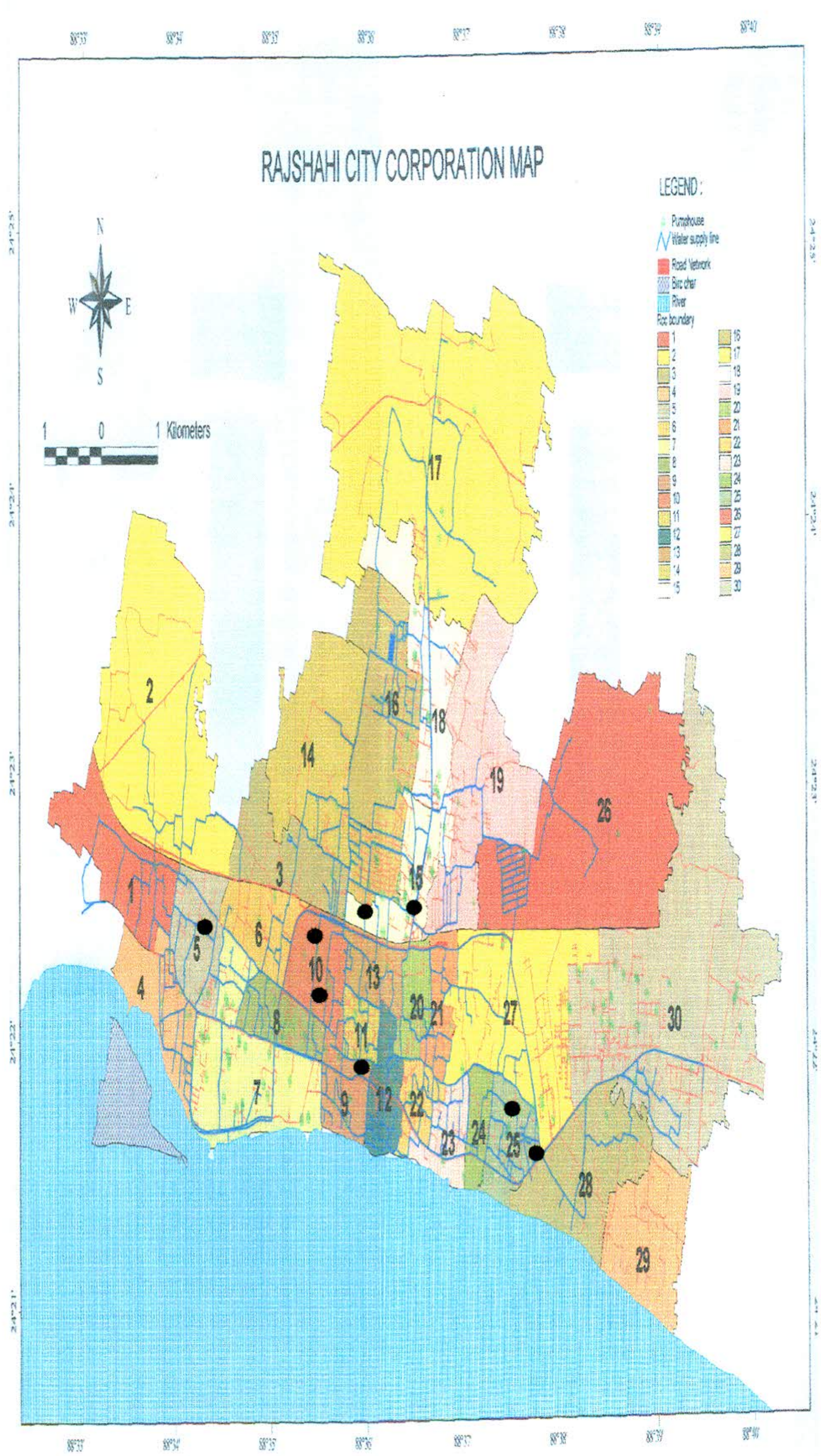
We have selected 'Rajshahi City' as our study area for obvious reasons. Rajshahi City is situated on the west corner in the Map of Bangladesh. It is the northwest divisional and district head quarter Of Bangladesh. It stands on the northern bank of the river Padma. It lies between 24°05′- 25°14′ north latitude and 88°01′- 89°25′ east latitude (Sheike and Haque, 1996:24). The total population of the city was 22291 in 1871. It has become the fourth largest city with current population above 0.7 million covering an average area of 92 square kilometer.

Map of Rajshahi City is appended showing various important locations



4.2 Sampling Design: In the study area there was 23 clinics and hospitals engaged in maternity and child delivery activities of which 17 was private and 6 was Govt./Semi-Govt./Autonomous managed. Of the Govt. hospital, Rajshahi Medical College hospital is of largest activities having 500 deliveries per month on an average was excluded from the study, because of our inability to handle such large number of babies. We have selected 6 private and 2 non-private clinics and hospitals out of 17 and 5 approximately on $\frac{1}{3}$ random sampling basis. Children born in between May 25 to December 13, 2002 in those selected clinics and hospitals are included in our study sample provided parents of those children are permanent resident of Rajshahi City Corporation.

RESEARCH AREA: RAJSHAHI CITY CORPORATION.



Bangladesh

Name of the selected clinics and hospitals including the number of sample babies from each of them are appended below:

i) Amena clinic and Diagonistic Center, Talimary Bazar, Rajshahi=20.

ii) City Hospital, Raninagar, Rajshahi=116.

iii) Endoscopy and Maternity Center, 13/A Mohis bathan, Rajshahi=3.

iv) Modern Maternity Center, Kajihata, Rajshahi=10.

v) Mohanagar clinic and Diagnostic Center, Bornalir more, Rajshahi=15.

vi) Mother and Child welfare Center, Hetemkhan, Rajshahi=115.

vii) Padma clinic and Diagnostic Center, Kajihata, Rajshahi=13.

viii) Zomzom Islami Bank Hospital, Laksmipur more, Rajshahi=11.

First of all we have prepared a complete questionnaire consistent with our study objectives. After selection of clinics and hospitals we have gone there everyday regularly to collect informations of newly born infants and have taken the first measurement of observation with the help of nurses and doctors. We have to go to the residences of the babies to continue the collection of data as per scheduled for long 48 month until the end of data collection.

4.3 Framing Questionnaire:

In order to conduct the proposed research primary data have been collected through observation, personal interviews from the infants parents and taking measurement of infant by the researcher. We are concerned here primarily with the growth of child as the natural creation. So the work was to run in its natural manner/ course. The study has been conducted in selected area and is based on field survey through questionnaire. The questionnaire was framed in consultation with supervisors keeping consistent with the objectives of the research study and pre-tested at the field level. Detailed questionnaire is appended in annexture-1.

4.4 Data collection:

Researcher has to gone to the study area from dawn to dusk everyday for the investigation and observations for the specimen. At the same day, in the morning 7.30 am-2.30pm have to collect specimen with data and from 3.30pm-7.00pm for observation of collected data. So it was the very painstaking work for the researcher.

To collect data about the Infant it was necessary to note down their permanent and temporary home address of Infant, also its grandfather home address. Because it was needful to continue the work regularly every after 15 days at 0-1 years old and then every after 1 month at age 1-4 years.

During the infancy, every measurement has taken in lie down position. After then when infant able to stand then the measurements have taken in the standing position except sitting height. As far possible, the measurements have taken just at their birth time of (every) infants. Beside this, all measurements of maximum infants have taken during the morning period (from 7.30am-12am) except at noon (from 12am-4pm) born babies. Its reason that individuals (infant) generally increase in height at morning but decrease in evening. Further because they tend to be more relaxed during the morning.

Where the body as a whole is being measured it is preferable that the subject (infant) be completely unclothed. When it is not possible the investigator have to make the best situation encountered. As for example, during the winter morning observational work it has to go to the subjects (infant) home at their bath time to take correct measurement.

It is specially mention that all measurements have taken with a minimum pressure by the instruments. Every measurement is repeated three times and the average recorded after excluding any clearly erroneous value. Therefore, it is practically every measurement of every infants has taken at a fixed time with date.

4.5 Problems of Data Collection:

This study is longitudinal growth study of Bangladeshi children. "Longitudinal study" means a long time observational study. Here the growth measurement of child have been taken from infancy to childhood at regular intervals properly and timely.

Longitudinal study is time-consuming and laborious, and it is quite difficult to observe particular subjects at regular intervals over a long period without any interruption. But only a study done this way can analyze the growth in individuals precisely.

Longitudinal data are preferred when the patterns of growth of two or more populations of children are compared. Only a longitudinal analysis allows for a determination of the rates of growth and the timing of developmental events that result in differences in size and maturity.

Longitudinal growth study is not the examination of a subject at one moment in time, but the analysis of changes over time in individuals as they grow and develop. In a longitudinal observational design study, a sample of subjects (child) is measured repeatedly at specific times and over pre-determined intervals.

To start this work firstly it needs to make intimacy with everyone of a family. We have gained success within a very short time on it and have got positive response from the respondents. The function of the study is humanly feeling area. So researcher's feeling was always consisting love and affection to the innocent babies expressing by gifting various kinds of objects regularly. But It was very difficult to collect data for the research in suspicious social condition of our country.

There are superstitions that babies would become ill if external visitors visit the residence and observe the baby frequently. Parents of babies were not agreed to allow entrance of the researcher into their residence and shut the door of the residence for the researcher. Some of the parents thought that the researcher is a child thief. Some of the parents considered the researcher as an agent of miscreants and for that reason they reported the local police all those events created mental and psychological pressure on the researcher.

At the time of measuring supine length of a baby, grandmother of the baby commented that such measurements would obstruct the growth of the baby. This wrong concepted comment of the old lady enchanted the neighbouring parents and they have denied to give onward measurements on their babies. Ultimately, we had to exclude those babies from our study sample. Most of the mothers did not show interest in providing informations about liquid and solid food (milk, fruit, juice etc.) consumption of babies because they were told by senior members of the family or neighbour that providing such informations to outsiders would decrease the food appetite of babies retarding their growth and babies may be attacked with severed kind of disease. During the illness of babies, some of the parents accused the researcher and her activities. We have faced, in practice, such real situation by consulting child specialist and arranging medicine for victim babies and training to mothers about child caring. Within six months the researcher had become a member of each and every family of the babies under her investigation due to her helping and cooperative attitude to the poor, illiterate, half literate and superstitious families.

As babies grow with time and starts moving of their hands and feet, it is difficult to take measurement on babies with instruments without help from babies mother. The researcher had to compensate babies mothers' time by helping them in home works.

Some of the times, babies were in sleep. The researcher had to wait in babies home unless babies sleep was complete. In the meantime she used to help the family in various works. Even sometimes, she used to tutor other senior babies of the family.

At the beginning measuring instruments were a source of fear to the babies and they began to cry on seeing those instruments. Combined efforts of parents, other family members and the researcher showing affectionate and loving attitude succeed to remove fear from babies. Ultimately, babies have become habituated with and introduced to the instruments and the researcher.

It was difficult to move from door to door during rainy season because roads and streets in the study area are not very well and in most of the extended city corporation area, these were not metaled but mudded.

More and over, the researcher had no financial support from any where of any form to conduct the study and she was in financial problem through out. It is extremely showing that she had lost her beloved father who was a teacher of Govt. College during the tenure of this work.

The researcher is thankful to the mothers of babies without whose sincere cooperation it would not be possible to conduct measurements and collect information for this study.

4.6 Scope of the Study:

This research was very depending on lengthy time limit work. After going specimen place taking some relax or waiting for both of mother and child, then have started measurement. Many of time it happened that it was not possible to take measurement of infant or baby for its longtime sleeping. In that case there have spent much times to collect data moving from door to door and returned those of babies for their observation.

Bangladesh is a six seasons country. Researcher have fallen many kinds of problems on observation duration of observation. To collect data bearing instruments were heavier for a researcher (single woman), such as weight machine, head measurement calipers etc. It was so painful with bothering unlimited spoken to go every home to know about the condition of babies health etc. Researcher has to be asked to know about the food habit, drinking milk, sleeping time.

In the rainy season, researcher has to gone to some house of infants by walking along nesty water of flood. In the winter season, firstly researcher has to faced the problem that it was impossible and not easy to collect data of infants early in the morning. Because there were no parents to give us asscent to open the warm clothes from their infants body. So at the morning 10.30am-3.30pm researcher has completed the study. For our research, if the infant wearing extra clothes then the weight and others measurements have to seen their inequality.

Though their was various types of limitation of the study, our observation never had stopped in any season in any case. It was smoothly running and wining its target to the last of the study.

Chapter – Five

Results and Discussion

5.1 Longitudinal Growth of Bangladeshi Children

Recumbent Length/Stature by age 0-48 months

The longitudinal data on recumbent length/stature of Bangladeshi Children from 0 to 48 months of age was collected individually and their age specific mean values for boys, girls and sex differences are shown in Table 5.1.1. An examination of the Table shows that mean stature at birth do not differ significantly between the sexes but at age 48 months the sex difference in average stature is observed to be 3.50 cm, 100.41 cm for males and 96.94 cm for females with standard deviation of 6.55 cm and 4.00 cm. This implies, mean height velocity for males are comparatively larger than females but females are more consistent than males.

Table 5.1.1 Longitudinal mean and standard deviation (SD) of stature (cm) for boys, girls and their differences by age 0-48 months.

Age	Boys			Girls			Sex Differences
(months)	n	Mean	SD	n	Mean	SD	Mean
0	162	48.55	2.58	134	48.53	2.46	0.02
3	161	56.13	3.11	134	55.74	2.80	0.40
6	160	62.14	2.92	133	61.70	2.71	0.45
9	160	67.60	2.79	133	67.01	2.39	0.59
12	160	72.44	2.78	133	71.62	2.44	0.82
15	127	75.61	3.00	118	74.91	2.82	0.71
18	127	77.97	3.23	118	77.35	3.08	0.61
21	127	80.68	3.45	118	80.00	3.32	0.67
23	127	82.44	3.60	118	82.00	3.43	0.43
25	127	84.26	3.73	118	83.90	3.61	0.36
28	96	87.02	3.97	87	86.16	3.73	0.87
31	96	89.37	4.53	87	88.14	3.80	1.24
34	96	91.83	5.07	87	90.20	3.85	1.63
38	91	94.61	5.62	79	92.64	4.03	1.97
42	91	96.91	6.00	78	94.47	4.14	2.45
46	91	98.23	6.30	78	96.44	4.07	1.93
48	91	100.41	6.55	78	96.94	4.00	3.47

Weight by age 0-48 months

The longitudinal data on weight of Bangladeshi Children from 0 to 48 months of age was collected individually and their age specific mean values for boys, girls and sex differences are shown in Table 5.1.2. At birth, difference in mean weight between males and females are observed to be 0.09 kg only, 3.04 kg for males and 2.95 kg for females with standard deviation of 0.54 kg and 0.47 kg in order. This implies, birth weight of among the children are homogeneous between the sexes. The growth in weight shows a faster velocity among the males than the females. At the age of 48 months, males are observed to gain 1.61 kg of weight on an average over the females. Females having 14.76 kg with SD 2.43 kg.

Table 5.1.2 Longitudinal mean and standard deviation (SD) of weight (kg) for boys, girls and their differences by age 0-48 months.

Age	Boys			Girls			Sex Differences
(month)	n	Mean	SD	n	Mean	SD	Mean
0	162	3.04	0.54	134	2.95	0.47	0.09
3	161	6.18	0.98	134	5.88	0.83	0.30
6	160	8.51	1.42	133	7.98	1.42	0.54
9	160	9.37	1.27	133	8.78	1.49	0.59
12	160	9.23	0.99	133	8.80	1.08	0.43
15	127	10.88	1.20	118	10.70	1.32	0.18
18	127	11.46	1.43	118	11.39	1.55	0.07
21	127	12.19	1.60	118	11.92	1.70	0.27
23	127	12.64	1.79	118	12.31	1.70	0.33
25	127	13.17	1.99	118	12.59	1.82	0.58
28	96	12.64	2.22	87	12.16	1.93	0.49
31	96	12.92	2.35	87	12.09	1.93	0.83
34	96	13.56	2.73	87	12.68	1.98	0.88
38	91	14.44	2.82	79	13.65	1.89	0.79
42	91	15.05	3.06	78	13.91	2.10	1.14
46	91	15.79	3.45	78	14.42	2.32	1.37
48	91	16.37	3.53	78	14.76	2.43	1.61

Sitting Height by age 0-48 months

The longitudinal data on sitting height (cm) of Bangladeshi Children from 0 to 48 months of age was collected individually and their age specific mean values for boys, girls and sex differences are shown in Table 5.1.3. At birth, difference in mean sitting height between females are observed to be apparently dominating but not significant. At the age of 3 months, the situation is just reverse and follows a continue increasing trend, the rate of increase is being larger for males than females. At the age of 48 months, the males superceded the females by 2.25 cm in sitting height.

Table 5.1.3 Longitudinal mean and standard deviation (SD) of sitting height (cm) for boys, girls and their differences by age 0-48 months.

Age	Boys			Girls			Sex Differences
(month)	n	Mean	SD	n	Mean	SD	Mean
0	162	29.52	2.68	134	29.56	2.55	-0.04
3	161	35.86	2.42	134	35.62	2.45	0.24
6	160	39.74	2.10	133	39.41	2.33	0.33
9	160	42.62	2.02	133	42.22	2.19	0.39
12	160	45.07	2.05	133	44.57	2.21	0.50
15	127	46.15	1.98	118	45.78	2.13	0.37
18	127	47.16	1.98	118	46.39	1.67	0.77
21	127	48.06	1.96	118	47.62	2.11	0.44
23	127	48.72	2.01	118	48.21	2.13	0.51
25	127	49.29	1.98	118	48.27	1.64	1.02
28	96	50.30	1.98	87	48.91	1.58	1.39
31	96	51.06	2.01	87	49.50	1.52	1.56
34	96	51.81	2.11	87	50.10	1.47	1.70
38	91	52.55	2.22	79	50.68	1.41	1.87
42	91	53.12	2.26	78	51.13	1.40	1.99
46	91	53.68	2.33	78	51.62	1.49	2.06
48	91	53.95	2.35	78	51.70	1.26	2.25

Chest Circumference by age 0-48 months

The longitudinal data on chest circumference (cm) of Bangladeshi Children from 0 to 48 months of age was collected individually and their age specific mean values for boys, girls and sex differences are shown in Table 5.1.4. At birth, the average chest circumference for females are observed to be 32.72 cm with standard deviation 2.79 cm. The corresponding figures for males are 32.50 cm and 3.13 cm. This implies, chest circumference of females are larger than males at birth on an average. The situation is reverse at 3 months of age. At 48 months of age, the difference has become 1.66 cm in favor of males like sitting height situation.

Table 5.1.4 Longitudinal mean and standard deviation (SD) of chest circumference (cm) for boys, girls and their differences by age 0-48 months.

Age	Boys			Girls			Sex Differences
(month)	n	Mean	SD	n	Mean	SD	Mean
0	162	32.50	3.13	134	32.72	2.79	-0.21
3	161	41.37	3.44	134	40.73	3.26	0.64
6	160	45.88	3.58	133	44.75	4.06	1.14
9	160	46.96	3.00	133	45.77	3.76	1.18
12	160	46.33	2.53	133	45.22	2.99	1.11
15	127	48.48	2.65	118	47.87	2.66	0.61
18	127	49.12	2.75	118	48.72	2.62	0.40
21	127	49.80	2.67	118	49.12	2.52	0.68
23	127	50.20	2.84	118	49.60	2.63	0.61
25	127	50.81	3.00	118	49.86	2.46	0.96
28	96	50.29	3.32	87	49.34	2.94	0.95
31	96	50.38	2.99	87	49.08	2.83	1.30
34	96	50.98	3.26	87	49.68	2.74	1.30
38	91	52.10	3.25	79	51.04	2.69	1.06
42	91	52.58	2.94	78	51.23	2.84	1.35
46	91	53.21	3.16	78	51.80	3.08	1.41
48	91	53.87	3.05	78	52.22	3.24	1.66

Arm Circumference by age 0-48 months

The longitudinal data on right arm circumference (cm) of Bangladeshi Children from 0 to 48 months of age was collected individually and their age specific mean values for boys, girls and sex differences are shown in Table 5.1.5. At birth, right arm circumference of females are found 10.08 cm on an average with an SD of 1.23 cm, while it is 10.07 cm and 1.20 cm in order for males. This implies, mean right arm circumference do not different significantly at birth but the velocity of increase with age is observed to be higher in males than females. At the age of 48 months, males superceded by 1.00 cm.

Table 5.1.5 Longitudinal mean and standard deviation (SD) of right arm circumference (cm) for boys, girls and their differences by age 0-48 months.

Age	Boys			Girls			Sex Differences
(month)	n	Mean	SD	n	Mean	SD	Mean
0	162	10.07	1.20	134	10.08	1.23	-0.02
3	161	14.49	1.77	134	13.99	1.59	0.50
6	160	16.70	2.01	133	16.23	1.96	0.47
9	160	17.18	2.03	133	16.54	2.15	0.64
12	160	16.15	1.77	133	15.51	1.81	0.64
15	127	17.54	1.83	118	16.83	1.95	0.71
18	127	17.91	2.20	118	17.20	1.99	0.71
21	127	18.28	2.25	118	17.39	2.07	0.89
23	127	18.46	2.39	118	17.75	2.27	0.70
25	127	18.76	2.66	118	17.91	2.31	0.85
28	96	17.89	3.01	87	17.71	4.09	0.18
31	96	17.88	2.99	87	17.50	4.03	0.39
34	96	18.17	3.08	87	17.91	4.08	0.26
38	91	18.69	2.90	79	18.22	2.33	0.47
42	91	18.94	2.94	78	18.14	2.62	0.79
46	91	19.41	3.14	78	18.48	2.66	0.93
48	91	19.81	3.09	78	18.80	2.67	1.00

The longitudinal data on left arm circumference (cm) of Bangladeshi Children from 0 to 48 months of age was collected individually and their age specific mean values for boys, girls and sex differences are shown in Table 5.1.6. The measures on left arm circumference, more or less, are found similar with that of right arm circumference for both males and females.

Table 5.1.6 Longitudinal mean and standard deviation (SD) of left arm circumference (cm) for boys, girls and their differences by age 0-48 months.

Age	Boys			Girls			Sex Differences
(month)	n	Mean	SD	n	Mean	SD	Mean
0	162	10.07	1.21	134	10.08	1.23	-0.01
3	161	14.48	1.77	134	13.99	1.60	0.49
6	160	16.69	2.02	133	16.23	1.96	0.47
9	160	17.17	2.02	133	16.53	2.14	0.64
12	160	16.15	1.78	133	15.51	1.80	0.64
15	127	17.54	1.83	118	16.83	1.95	0.71
18	127	17.91	2.20	118	17.20	1.99	0.71
21	127	18.28	2.25	118	17.39	2.07	0.89
23	127	18.46	2.39	118	17.75	2.27	0.70
25	127	18.76	2.66	118	17.91	2.31	0.86
28	96	17.90	3.02	87	17.71	4.09	0.19
31	96	17.89	3.00	87	17.50	4.03	0.39
34	96	18.18	3.10	87	17.92	4.07	0.26
38	91	18.69	2.90	79	18.21	2.33	0.48
42	91	18.94	2.94	78	18.13	2.61	0.81
46	91	19.41	3.14	78	18.48	2.66	0.93
48	91	19.81	3.09	78	18.81	2.67	1.00

Shoulder-Elbow Length by age 0-48 months

The longitudinal data on right shoulder-elbow length (cm) of Bangladeshi Children from 0 to 48 months of age was collected individually and their age specific mean values for boys, girls and sex differences are shown in Table 5.1.7. It is evident that males and females are approximately equivalent in the measure of right shoulder-elbow having a slight dominating tendency of the males. The growth patterns and velocity are observed to be consistent and approximately equal between the sexes. At the age of 48 months, males superceded females by 0.60 cm with an average value for females to be 19.63 cm.

Table 5.1.7 Longitudinal mean and standard deviation (SD) of right shoulder-elbow length (cm) for boys, girls and their differences by age 0-48 months.

Age	Boys			Girls			Sex Differences
(month)	n	Mean	SD	n	Mean	SD	Mean
0	162	9.09	0.69	134	9.06	0.63	0.03
3	161	11.28	0.73	134	11.26	0.63	0.03
6	160	12.45	0.77	133	12.30	0.68	0.15
9	160	13.42	0.83	133	13.17	0.76	0.25
12	160	14.34	0.90	133	14.05	0.86	0.29
15	127	14.99	0.94	118	14.69	0.89	0.30
18	127	15.59	0.98	118	15.27	0.91	0.33
21	127	16.17	1.00	118	15.84	0.94	0.32
23	127	16.53	1.07	118	16.23	0.97	0.30
25	127	16.84	1.17	118	16.61	1.02	0.23
28	96	17.45	1.17	87	17.18	1.02	0.27
31	96	17.96	1.25	87	17.64	1.08	0.31
34	96	18.46	1.35	87	18.10	1.16	0.36
38	91	19.08	1.42	79	18.55	1.25	0.53
42	91	19.54	1.49	78	19.09	1.85	0.45
46	91	19.99	1.58	78	19.41	1.35	0.59
48	91	20.23	1.62	78	19.63	1.39	0.59

The longitudinal data on left shoulder-elbow length (cm) of Bangladeshi Children from 0 to 48 months of age was collected individually and their age specific mean values for boys, girls and sex differences are shown in Table 5.1.8. The observations are very much similar to that of right shoulder-elbow measurements.

Table 5.1.8 Longitudinal mean and standard deviation (SD) of left shoulder-elbow length (cm) for boys, girls and their differences by age 0-48 months.

Age (month)	Boys			Girls			Sex Differences
	n	Mean	SD	n	Mean	SD	Mean
0	162	9.08	0.66	134	9.05	0.63	0.03
3	161	11.27	0.74	134	11.24	0.65	0.02
6	160	12.45	0.77	133	12.29	0.70	0.16
9	160	13.42	0.83	133	13.16	0.79	0.26
12	160	14.26	1.36	133	14.03	0.89	0.23
15	127	14.98	0.93	118	14.69	0.88	0.29
18	127	15.58	0.98	118	15.27	0.91	0.31
21	127	16.15	0.99	118	15.84	0.94	0.31
23	127	16.51	1.07	118	16.23	0.97	0.28
25	127	16.82	1.16	118	16.61	1.02	0.21
28	96	17.43	1.17	87	17.18	1.02	0.25
31	96	17.93	1.26	87	17.64	1.08	0.29
34	96	18.43	1.36	87	18.10	1.16	0.33
38	91	19.08	1.42	79	18.59	1.30	0.49
42	91	19.54	1.49	78	19.13	1.88	0.41
46	91	19.99	1.58	78	19.45	1.39	0.55
48	91	20.23	1.62	78	19.67	1.43	0.55

Elbow-Wrist Length by age 0-48 months

The longitudinal data on left elbow-wrist length (cm) of Bangladeshi Children from 0 to 48 months of age was collected individually and their age specific mean values for boys, girls and sex differences are shown in Table 5.1.9. At birth, on an average, left elbow-wrist of males is found to be 9.08 cm with SD of 0.66 cm, while it is 9.05 cm and 0.63 cm for females. It implies, there is no significant difference between the sexes. At the age of 48 months, the corresponding figures are 20.23 cm, 1.62 cm, and 19.67 cm, 1.43 cm with an increase of 0.55 cm for males over females. The nature of increment within and between sexes are systematic and consistent.

Table 5.1.9 Longitudinal mean and standard deviation (SD) of left hand elbow-wrist length (cm) for boys, girls and their differences by age 0-48 months.

Age	Boys			Girls			Sex Differences
(month)	n	Mean	SD	n	Mean	SD	Mean
0	162	9.08	0.66	134	9.05	0.63	0.03
3	161	11.27	0.74	134	11.24	0.65	0.02
6	160	12.45	0.77	133	12.29	0.70	0.16
9	160	13.42	0.83	133	13.16	0.79	0.26
12	160	14.26	1.36	133	14.03	0.89	0.23
15	127	14.98	0.93	118	14.69	0.88	0.29
18	127	15.58	0.98	118	15.27	0.91	0.31
21	127	16.15	0.99	118	15.84	0.94	0.31
23	127	16.51	1.07	118	16.23	0.97	0.28
25	127	16.82	1.16	118	16.61	1.02	0.21
28	96	17.43	1.17	87	17.18	1.02	0.25
31	96	17.93	1.26	87	17.64	1.08	0.29
34	96	18.43	1.36	87	18.10	1.16	0.33
38	91	19.08	1.42	79	18.59	1.30	0.49
42	91	19.54	1.49	78	19.13	1.88	0.41
46	91	19.99	1.58	78	19.45	1.39	0.55
48	91	20.23	1.62	78	19.67	1.43	0.55

The longitudinal data on right elbow-wrist length (cm) of Bangladeshi Children from 0 to 48 months of age was collected individually and their age specific mean values for boys, girls and sex differences are shown in Table 5.1.10. Here, observations are found to be similar as that of Table 5.1.9 (left elbow-wrist). But one thing is interesting that for both the sexes, right elbow-wrist is found to be shorter than the left elbow-wrist by more than 2 cm at the age of 48 months.

Table 5.1.10 Longitudinal mean and standard deviation (SD) of right hand elbow-wrist length (cm) for boys, girls and their differences by age 0-48 months.

Age	Boys			Girls			Sex Differences
(month)	n	Mean	SD	n	Mean	SD	Mean
0	162	7.73	0.68	134	7.64	0.58	0.10
3	161	9.89	0.67	134	9.77	0.61	0.12
6	160	10.91	0.70	133	10.68	0.66	0.23
9	160	11.73	0.78	133	11.38	0.74	0.35
12	160	12.46	0.87	133	12.10	0.81	0.35
15	127	13.08	0.89	118	12.71	0.84	0.37
18	127	13.66	0.95	118	13.25	0.87	0.41
21	127	14.21	0.97	118	13.80	0.93	0.41
23	127	14.55	1.05	118	14.15	0.97	0.40
25	127	14.92	1.11	118	14.50	0.99	0.42
28	96	15.51	1.11	87	15.04	1.03	0.46
31	96	15.98	1.19	87	15.50	1.09	0.47
34	96	16.45	1.27	87	15.95	1.17	0.50
38	91	17.00	1.40	79	16.48	1.39	0.51
42	91	17.47	1.50	78	16.86	1.44	0.61
46	91	17.92	1.59	78	17.29	1.50	0.63
48	91	18.14	1.64	78	17.49	1.56	0.65

Head Circumference by age 0-48 months

The longitudinal data on head circumference (cm) of Bangladeshi Children from 0 to 48 months of age was collected individually and their age specific mean values for boys, girls and sex differences are shown in Table 5.1.11. At birth, median length of head circumference is observed to be 32.87 cm for males and 32.48 cm for females. This implies that head circumference of males are slightly larger than females. On an average, growth in males are more prominent than females. At the age of 48 month, the average head circumference of males are found to be 49.04 cm with SD 1.26 cm and for females it was 47.75 cm with SD 1.36 cm. This implies growths are systematic and consistent having comparatively a larger velocity for males than females.

Table 5.1.11 Longitudinal mean and standard deviation (SD) of head circumference (cm) for boys, girls and their differences by age 0-48 months.

Age	Boys			Girls			Sex Differences
(month)	n	Mean	SD	n	Mean	SD	Mean
0	162	32.87	2.33	134	32.48	2.65	0.39
3	161	37.88	2.22	134	37.25	2.19	0.63
6	160	40.74	1.82	133	40.29	1.80	0.45
9	160	42.84	1.46	133	42.34	1.39	0.50
12	160	44.47	1.38	133	43.80	1.29	0.67
15	127	45.09	1.34	118	44.32	1.26	0.77
18	127	45.66	1.31	118	44.78	1.27	0.87
21	127	46.18	1.35	118	45.21	1.27	0.97
23	127	46.52	1.30	118	45.16	3.99	1.36
25	127	46.82	1.29	118	45.74	1.29	1.08
28	96	47.27	1.26	87	46.11	1.27	1.16
31	96	47.62	1.25	87	46.44	1.28	1.18
34	96	47.96	1.25	87	46.77	1.30	1.19
38	91	48.39	1.26	79	47.07	1.35	1.32
42	91	48.66	1.26	78	47.32	1.35	1.33
46	91	48.91	1.26	78	47.61	1.35	1.30
48	91	49.04	1.26	78	47.75	1.36	1.30

Maximum Head Breadth by age 0-48 months

The longitudinal data on maximum head breadth (cm) of Bangladeshi Children from 0 to 48 months of age was collected individually and their age specific mean values for boys, girls and sex differences are shown in Table 5.1.12. At birth, it is found that average head breadth of males is 9.39 cm which is slightly larger than females (9.33 cm). The growth difference between the sexes over the age 0-48 months is very much negligible. At the age 48 month, average maximum head breadth for males and females are found to be 14 62 cm and 14 35 cm, having a difference of 0.27 cm only. The growth velocity is observed to be very slow but consistent.

Table 5.1.12 Longitudinal mean and standard deviation (SD) of maximum head breadth (cm) for boys, girls and their differences by age 0-48 months.

Age	Boys			Girls			Sex Differences
(month)	n	Mean	SD	n	Mean	SD	Mean
0	162	9.39	0.63	134	9.33	0.56	0.06
3	161	10.60	0.57	134	10.44	0.53	0.16
6	160	11.32	0.55	133	11.16	0.55	0.16
9	160	11.92	0.55	133	11.71	0.57	0.21
12	160	12.39	0.58	133	12.14	0.56	0.25
15	127	12.71	0.59	118	12.41	0.54	0.31
18	127	12.98	0.60	118	12.67	0.54	0.30
21	127	13.23	0.62	118	12.94	0.54	0.30
23	127	13.40	0.64	118	13.11	0.55	0.29
25	127	13.55	0.63	118	13.27	0.56	0.28
28	96	13.75	0.67	87	13.47	0.57	0.28
31	96	13.91	0.69	87	13.65	0.59	0.26
34	96	14.08	0.71	87	13.81	0.64	0.27
38	91	14.25	0.75	79	13.96	0.64	0.28
42	91	14.39	0.76	78	14.11	0.65	0.28
46	91	14.55	0.73	78	14.26	0.66	0.29
48	91	14.62	0.72	78	14.35	0.65	0.27

Maximum Head Length by age 0-48 months

The longitudinal data on maximum head length (cm) of Bangladeshi Children from 0 to 48 months of age was collected individually and their age specific mean values for boys, girls and sex differences are shown in Table 5.1.13. At birth, average maximum head length was found to be 9.62 cm for males and 9.50 cm for females with SD 0.60 cm and 0.66 cm, respectively. This implies, diversity in maximum head length is more prominent among the females than males but average difference is not significant, though, males show a dominating tendency. At the age of 48 month, average maximum of head length for males and females are found to be 14.49 cm and 14.33 cm, a surplus of 0.26 cm for males over females. The difference is being statistically insignificant. The growth velocity for both the sexes found to be slow and consistent.

Table 5.1.13 Longitudinal mean and standard deviation (SD) of maximum head length (cm) for boys, girls and their differences by age 0-48 months.

Age	Boys			Girls			Sex Differences
(month)	n	Mean	SD	n	Mean	SD	Mean
0	162	9.62	0.60	134	9.50	0.66	0.12
3	161	10.82	0.57	134	10.63	0.59	0.19
6	160	11.58	0.60	133	11.38	0.63	0.20
9	160	12.21	0.60	133	12.00	0.61	0.22
12	160	12.82	0.61	133	12.60	0.61	0.23
15	127	13.10	0.52	118	12.85	0.58	0.26
18	127	13.32	0.48	118	13.08	0.57	0.24
21	127	13.52	0.45	118	13.30	0.53	0.22
23	127	13.65	0.45	118	13.43	0.52	0.22
25	127	13.76	0.46	118	13.56	0.51	0.20
28	96	13.83	0.45	87	13.64	0.46	0.19
31	96	13.94	0.44	87	13.76	0.45	0.17
34	96	14.04	0.44	87	13.89	0.43	0.14
38	91	14.16	0.42	79	14.01	0.43	0.15
42	91	14.29	0.40	78	14.14	0.42	0.15
46	91	14.42	0.40	78	14.26	0.42	0.16
48	91	14.49	0.40	78	14.33	0.43	0.16

Maximum Head Height by age 0-48 months

The longitudinal data on maximum head height of Bangladeshi Children from 0 to 48 months of age was collected individually and their age specific mean values for boys, girls and sex differences are shown in Table 5.1.14. Average maximum head height at birth for males and females are found to be 8.46 cm amd 8.39 cm with a difference of 0.07 cm which is very much negligible. The velocity of increment among the sexes over the age 0-48 months is found to be approximately equal and moderate. At the age of 48 month, the average maximum head height for males and females are found to be 14.48 cm and 14.33 cm, respectively. The difference of 0.15 cm is negligible.

Table 5.1.14 Longitudinal mean and standard deviation (SD) of maximum head height (cm) for boys, girls and their differences by age 0-48 months.

Age	Boys			Girls			Sex Differences
(month)	n	Mean	SD	n	Mean	SD	Mean
0	162	8.46	0.68	134	8.39	0.64	0.07
3	161	9.75	0.95	134	9.59	0.53	0.16
6	160	10.63	0.60	133	10.36	0.54	0.27
9	160	11.29	0.61	133	10.99	0.56	0.30
12	160	11.91	0.63	133	11.60	0.56	0.31
15	127	12.24	0.62	118	11.85	1.13	0.39
18	127	12.52	0.61	118	12.23	0.56	0.28
21	127	12.80	0.60	118	12.53	0.55	0.28
23	127	12.97	0.61	118	12.73	0.56	0.24
25	127	13.17	0.61	118	12.92	0.57	0.25
28	96	13.46	0.55	87	13.17	0.56	0.29
31	96	13.67	0.52	87	13.41	0.53	0.26
34	96	13.87	0.52	87	13.66	0.53	0.21
38	91	14.07	0.49	79	13.90	0.53	0.17
42	91	14.23	0.46	78	14.08	0.51	0.15
46	91	14.40	0.45	78	14.24	0.51	0.16
48	91	14.48	0.44	78	14.33	0.51	0.15

5.2 Reference growth charts of body proportion

It is hard to be "ethnically correct" when assessing growth in international adoption. Many of the available country-specific growth charts are out-of-date, from a small sample size, drawn from ethnic groups that may not represent every child's ethnicity, based on malnourished populations, or all of the above.US growth charts aren't perfect either,but they are drawn from large population surveys, and were recently revised to better reflect the racial-ethnic diversity and combination of breast- and formula-feeding in the US.

In 2006, the **WHO** (World Health Organization) released new international birth-5yrs charts based on 8,500 children from Brazil, Ghana, India, Norway, Oman and the USA.Their unique approach was to select children whose care meets recommended health promotion standards (breastfeeding, standard pediatric care, anti-smoking, etc) so that the charts would represent how children should grow, not necessarily how they are growing.Their big finding was that "child populations grow similarly across the world's major regions when their needs for health and care are met."

Growth charts are a graphic presentation of body measurements that aid in the assessment of body size, shape and in the observation of trends in growth performance. They are used in the assessment and monitoring of individual children and in screening whole populations. Growth charts are not diagnostic and should be used in conjunction with other information when evaluating a child's general health. There is an important distinction between a growth reference and a growth standard. A reference simply describes its sample without making any claims about the health of its sample, whereas a standard represents 'healthy' growth of a population and suggests a model or target to try and achieve the given charts. Growth charts currently in use describe existing growth patterns and are therefore references, not prescriptive standards.

Bangladesh does not have a national pediatric surveillance system for collecting anthropometric and nutritional data; therefore, national growth charts do not exist for Bangladeshi children. Growth references have been developed from small populations from Rajshahi City in Bangladeshi children by this longitudinal study. That were not nationally collected. Over the last four years from 2002- 2006,there has been substantial discussion on which reference population to use in assessing adequacy of childhood growth. Increasing evidence that growth patterns of well-fed, healthy preschool children from diverse ethnic backgrounds were comparable to supported the use of a single national growth charts based on international growth reference (WHO) who were healthy, well-nourished children from different geographic and genetic origins who had fully met their growth potential.

5.2.1 Background

National Centre for Health Statistics (NCHS) growth references have been using since the late 1970's.Centre for Disease Control (CDC) in the United States of America, revised these references and released new charts in 2000 that are based on 5 national surveys. In 2006 the WHO released a new set of growth standards and charts, based on data from the Multi-centre Growth Reference Study (MGRS).

The WHO recommends the application of these standards for all children worldwide, regardless of ethnicity, socioeconomic status and type of feeding.

A large number of countries have officially adopted the new standards and many others are in the process of doing so. In 2002 the Australian National Health and Medical Research Council (NHMRC) recommended the use of the CDC 2000 growth standards. The NHMRC does not currently plan to consider the WHO growth standards.

5.2.2 Importance of Growth monitor

The growth charts compact a lot of information into a small space, parents can be a little confusing to use because what type of chart is appropreate to their child and how to plot their child on the charts.

Proper growth monitoring consists of serial assessments of both weight and height measurements over time so that growth velocity can be assessed. In some situations, a single set of measurements may be used for screening populations or individuals to identify abnormal nutritional status and priority for treatment. Growth monitoring strives to improve nutrition reduce the risk of inadequate nutrition, educate caregivers, and produce early detection and referral for conditions manifested by growth disorders. At the population health level, cross-sectional surveys of anthropometric data help define health and nutritional status for purposes of program planning, implementation, and evaluation. In all settings, growth monitoring is also used to assess the response to intervention. Optimal growth depends on genetic constitution, normal endocrine function, adequate nutrition, absence of chronic disease, and a nurturing environment. Fetal, infant, environmental, and maternal factors can interact to impair intrauterine and postnatal growth. Observed genetic differences in birth weight among various children are small and although there are some racial/ethnic differences in growth, these differences are relatively minor compared to worldwide variations in growth due to health and environmental influences (i.e., poor nutrition, infectious disease, socio-economic status). There must be ethnic differences comparable than the any other countries in the World, in weight and growth of infants and children would remain till their adulthood if they all lived in a similar environment and received the same optimal nutrition and care.

The most common physical measurements for evaluating growth are recumbent length (birth to age two) and standing height (children ≥ age two who are able to stand straight),weight, and head circumference (until age four).Weight and height reflect the size of a child (i.e. large or small) and head circumference reflects brain size. Assessment of weight alone (i.e. weight-for-age) is not useful because it cannot distinguish a tall, thin child from one who is short but well-proportioned. A much better anthropometric index for determining nutritional status considers a child's weight relative to his/her height, which is a measure of shape (i.e. fatness, thinness or wasting). There are several such indices (percent ideal body weight, weight-for-stature, body mass index) and they are better associated with body composition and nutritional status than weight on its own. A second preferred anthropometric index is length/height-for-age, an indicator of tallness, shortness or stunting. Low length/height-for-age is frequently associated with chronic malnutrition, organic disorders, or chronic disease.

Although growth monitoring is an important standard component of pediatric services throughout the world, little research has been performed to evaluate its potential benefits and harms. A Cochrane Systematic Review found only two well-designed studies that evaluated benefits and possible harms of routine growth monitoring on the child and mother. Evaluation of these two programs in developing countries demonstrated no real health benefits or harms. This shortage of evidence should not be misconstrued as an indication that growth monitoring is unnecessary, but rather as a sign that research is needed in the area, in developed as well as developing countries, like our country. The potential for harm relates to inappropriate practice. Practices that suggest blame or result in feelings of guilt or shame or those that focus on physical appearance rather than healthy eating and lifestyle habits have the potential to cause harm and should be avoided. Growth monitoring is an opportunity for health providers to increase awareness and provide anticipatory guidance on the importance of healthy feeding and eating practices.

Growth charts are an important way for pediatricians to monitor parent's child growth. With the availability of growth charts of WHO, many parents have begun using them at home too.

Recent changes to commonly used growth charts (WHO/CDC), including the addition of charts for body mass index, have raised questions on which growth charts to use for Bangladeshi children and how to apply body mass index in the pediatric population. This statement, developed collaboratively by key organizations in pediatric health care, is intended for use as a practice guideline for medical practitioners and clinical and community health (public health, home health) professionals. The desired outcome is the provision of recommendations that will promote consistent practices in monitoring growth and assessing atypical patterns of linear growth and weight gain in infants, children. (Can J Diet Prac Res 2004; 65:22-32).

5.2.3 At the Doctor's Office

"Is my child growing well?" Questions of the parents.

Beginning in infancy, parents of a child always visit a doctor for regular checkups in foreign countries but not in Bangladesh. Though a few number of parents at each of these visits, the doctor will record the child's height and weight on a growth chart. This chart shows the doctor and parents how the child's height and weight compare to that of other children the same age. This valuable tool can help their child's doctor determine whether their child is growing at an appropriate rate or whether there might be any problems.

By this method, Doctors use growth charts and body mass index charts to compare a child's measurements with those of other children in the same age group. By doing this, doctors can track a child's growth over time and monitor how a child is growing in relation to other children. The doctor uses growth charts for this purpose, a standard part of any checkup.

There are different charts for boys and girls because their growth rates and patterns differ from to each other. For both boys and girls there are (CDC/WHO) have charts. That are about infants age 0 to 36 months. The charts show the range of heights and weights at a certain age of thousands of children from across the many countries. The birth of a new baby is greeted by many questions from parents, relatives and friends. "Is the baby okay?" "Does the baby have all its fingers and toes?" The next most common questions are about the infant's size - "how much did the baby weight and what is the length?" These important values are then carefully recorded in the infant's "baby book," written on birth announcements, and given out to grandparents, relatives and friends in the develop countries.

Bangladeshi clinic or hospitals are only sources of record of babies's birth weight not of supine length. So researcher's selected topic is very important to the Bangladeshi parents for taking regular measurements. Parents really have the right idea here. These measurements will become a good indicator of the baby's overall health, especially during the first four years. Physicians too are well aware of this close relationship. Infants who are well nourished nutritionally, receive emotional bonding from their parents, and have not developed a chronic medical problem will grow following a regular pattern.

A pediatric growth chart shows us how a child's height compares with those of other children the same age. It also shows us a child's growth pattern over time. After 2 years of age, most children maintain steady growth throughout childhood, along one of the percentile lines. Children over 2 years of age who move away from their established growth curve should be thoroughly evaluated by a healthcare provider, no matter how tall they are.

Pediatric in our country use CDC growth charts. They are simple grids that allow parents to plot a child's height, according to his or her age. First of all, parent's'll learn and have concept about how to read growth charts. Then, they'll have the opportunity to enter a child's age and height to find out how their child's height compares with sample heights of other children the same age. But it is specially mentioned that Pediatric growth charts is not perfect/suitable for Bangladeshi infant and children.

A child's height and weight had measured and marked on his or her growth chart as part of every visit to a researcher regularly from 0- 4 years of age. Children under age 2 had measured at every after 15 days; children over 1 year, every after 1 month until a growth pattern becomes from age 0- 4 years.

Currently researcher's growth reference data and growth charts are used in a number of ways.

(1). as a surveillance tool to monitor the pattern of an individual child's longitudinal growth .Aiming to identify growth faltering which may indicate underlying physical ill-health, deprivation or neglect and allow early intervention,

(2). as a screening test at a single point of time to indicate possible abnormalities or short stature may indicate investigation for lower growth Syndrome,

(3). as an eligibility criteria for growth hormone replacement,(if possible in Bangladesh),

(4). as a surveillance tool for individual children aiming to identify early features of obesity and allow intervention to occur and

(5). for analysis and reporting of population growth data and trends.

(Recently WHO growth monitoring has come under scrutiny, and has been criticised as a waste of valuable time and a cause of unnecessary parental anxiety. A Cochrane review concluded there was insufficient evidence that routine growth monitoring is of benefit to child health in either developing or developed countries. A review of the evidence concerning growth monitoring and surveillance could find little evidence for monitoring weight beyond 12 months).

(6). There is however a strong support for monitoring growth using growth charts. The National Aboriginal Community Controlled Health Organisation (NACCHO) recommends growth monitoring, as a minimum,to coincide with the routine immunization schedule because of high rates of growth failure in Aboriginal) and Torres Strait Islander children.

Which may be occur the Santal community child growth in Bangladesh. If also they use this normal children's growth chart.

(7). Programs of growth monitoring and intervention occur throughout urban and may remote services in the rural area in the next. There is a concern about increasing prevalence of overweight and obesity in children and adolescents in Bangladesh and references are needed both for

assessment and monitoring of individual children and of populations.

(8). Growth charts are used universally in paediatric care.

5.2.4 Growth monitoring problem

Growth disorders often go unrecognized, and therefore undiagnosed, for several reasons in Bangladesh. Naturally, maximum infants and children are not routinely weighted and measured at their regular health care visits. Some children see a health care professional only for acute care and may not be measured at all in our country. If any measurements taken by nurses often, incorrectly, inaccurately and plotted, or not plotted at all may lead to erroneous interpretation of growth patterns and unnecessary or missed referrals. A fixation on weight alone fails to address linear growth and body shape and misses the opportunity to educate children and their caregivers about atypical and normal patterns of growth. For this reason, the aim of such types of longitudinal research may be a milestone for desirable accurate monitoring growth of Bangladeshi infant and children.

Growth charts used to monitor and assess growth vary across the country, as do systems for classification of body size and growth deviation. As for example- Use the growth percentile calculator below to enter a child's sex, age, and height and see the child's percentile bracket on the growth chart. As for Example: Using a growth chart, find the child's age along the bottom and draw a straight line going up, parallel to the right and left sides of the chart. Then find the child's height along the side and draw a line across, marking the point where the child's age line and height line cross.

The study of secular changes in biological phenomena is of interest of human biologists. The fact that some areas of the world show such changes in size and maturity while others do not. There is, in addition, evidence that suggests a reversal of the secular trend in several areas of the world. The growth changes thus reflect a remarkable degree of developmental plasticity in the human species. It is important to document the extent of this changes and or reversals, as well as of those factors associated with them.

Fitting parametric models to the human stature curve is an interesting challenge for the modeler, but it is also practically useful for summarizing patterns of growth in individuals or populations (Jolicoeur et al. 1988). However, it is only useful for clinical prediction when combined with prior information on the shape of the child growth curve.

The size attained at successive ages is plotted as a percentage of total size gain from birth to maturity. Height and most of the body measurements follow the 'general' curve. The external and internal reproductive organs follow a curve that is perhaps not very different in principle but is so far in effect. There are several studies that reported percentile curves of stature for the assessment of growth in Japanese children (Ashizawa, 2002; Konishi, 1990; Malina and Bouchard 1991; Murata et al, 2002; Ogawa et al. 1991, Tanner et al., 1982). Ashizawa (2002) reported that until the 1970s, the Japanese became taller because of increasing leg length.

The percentile curves of stature and sitting height of male and female children have been calculated from their mean values of percentiles for each individual age group. The upper lower ratio (ULR) was calculated height devided by sitting height for the individual age groups from 0-48 months.

Stature, an index of skeletal growth of the whole body, is a projected distances, reflecting the length of the head, neck, trunk and lower limbs. Growth patterns of the head neck, trunk and lower limbs are different from one another (Satake et al.1994,). The present study highlights the child growth on stature, weight, chest circumference, sitting height and other body segments of Bangladeshi children.

The data from the longitudinal growth studies provided the mean values for each age group of healthy and thin children, but not standard curves describing the distribution (including the medians) of body proportions at different ages for male and female of Bangladeshi children. The curves allow the monitoring of an individual's change of proportion from the period of infant to childhood. In the present study, we constructed reference percentile curves of the ratio of sitting height and subschial leg length.

The pattern of child growth may also reflected in the next to the changing patterns of sexual dimorphism in height –for –age, weight-for –age etc if will observable for the children in Bangladesh.

5.2.5 Stature

Eight percentile values were calculated: 3^{rd}, 5^{th},10^{th},25^{th},50^{th} ,75^{th},90^{th},95^{th} percentiles. All calculations were performed using by SPSS program. Each percentile value was smoothed by a least squares method with the use of a cubic spline function (Ohno et al.1988). Actually, the percentile curves of stature, sitting height and ULR are originally rather smooth with little fluctuations.

Figure 5.2.1 describes the growth percentile of the stature of male children by age, 0-48 months. An examination of this figure indicates that within the age of 0-12 months, growth in stature is more or less uniform for entire study population. After that, an increasing diversity is observed in the growth in stature of male children. There might be some causes, either social or psychological or genetical, demands further investigation over the issue. Similar difference in growth in stature is also observed for female (Figure 5.2.2) children also but the intensity of diversity over the age 0-12 is comparatively smaller for females than males. These sex differentials for growth in stature between males and females and below and above age 1 year is interesting and should be investigated properly. Because, such differences are not significantly observed in other studies so far. After 2 years of age, female growth rate became slower. and male growth rate improved nicely, till to 48 months. It is specially mention that the growth rate of females is the most augmented up to the 25 months of age. It is the peak point of growth during the infancy. On the other hand, during this same period females growth of stature gradually developed but slowly up to the study period. When the 50^{th} percentile curves for stature of male are about 99 cm, on the other hand the stature of female is about 97.7 cm. The maximum height/ stature of male is about 116 cm and the minimum stature is about 87.5 cm. The maximum stature of female is about 103 cm and the minimum stature is about 83 cm. So the males are taller than females.

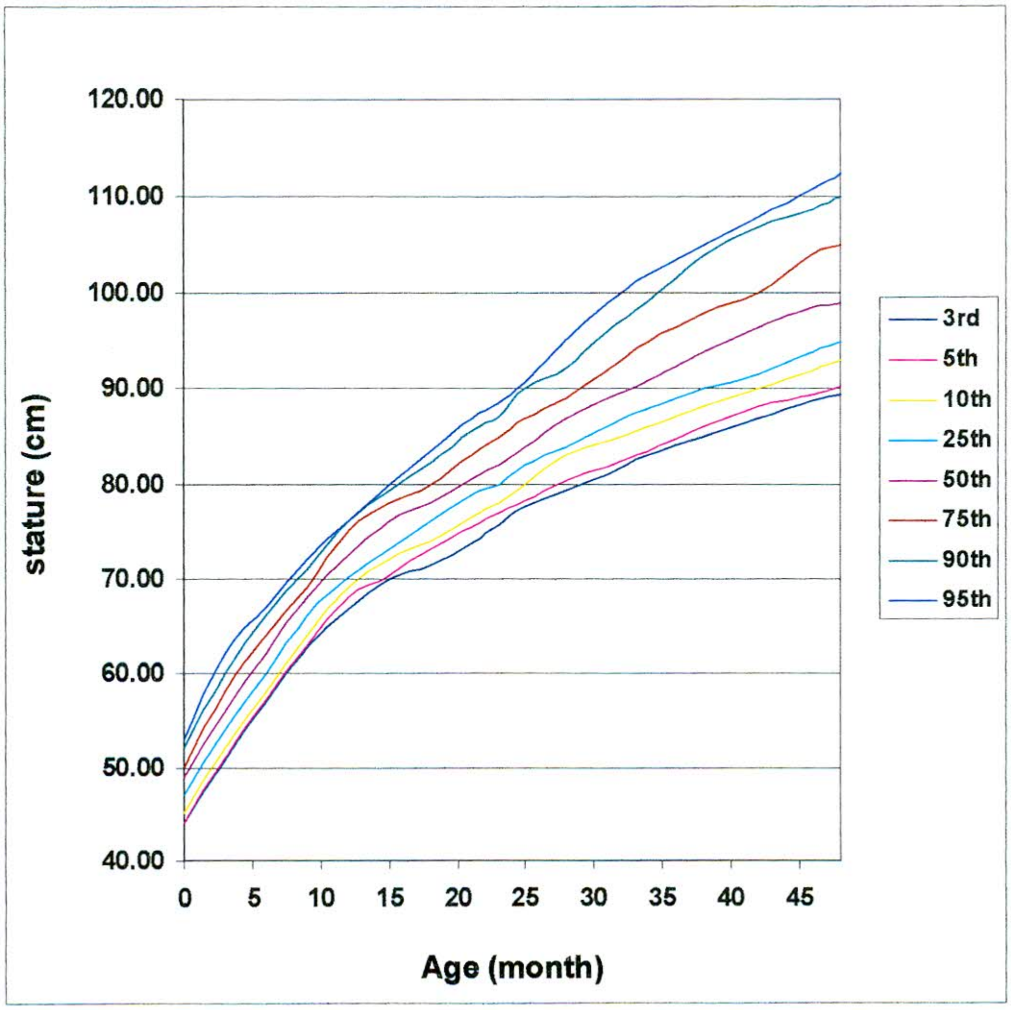


Figure 5.2.1 Stature Percentile chart of Male children from 0-48 month.

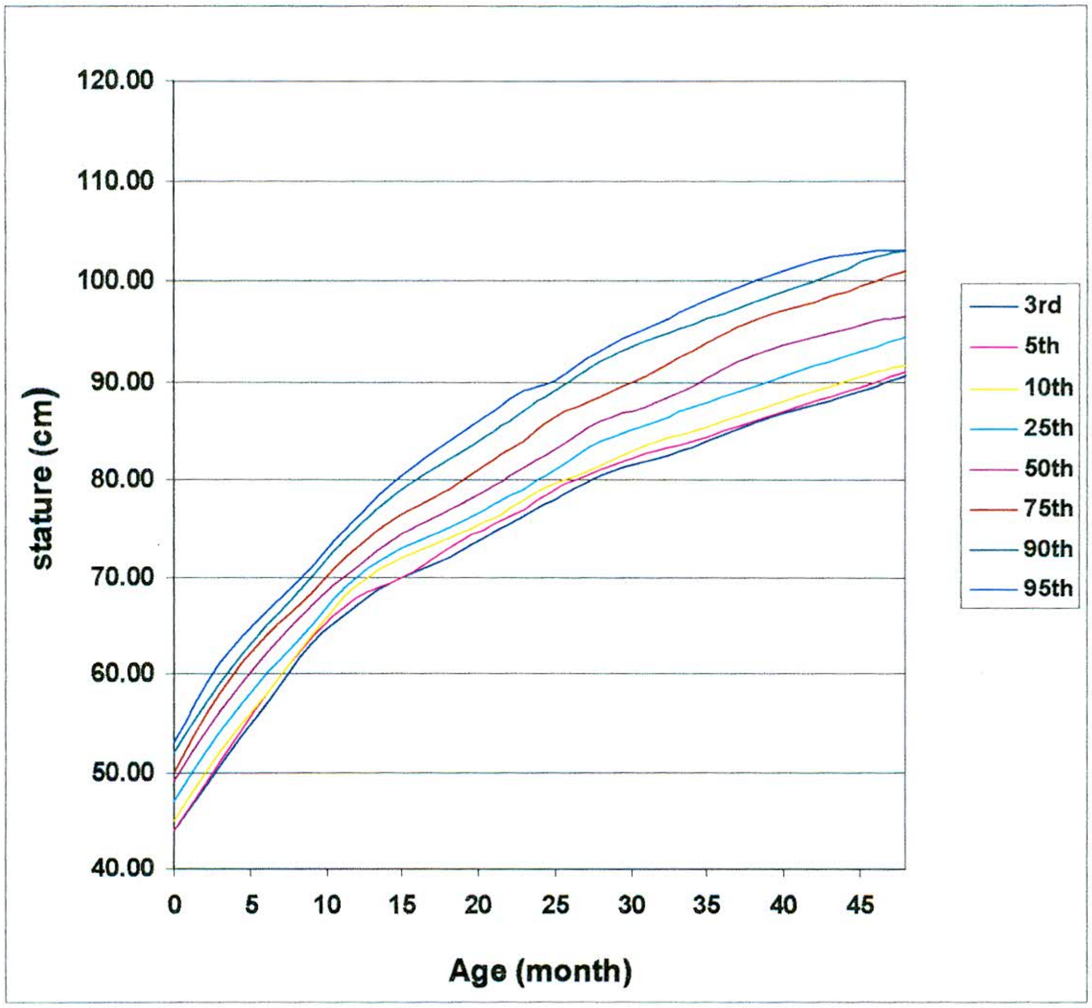


Figure 5.2.2 Stature Percentile chart of female children from 0-48 month.

5.2.6 Sitting Height

The percentile curves for sitting height by age 0-48 months are depicted in figure 5.2.3 and 5.2.4, the first one for male and the second one for female children. An over through of the curves indicates that sitting height of males are consistently divergent over 0-48 months. While for females, these divergence is prominent only after 12 months of age, all on a sudden. This sex differential in sitting height growth is not generally observed in other studies and thus demands the further investigations.

The increases in the percentile values from the 3rd to the 95th for sitting height were almost likely parallel through the growth period (0-12) months for both sexes. After this period, the sitting height rose sharply of males. The 50th percentile curve gradually upride with the rhythms of time for both sexes. From 12-48 months of age, the sitting height curves of males increase smoothly and fluently with standard growth rate. But the increases of female after 12 months of age is fluctuating. The 50th percentile curves for sitting height of males is about 53.8 cm at age 48 month, and that of females is about 51.9 cm. The maximum sitting height of male is about 87.5 cm and the minimum is about 49.2 cm. The maximum sitting height of female is about 53.4 cm and the minimum sitting height is about 46.5cm. So the males are taller in sitting height than female on an average.

5.2.7 Upper-Lower Ratio

Figures 5.2.5 and 5.2.6 delineated the upper-lower ratio percentiles for male and female babies over the period of 0-48 months age. The description and curves of body proportion changes and percentiles may be useful in explaining the anthropological and nutritional parameters of a population. It is observed that this ratio varies between 1.35 to 1.85 at birth while it is between 1.69 and 1.98 at the age 48 month for the males. The corresponding figures for females are 1.35 and 1.88, 1.73 and 1.97. At birth, the deviation for males is comparatively lower than that of females but at the age 48 months this deviation is just reverse. There is a break point at the age 18-20 months for males. This break is not prominent for females but only for the lowest and highest percentile groups. Such deviations are not generally observed in other studies. This break point including sex differentials matters further investigations. It is observed that upper-lower ratio is less than 2 for all children in the study area. This implies that upper portion of the body is comparatively taller than the lower part and hence the growth in body proportion is not uniform. Policy maker may give attention to this matter for the overall health and growth of the population at large. The leg length growth of female and male children appeared to some diverge reached at the 48 months of age, the difference was clear. The change in ULR was due to the different sitting height and leg length velocities.

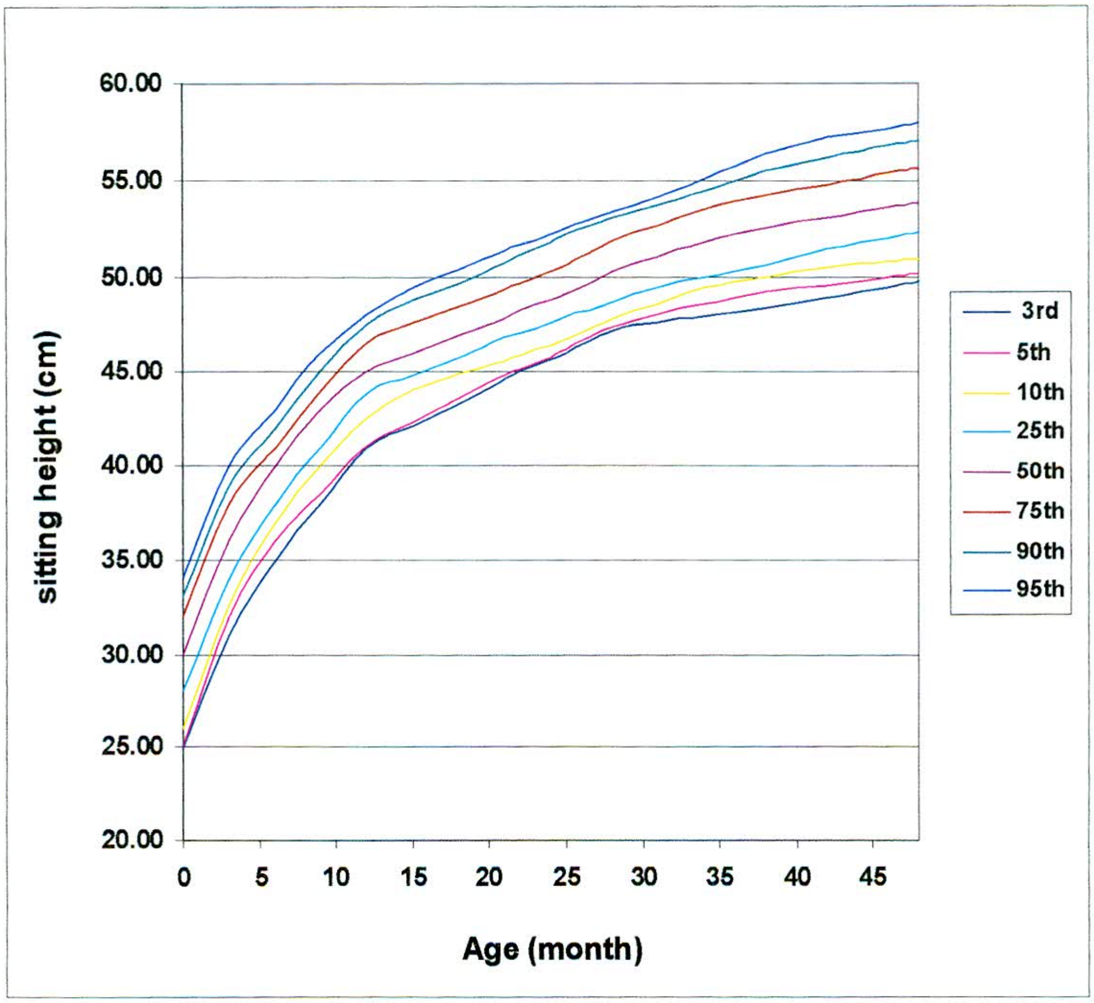


Figure 5.2.3 Sitting height Percentile chart of male children from 0-48 months

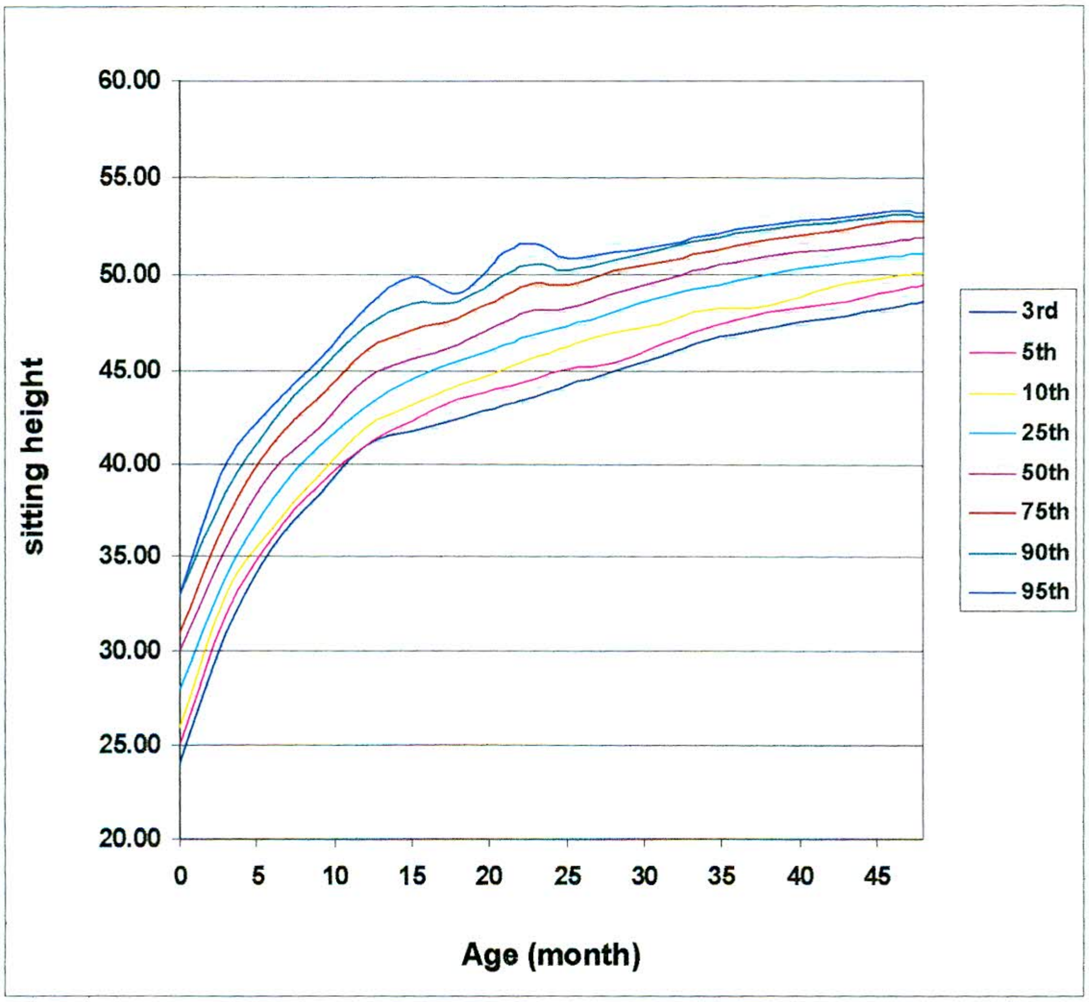


Figure 5.2.4 Sitting height Percentile chart of female children from 0-48 month.

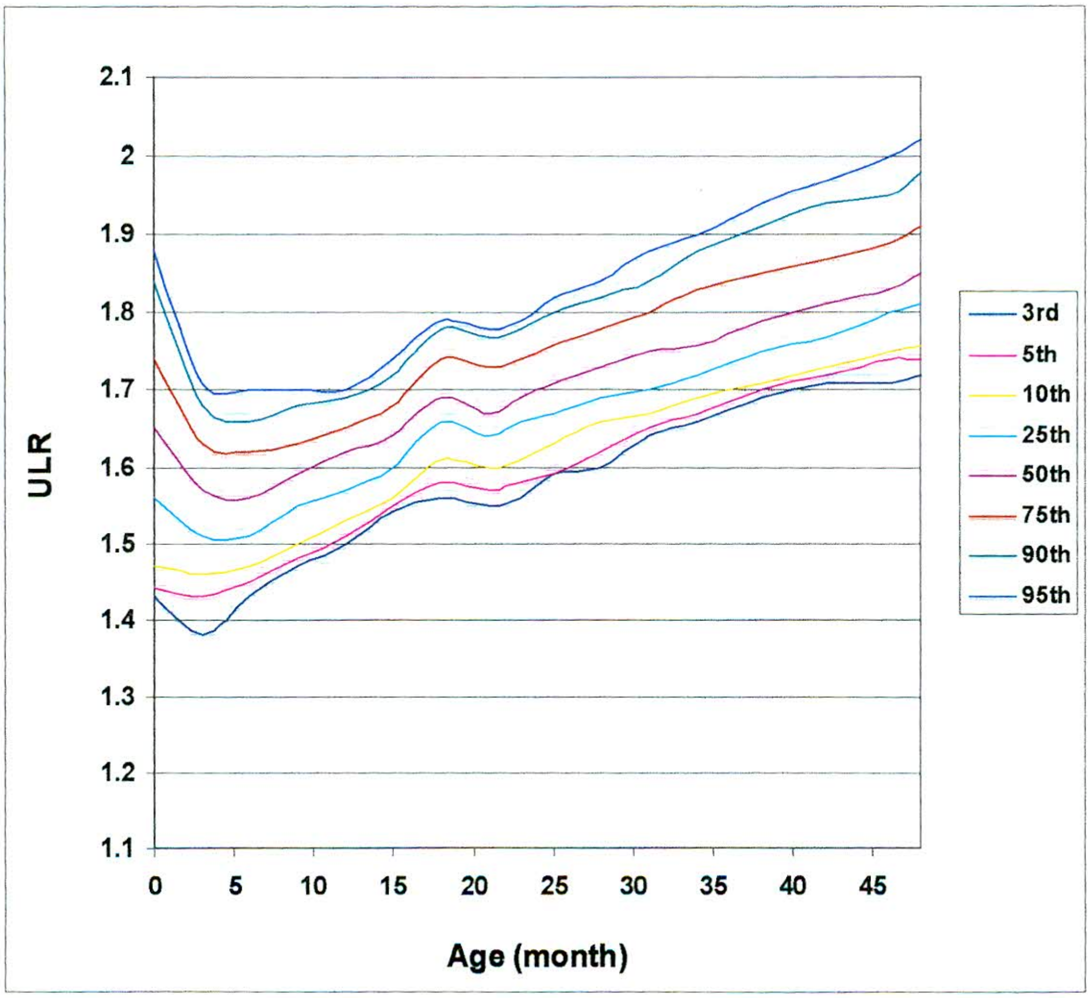


Figure 5.2.5: Percentile values of upper-lower ratio of male children for 0-48 months

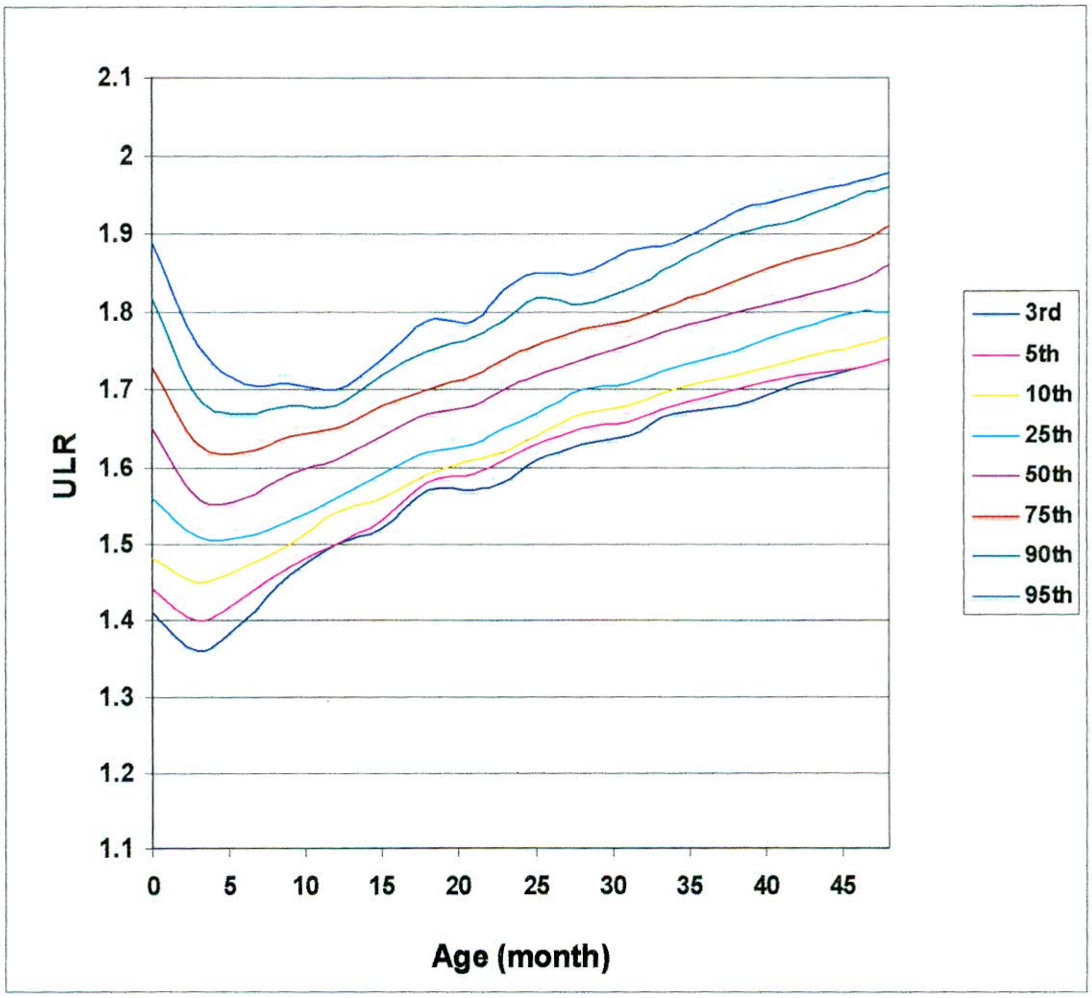


Figure 5.2.6: Percentile values of upper-lower ratio of female children, 0-48 months

5.2.8 Weight

Figures 5.2.7 and 5.2.8 sketch the male and female growth in weight for age, 0-48 months, classified by percentile groups. At birth, weight of male babies are observed to vary between 2.3 kg to 4.0 kg with the median weight of 3.0 kg. The corresponding figures for females are 2.34 kg, 3.71 kg and 3.0 kg. This implies that on and average, males are comparatively heavier than females at birth. The growth in weight is observed to be consistent for both males and females up to the age of 9 months for all percentile groups. In the age range of 9-12 months, there is a decline or steadiness in the growth of all children and this decline is prominent in the upper 50th percentile groups. Afterwards, growth in weight increases with certain degree of regularities up to the age of about 24 months for both males and females. On an average, males gain about 0.5 kg weight over females but at the upper percentiles, females supercede the males. Again, there is a weight loss situation around the age of 30 months for males and 27 months for females with minor variations in ages for different percentile groups. At the end, we observed that velocity of weight gain is on an average faster among the males than the female in general and among the upper 50th percentile groups in particular. At the lower percentile group (3rd), it is 11.0 kg for both males and females. The median weight for males and females are found to be 15.5 kg and 14.5 kg, while it is 24.0 kg for males and 20.0 kg for females at the upper 95th percentile groups at the end of the project. The drifts at age 9-12 months and 27-30 months are not found in any other studies which require special attention for further research.

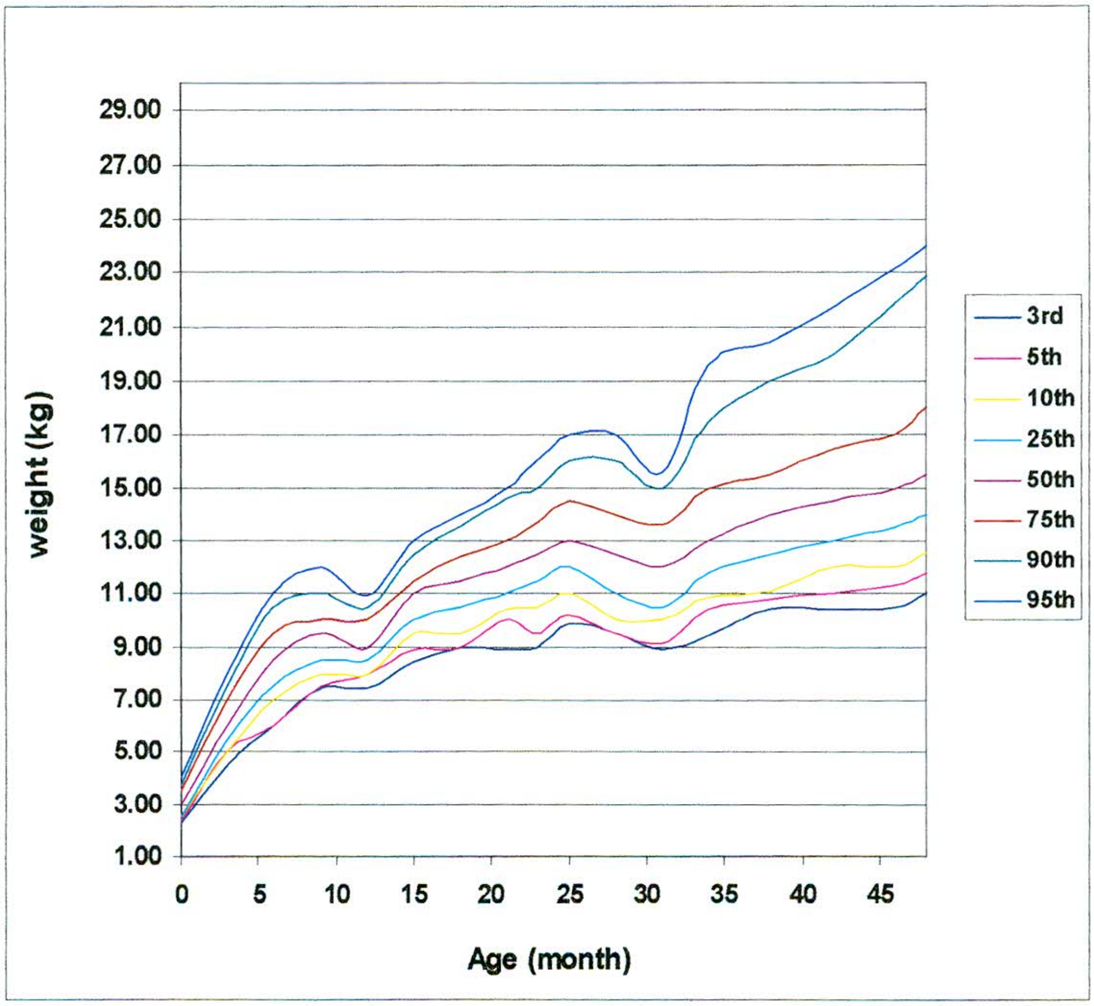


Figure 5.2.7 Percentile values of weight- for- age, male children 0- 48 months

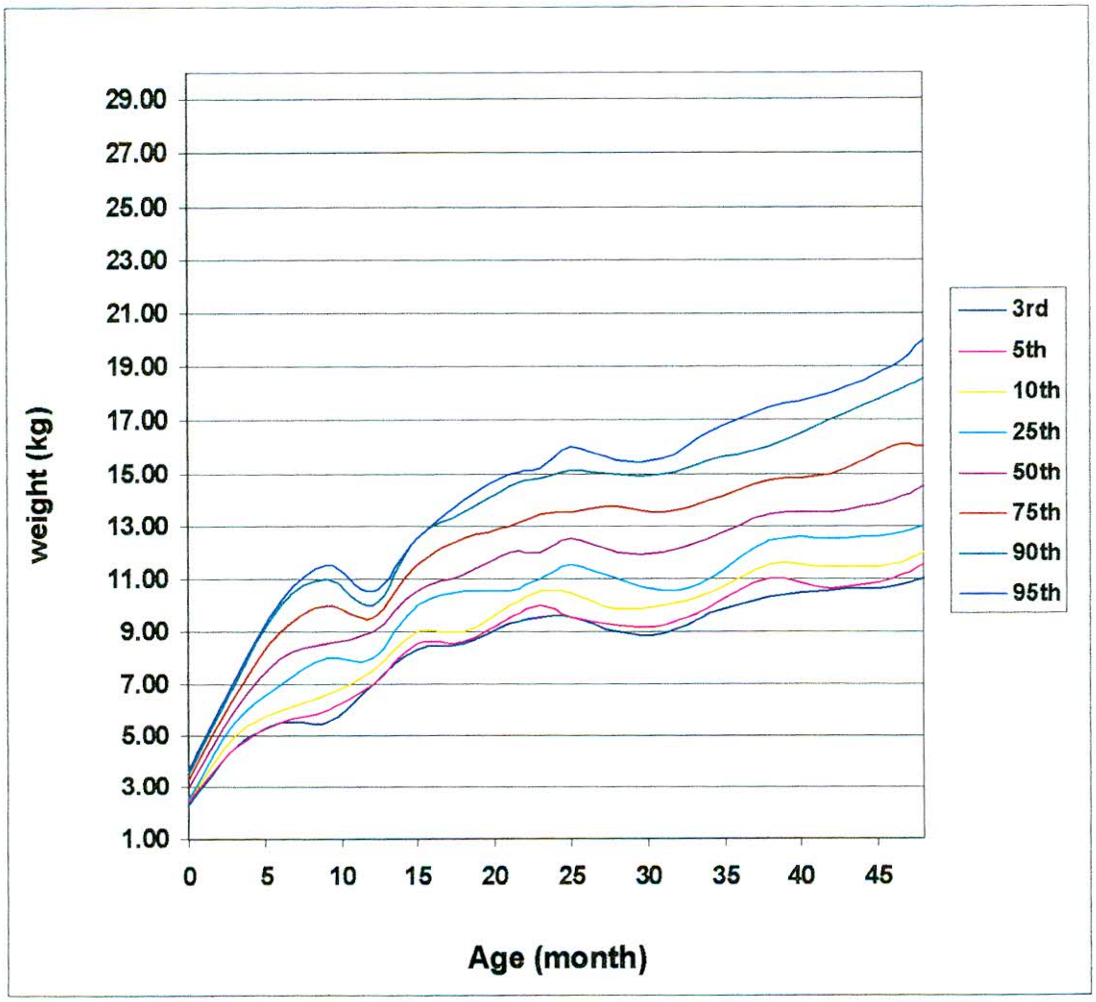


Figure 5.2.8 Weight- for- age percentile for female children, 0-48 months.

5.2.9 BMI- for Age

Figures 5.2.9 and 5.2.10 represents growth of males and females in BMI-for age, (0-48 months) by percentile groups. An over view of the figures reflect that BMI of males are comparatively lager than females at birth. It increases sharply upto 6 and 9 months of age for females and males respectively. For females, a drift of decrease is observed between 6-9 months of age. A similar drift is observed for males in the age range of 9-12 months. Also decreasing drifts are observed between (15-18) months of age at the lower 50^{th} percentiles and between (21-28) months of age at the upper 50^{th} percentiles of females. This decreasing trend follows upto 36 months of age. Beyond 36 months BMI is observed to be constant for females with some minor irregularities upto the age of 48 months. At the lower 25^{th} percentiles of males a drift of decrease in BMI is observed between 18-21 months of age. Another decreasing drift is observed in the age range of (25-28) months for all percentiles of males. This drift continues up 36 months of age. Over the age of 36 months, BMI is observed to be constant, more or less. According to Cole e. at. (1995), BMI of Dutch children show rapid increasing trend upto the age of one year and then a slow decreasing trend upto pre-school age (upto 6 years) and again a steady increasing trend upto 20 years without any drifts. Dutch data was of yearly observations. Necessary attention is to be given for further studies to single out causes of observed drifts with the age of drifts and their remedial measures. It is alarming that up to 25^{th} percentile, almost all the children belongs to BMI less than 18, which implies serious malnutrition. At the 50^{th} and over percentile, beyond the age of 2 years more than 75% children suffer from malnutrition irrespective of sex. At birth, almost all the children in the study area suffer from malnutrition having the BMI in between 9 and 17. The situation of females is comparatively worse than males.

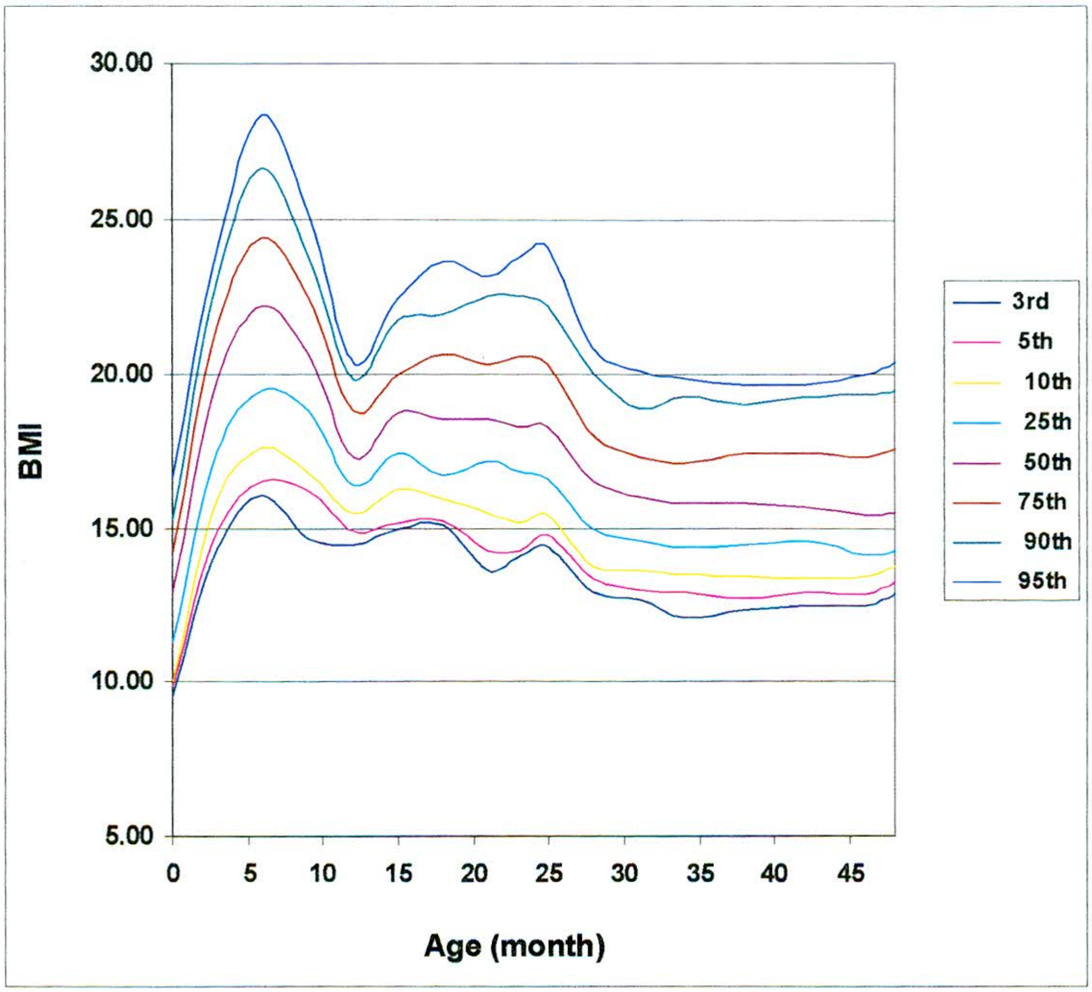


Figure 5.2.9 BMI- for- age percentile for male children, 0-48 months.

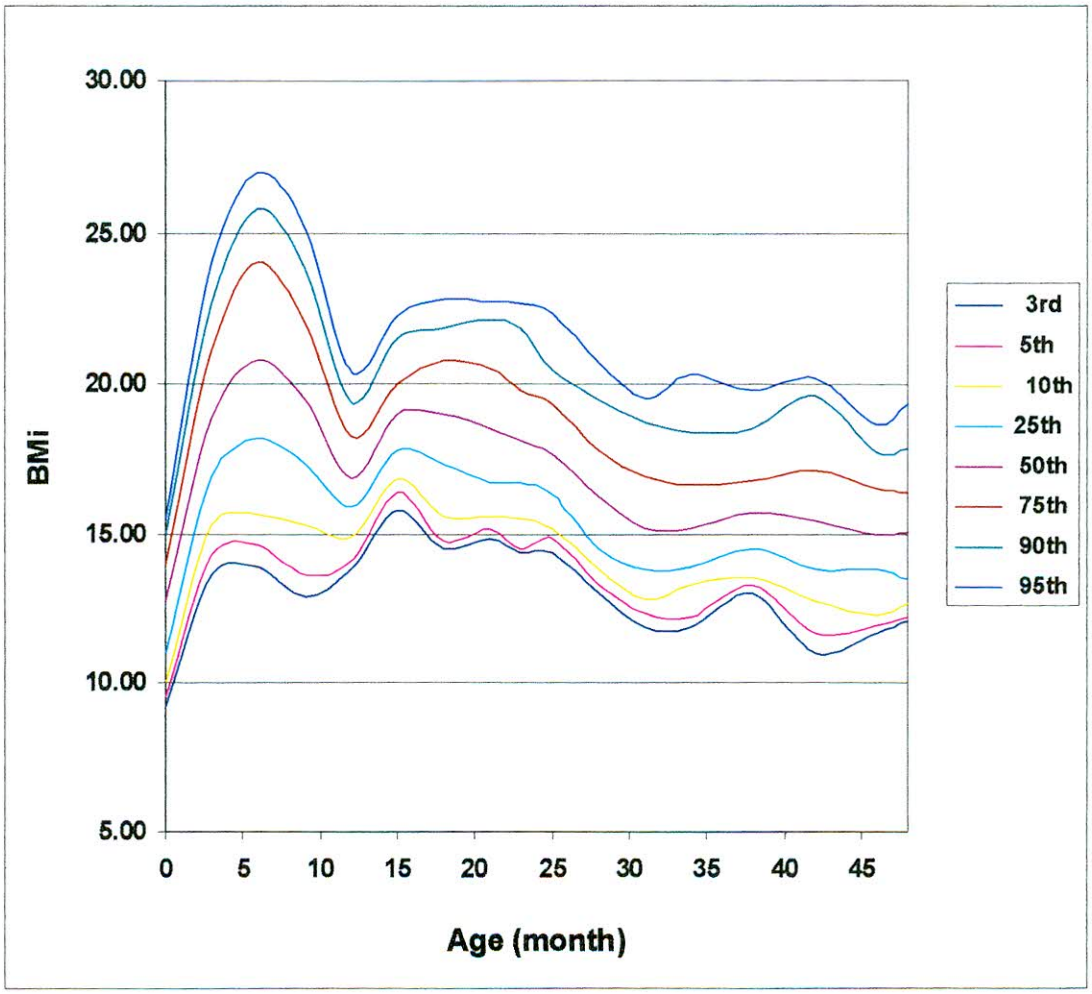


Figure 5.2.10 BMI- for- age percentile for female children, 0-48 months.

5.2.10 Chest circumference for age

Chest circumference for age of males and females are shown in figures 5.2.11 and 5.2.12 by percentiles. At birth it was observed for 50^{th} percentile about 33.0 cm with the maximum of 40.0 cm and minimum of 22.5 cm for males. The corresponding figures for females are 33.0 cm, 42.0 cm and 25.0 cm.

At the age of 48 month, chest circumference of males are observed to be 54.0cm at the 50^{th} percentile, while the minimum and the maximum observed values are 47.0cm and 63.0cm. For females, the corresponding figures are 52.0cm, 44.0cm and 59.5 cm in order. An examination of the figurers reveals that at birth, males and females do not differ in chest circumference measure. The growth in chest circumference is observed to be sharp and systematic upto the age of 9 month for both males and females. At the upper 50^{th} percentile, a drift of decrease in growth is measured for both the sexes during the age of 9-12 months. On wards, the growth is consistently increasing with a second drift of decrease during the age of 28-31 months, the drift being much more prominent for males than females. The overall growth in chest circumference is observed to be faster among males than females. These drifts are not found in other standard growth charts.

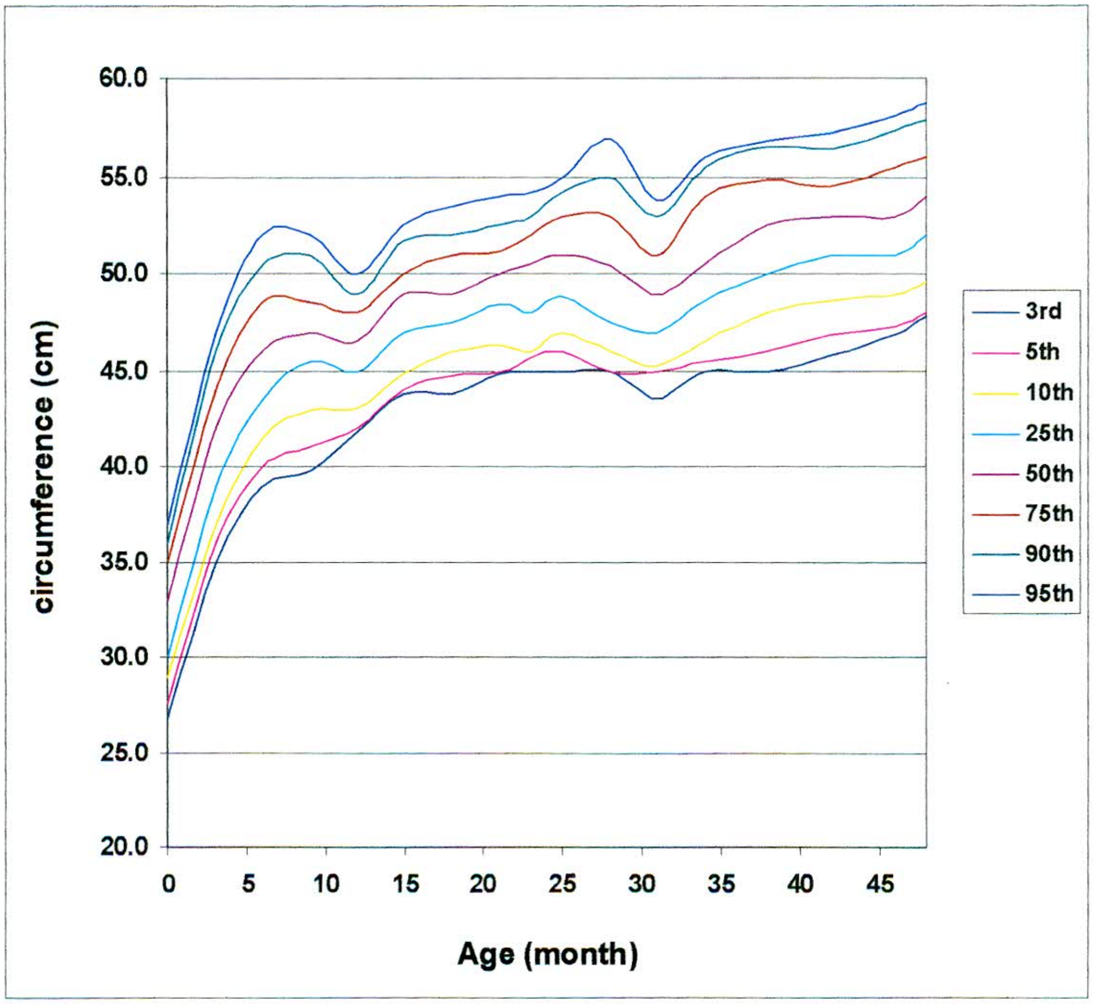


Figure 5.2.11 Chest circumference for age percentile for males, 0-48 months.

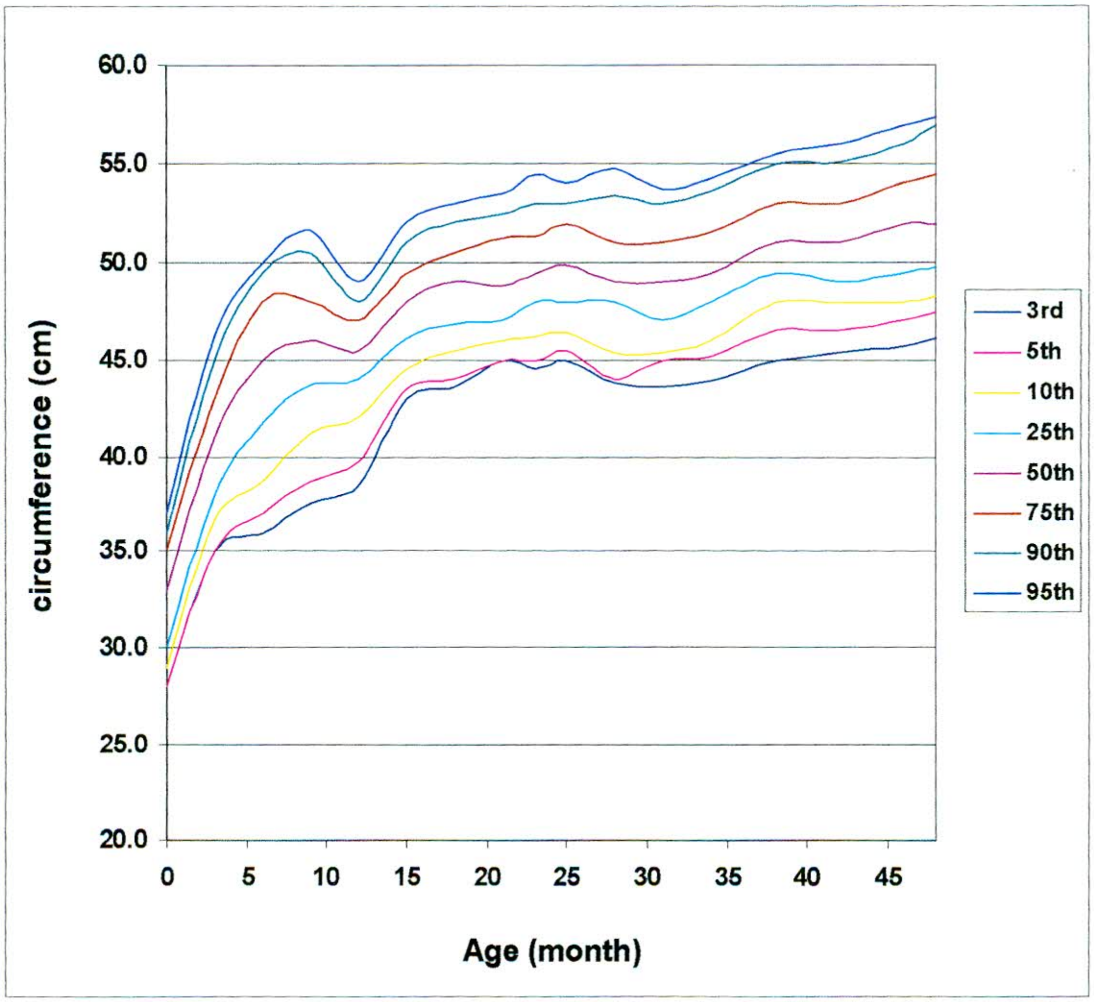


Figure 5.2.12 Chest circumference for age percentile for females, 0-48 months.

5.2.11 Head Circumference for age

Growth of head circumference for age, 0-48 months are portrayed in figures 5.2.13 and 5.2.14. for males and females respectively by percentile groups. At birth, median length of head circumference is observed to be 33.0 cm for both males and females having 5th and 95th quartile values to be 28.2cm, 28.0cm and 36.5cm, 36.0cm in order for males and females. This implies that head circumference of males are slightly larger than females at the extreme percentiles. On an average, growth in males are more prominent than females and growth in the lower percentiles are prominent than in upper percentiles for both the sexes. Unlike other types of growth, there is no drift of decreasing age range in the growth of females but with one drift of decrease for males at the age of 28-31 months. No such drift is observed in the CDC reference chart for head circumference for age, 0-36 months. Length of head circumference is very much related with formation of brain of babies. So from health and psychological points of views, attention of policy makers is solicited for further in-depth study on this issue.

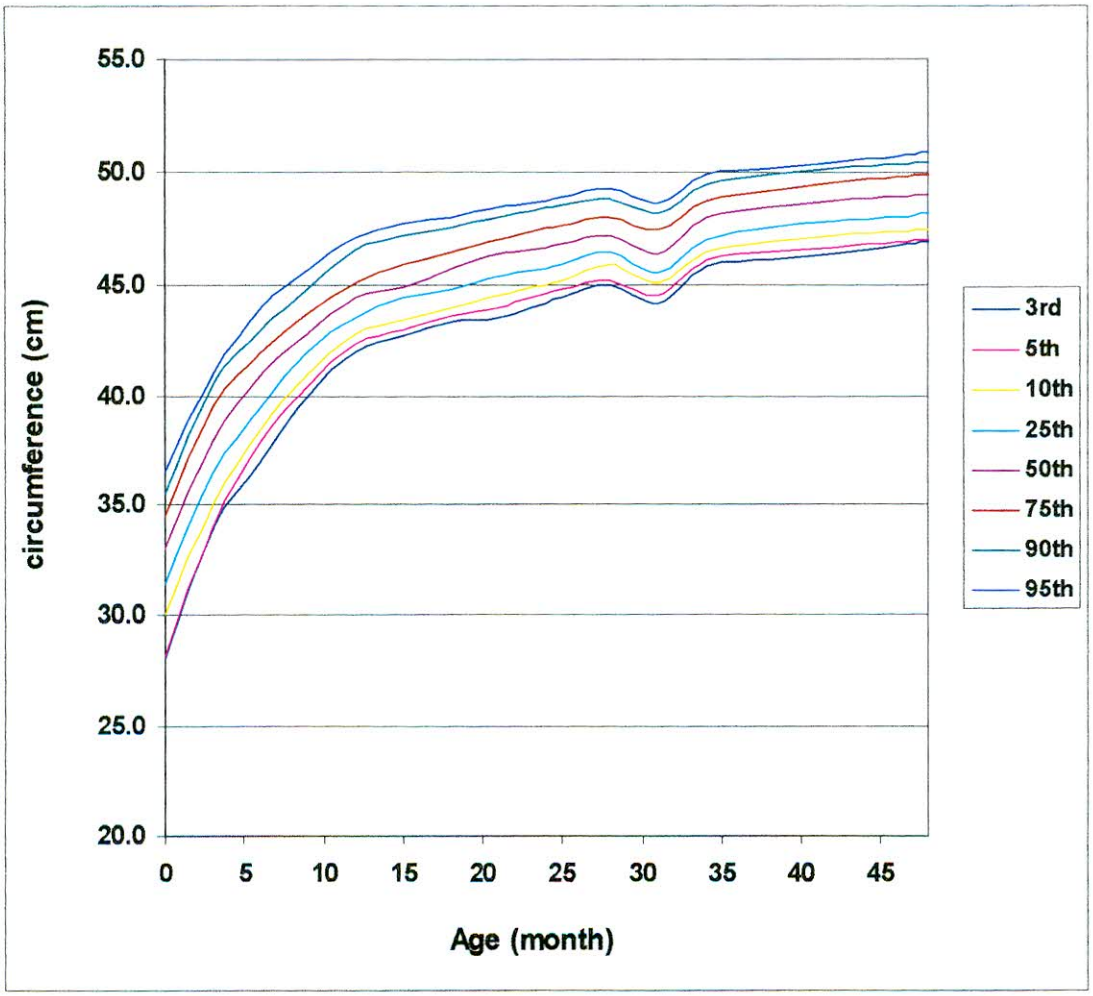


Figure 5.2.13 Head circumference for age percentile for males, 0-48 months.

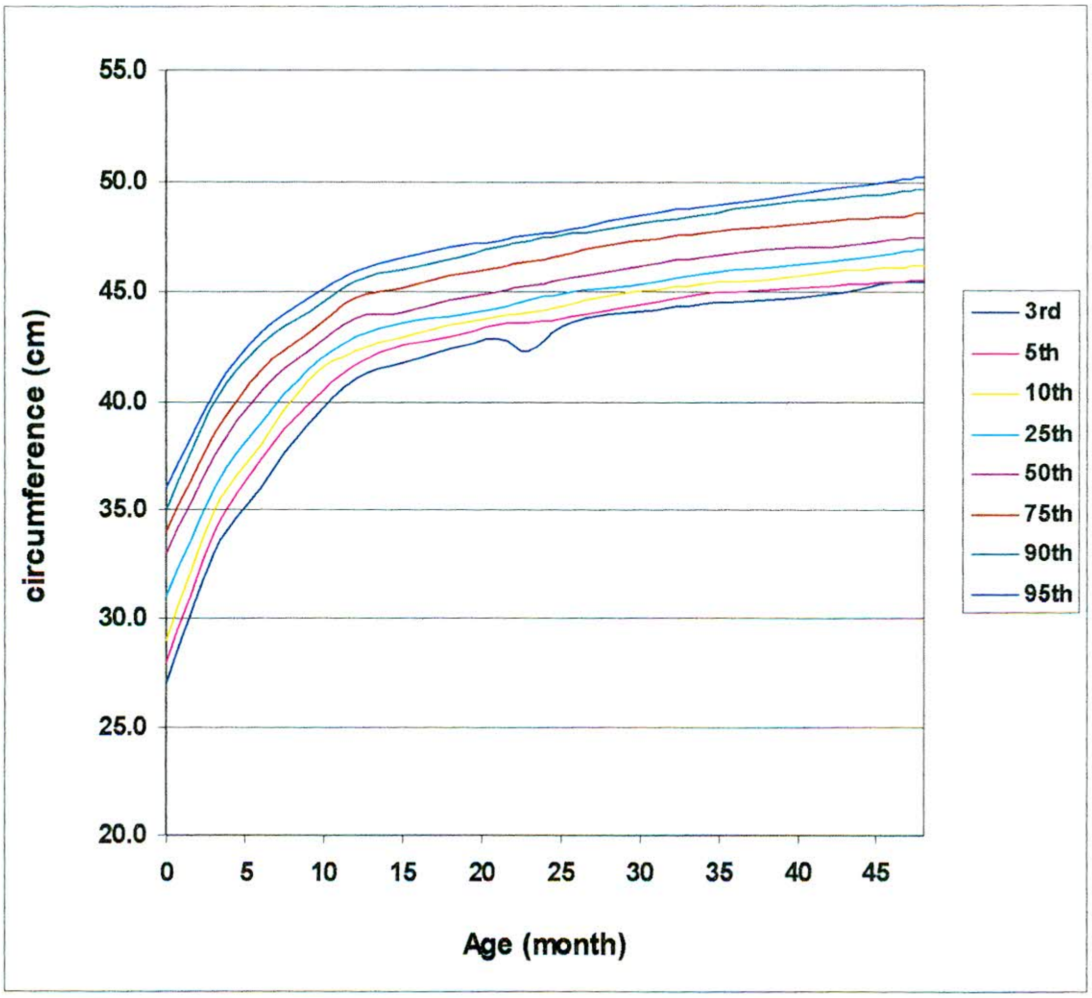


Figure 5.2.14 Head circumference for age percentile for females, 0-48 months.

Chapter – Six

Concluding Remarks

6.1 Major Findings

The objective of growth monitoring is timely identification of disturbances in normal weight gain and linear growth in order to instigate corrective therapy and achieve full growth potential. Growth monitoring also provides health care providers with an opportunity to discuss healthy eating and active living with children and their caregivers. Optimal growth monitoring requires accurate anthropometric measurements using appropriate equipment and techniques and accurate plotting on a consistent growth chart appropriate for age and gender. Differences in growth between populations are affected primarily by environmental factors and the role of genetic factors is smaller than previously thought. Therefore, use of a single international growth chart is appropriate. In the absence of such a geographically diverse chart, the American CDC growth charts are recommended for use by pediatric health care providers for the assessment and monitoring of growth in Bangladeshi infants and children. When the new WHO growth standards become available, their use for Bangladeshi infants and children from birth to age five are strongly considered and evaluated. While local growth charts are unnecessary, this does not argue against the collection and use of local anthropometric survey data to facilitate monitoring of the overall nutritional and health status of Bangladeshi infants and children and trends within this population. Evidence demonstrating the benefits of growth monitoring on clinical outcomes is quite limited. This likely reflects the paucity of research, rather than providing proof against such rewards.

Average stature at birth did not differ significantly between the sexes but at age 48 months the sex difference in average stature was observed to be 3.50 cm, 100.41 cm for males and 96.94 cm for females with standard deviation of 6.55 cm and 4.00 cm. Average height velocity for males are comparatively larger than females but females are more consistent than males.

Difference in mean weight between males and females were observed to be 0.09 kg only, 3.04 kg for males and 2.95 kg for females with standard deviation of 0.54 kg and 0.47 kg in order. This implies, birth weights among the children are homogeneous between the sexes. A faster velocity in weight growth among the males than the females is observed. Males are observed to gain 1.61 kg of weight on an average over the females at age 48 months.

Differences in mean sitting height between females were observed to be apparently dominating but not significant at birth. At the age of 3 months, the situation is just reverse and follows a continue increasing trend, the rate of increase is being larger for males than females. The males superceded the females by 2.25 cm in sitting height at age 48 months.

Chest circumference of females were larger than males at birth on an average. The situation is reverse at 3 months of age. At 48 months of age, the difference has become 1.66 cm in favor of males like sitting height situation.

Average right arm circumference was not significantly different at birth but the velocity of increase with age was observed to be higher in males than in females. At the age of 48 months, males superceded by 1.00 cm. The left arm circumference were, more or less, similar with that of right arm circumference for both males and females.

Males and females were approximately equivalent in the measure of right shoulder-elbow having a slight dominating tendency of the males. The growth patterns and velocity in right shoulder-elbow were observed to be consistent and approximately equal between the sexes. The left shoulder-elbow were very much similar to that of right shoulder-elbow measurements.

At birth, on an average, left elbow-wrist of males was found to be 9.08 cm with SD of 0.66 cm, while it was 9.05 cm and 0.63 cm for females. It implies, there was no significant difference between the sexes. At the age of 48 months, the corresponding figures were 20.23 cm, 1.62 cm, and 19.67 cm, 1.43 cm with an increment of 0.55 cm for males over females. The nature of increment within and between sexes were systematic and consistent. But it was interesting that for both the sexes, right elbow-wrist was found to be shorter than the left elbow-wrist by more than 2 cm at the age of 48 months.

Head circumferences of males were slightly larger than females. On an average, this growth in males were more prominent than females and were systematic and consistent having comparatively a larger velocity for males than females.

Average head breadths of males were slightly larger than females and their differences between the sexes over the age 0-48 months were very much negligible with slow but consistent velocity.

Average maximum head length was found to be more prominent among the females than males but their difference was not significant, though, males showed a dominating tendency.

Maximum head heights, on an average, were found to be with negligible differences between sexes but their velocities were approximately equal and moderate.

In total, 14 growth charts was constructed in this study. These were: percentile growth of 1) Stature, 2) Sitting height, 3) Upper-lower ratio, 4) Weight, 5) Chest circumference, 5) Head circumference, and 6) BMI, for males and females, 0-48 months of age. These growth curves were compared with standard curves like, CDC curves, WHO curves and curves given by Cole et al. (1995). Some irregularities were observed in the curves studied. Those irregularities are as below:

An examination of this figure indicates that within the age of 0-12 months, growth in stature is more or less uniform for entire study population. After that, an increasing diversity is observed in the growth in stature of male children. These sex differentials for growth in stature between males and females and above age 1 year was interesting and should be investigated properly. After 2 years of age, female growth rate became slower and male growth rate improved nicely till to 48 months.

The upper-lower ratio was less than 2 for all children in the study area. This implies that lower portion of the body is comparatively smaller than the upper part and hence the growth in body proportion is not uniform. Policy maker may give attention to this matter for the overall health and growth of the population at large. The leg length growth of female and male children appeared to some diverge reached at the 48 months of age, the difference was clear. The change in ULR was due to the different sitting height and leg length velocities.

Males were comparatively heavier than females at birth. The growth in weight was observed to be consistent for both males and females up to the age of 9 months for all percentile groups. In the age range of 9-12 months, there was a decline or steadiness in the growth of all children and this decline was prominent in the upper 50th percentile groups. Afterwards, growth in weight increased with certain degree of regularities up to the age of about 24 months for both males and females. On an average, males gained about 0.5 kg weight over females but at the upper percentiles, females superceded the males. Again, there was a weight loss situation around the age of 30 months for males and 27 months for females with minor variations in ages for different percentile groups. At the end, we observed that velocity of weight gain was on an average faster among the males than the female in general and among the upper 50th percentile groups in particular. At the lower percentile group (3rd), it was 11.0 kg for both males and females. The median weight for males and females were found to be 15.5 kg and 14.5 kg, while it was 24.0 kg for males and 20.0 kg for females at the upper 95th percentile groups at the end of the project. The drifts at age 9-12 months and 27-30 months were not found in any other studies requiring special attention for further research.

The BMI of males were comparatively lager than females at birth and increases sharply upto 6 and 9 months of age for females and males, respectively. For females, a drift of decrease was observed between 6-9 months of age. A similar drift was observed for males in the age range of 9-12 months. Also decreasing drifts were observed between (15-18) months of age at the lower 50th percentiles and between (21-28) months of age at the upper 50th percentiles of females. This decreasing trend followed up to 36 months of age. Beyond 36 months BMI was observed to be constant for females with some minor irregularities up to the age of 48 months. At the lower 25th percentiles of males a drift of decrease in BMI was observed between 18-21 months of age. Another decreasing drift was observed in the age range of (25-28) months for all percentiles of males. This drift continued up 36 months of age. Over the age of 36 months, BMI was observed to be constant, more or less. According to Cole et at. (1995), BMI of Dutch children showed rapid increasing trend up to the age of one year and then a slow decreasing trend up to pre-school age (up to 6 years) and again a steady increasing trend up to 20 years without any drifts. Dutch data was of yearly observations. Necessary attention was to be given for further studies to single out causes of observed drifts with the age of drifts and their remedial measures. It was alarming that up to 25th percentile, almost all the children belongs to BMI less than 18, which implies serious malnutrition. At the 50th and over percentile, beyond the age of 2 years more than 75% children were suffered from malnutrition irrespective of sex. At birth, almost all the children in the study area were suffered from malnutrition having the BMI in between 9 and 17. The situation of females is comparatively worse than males.

At birth, males and females did not differ in chest circumference and their its growth was sharp and systematic up to the age of 9 month. At the upper 50th percentile, a drift of decrease in growth was measured for both the sexes during the age of 9-12 months. On wards, the growth was consistently increasing with a second drift of decrease during the age of 28-31 months, the drift was much more prominent for males than females. The overall growth in chest circumference was observed to be faster among males than females.

Growth in head circumference for males were more prominent than females and the lower percentiles were prominent than the upper percentiles. Unlike other types of growth, there was no drift of decreasing age range in the growth of females but with one drift of decrease for males at the age of 28-31 months.

6.2 Limitations of the Study

We have started our study with 296 babies, 162 males and 134 females. At the end of the year, number of babies stands to be 293, 160 males and 133 females. In between 12-15 months of the study, we have lost about 16% of the sample babies due to mainly transfer of the parents from the study area. A second shocking lose in the study sample was experienced during the age of 25-28 months, comprising of 22% of the total population and a cumulative lose of 38%. The irregularities observed in different figures were just immediate before and after this loses in sample size. This might be due to fluctuation in sample size or some other reasons and was a question mark to this study.

This problem might be overcome with a larger samples. But, the researcher was lacking of finance to support this study and hence a larger sample was possible, though it was a priori known that lose of sample size is a much in each and every longitudinal study.

Longitudinal growth may be affected by some other socio-economic, psychological, environmental, etc factors. Initially, we have planned to study those factors in relation to longitudinal growth but for obvious socio-economic and psychological reasons we had to left this ideas from our research plan.

We had to work with our own collected data and this collection of data was spread over 4 years of time. Before that, the researchers had to under gone and pass a compulsory course work of 1 year. Ph.D. program in Rajshahi University is spreaded over 6 years to a maximum. Hence, time was a factor of limitations to this study.

6.3 Scope for further Research

For a complete growth study, longitudinal data from birth to 18 years, at least, is necessary. This study has covered only 0-4 years of age and may be extended for further investigation, provided that there are financial and logistic supports. Impact of sample size variation, that might be a cause of fluctuations and variations in the observed growth curves may be studied with different samples. Variation in right and left elbow-wrist may be investigated further and should be followed up to the age of 18 years for a conclusion. Impact of food that is calorie and protein intake on the longitudinal growth may be studied. Different growth models for predicting growth patterns may be investigated. Inter-correlation between calorie, protein intake, seasonality of birth, nutritional, etc influencing the growth pattern may be investigated as part of further research. Nutritional status and reproductive health of the mothers during pregnancy are important issues of further research on child growth.

Bibliography

Ali MA and Ohtsuki F (2000) Estimation of Maximum Increment Age in Height and Weight During Adolescence and the Effect of World War II. American Journal of Human Biology 12:363-370.

Ali MA and Ohtsuki F (2001) Prediction of Adult Stature for Japanese Population : A Stepwise Regression Approach. American Journal of Human Biology 13:000-000.

Ashizawa K, Kato S and Eto M (1994) Individual Adolescent Growth of Stature , Body Weight, and Chest Circumference of Girls in Tokyo. Anthropol. Sci. 102(4), 421-446.

Bacallao, J, Molina, JR, Izquierdo and Castillo MM (1992) Multivariate Allometry as a model of Morphometric Harmony of Four Skinfolds in the Newborn. American Journal of Human Biology 4:285-290.

Beunen.G, Oystyn M, Simons J, Renson R and Van Gerven D (1981) Chronological age and Biological age as related to physical fitness in boys 12 to 19 years. Annals of Human Biology, vol. 8, No. 4, 321-331.

Beyer and Doer (1998) Observations of reported and measured heights of mothers of short statured children. Annals of Human Biology. vol. 25, No. 4, 387-390.

Bielicki T, Koniarek J and Malina RM (1984) Interrelationships among certain measures of growth and maturation in boys during adolescence. Annals of Human Biology, 1984, vol. 11, No. 3, 201-210.

Blanksby BA, Freedman F, Barrett P and Bloomfield J ((1974) Secular changes in the heights and weights of Western Australian primary school children. vol. 1, No. 3, 301-309.

Cameron N, Gordon-Larsen P and Wrchota EM (1994) Longitudinal Analysis of Adolescent Growth in Height, Fatness, and Fat Patterning in Rural South African Black Children. American Journal of Physical Anthropology 93:307-321.

Chiaki Tanaka, Mitsunori Murata and others (2004) Reference charts of body proportion for Japanese girls and boys. Annals of Human Biology, November-December, vol. 31, No. 6, 681- 689.

Chinn S, Rona RJ and Price CE (1989) The secular trend in height of Primary School children in England and scotland 1972-1979 and1979-1986. Journal of Human Biology. Vol 16,No 5,387-395.

Chowdhury, Shahabuddin, Talukdar et al. (2000) Nutritional status and age at menarche in a rural area of Bangladesh. Annals of Human Biology, vol. 27, No. 3, 249-256.

Cole TJ and Roede MJ (1999) Centiles of body mass index for Dutch children aged 0-20 years in 1980- a baseline to assess recent trends in obesity. Annals of Human Biology, vol. 26, No. 4, pp.303- 308.

Gallo PG and Mestriner MF (1980) Growth of children in Somalia. Human Biology, vol. 52, No. 3, pp.547- 561.

Hoppa RD and Garlie TN (1998) Secular changes in the growth of Toronto children during the last century. Annals of Human Biology, vol. 25, No. 6, 553-561.

Gasser T, Sheehy. A, Molinari L and Largo RH (2000) Sex Dimorphism in growth.Annals of Human Biology, vol. 27, No. 2, 187-197.

Greulich WW (1976) Some Secular Changes in the Growth of American- Born and Native Japanese Children. American Journal of Physical Anthropology 45 :553-568.

Gualdi- Russo et al . (2005) Growth of Chinese Italian infants in the first 2 years of life. Annals of Human Biology, January-February 2005; 32(1) 15-29.

Gyenis G (1997) Continuing positive growth changes in height and weight of Hungarian University Students. Annals of Human Biology, vol. 24, No. 5, pp. 475- 479.

Henneberg GM and Louw JG (1998) Cross sectional Survey of Growth of Urban and Rural" Cape coloured" Schoolchildren: Anthropometry and Functional Tests. American Journal of Human Biology 10:73 – 85.

Huda. S and Bener A (1988) Estmation of Correlation Coefficients for Growth Measurements Under Age – Grouping. Human Biology, vol. 60, No. 2, pp.341- 349.

Ji C-Y, Ohsawa S and Kasai N (1995) Secular changes in the stature, weight, and age at maximum growth increments of urban Chinese girls from the 1950s to 1985. American Journal of Human Biology 7:473-848.

Johnston E, Roche AF, and Susanne C (1980) Human Physical Growth and Maturation: Methodologies and Factors. New York: Plenum Press.

Kaplowitz HJ, Christine EC, Martorell R and Rivera J (1991) Longitudinal Principal Components Analysis of Patterns and Predictors of Growth in Guatemalan Children. American Journal of Human Biology 3:169-180.

Kim YS (1982) Growth status of Korian schoolchildren in Japan. Annals of Human Biology, vol. 9, No. 5, pp. 453- 458.

Lindgren. WG and Hauspie CR (1989) Heights and weights of swedish school children born in 1955 and 1967. Journal of Human Biology.vol 16,No. 5, 397-406.

Livshits G, Peter I, Vainder M and Hauspie R (2000) Genetic analysis of growth curve parameters of body weight, height and head circumference. Annals of Human Biology, vol. 27, No. 3, 299-312.

Malina RM (1979) Secular changes in growth, maturation, and physical performance. Exercise and Sport Science Reviews, vol 6, pp. 203-255.

Malina RM, Kathryn H. Brown and others (1987) Relative Lower Extremity Length in Maxican American and in American Black and White youth. American Journal of Physical Anthropology 72:89-94.

Mc Gregor and Billewicz (1982)A birth –to-maturity longitudinal study of heights and weights in two West African(Gambian) villages, 1951-1975. Annals of Human Biology, vol. 9, No. 4, 309-320.

Mohammad K and others (1999) Weight-for-Height of children in Iran . Annals of Human Biology, 1999, vol. 26 No. 6, 537-547.

Norgan NG, Ferro-Luzzi A and Durnin JVGA (1982) The body composition of New Guinean adults in contrasting environments. Annals of Human Biology, vol. 9, No. 4, 343-353.

Rao and Reddy (2000) Growth pattern of the Sugalis – a tribal population of Andhra Pradesh, India. Annals of Human Biology, vol. 27 No. 1, 67-81.

Roche AF (1992) Growth maturation and body composition, The fels Longitudinal Study 1929-1991. Cambridge University Press. NY

Rosique J and Rebato E (1995) Comparative Study of Statural Growth in Spanish Populations. American Journal of Human Biology 7:553-564.

Shani D, Jit I and Sanjiv (1994) Weights of the Heart in Northwest Indian Adults. American Journal of Human Biology 6:419-423.

Shinkichi Nagamine and Shinjiro Suzuki (1994) Anthropometry and body composition of Japanese young man and women. Human Biology, vol. 36, No. 8, 8-15.

Togo M and Togo T (1982) Time-series analysis of stature and body weight in five siblings. Annals of Human Biology, vol. 9, No. 5, 425-440.

Tsuzaki S, Matsuo N, Saito M and Osano M (1990) The head circumference growth curve for Japanese children between 0-4 years of age: comparision with Caucasian children and correlation with stature.

Wales JKH (1998) A brief history of the study of human growth dynamics. Annals of Human Biology, vol. 25, No. 2, 175-184.

Appendix

Questionnaire:

Statistical study of child growth: A case study of Rajshahi City.

Department of Statistics

University of Rajshahi,

Bangladesh.

(Collected data will be used only for research work)

(1) Name of Hospital/Clinic:

(2) Name of Child: (a)Son- (b)Daughter-

(3)The name of father of child and his permenent address:

(a)Name: Village: Post:

Police station: Ward no: District:

(4) Age of father: Education: Annual income: Occupation:

(5) Age of mother: Education: Annual income: Occupation:

(6)Serial of baby:

(7)Baby's delivery type: (a)Normal (b)Operation

(8)If there were any problem when mother was pregnant? Yes o/ No.

(9)If there were completed course of when mother was pregnant?Yes / No.

(10)If there was malnutrition when mother was pregnant? Yes /No.

(11)(a) Height of Father: (b) Weight of Father:

(c) Height of Mother: (b) Weight of Mather:

(12)The cleanness of mother and child: (13) Cleanness of Environment:

Month of Age	Supine length/ Stature (cm)	Weight (kg)	Sitting height (cm)	Chest circumferenc e (cm)	Arm circumference (cm)		Shoulder elbow length (cm)		Wrist elbow length (cm)		Head circumference (cm)	Maximum head breadth (cm)	Maximum head height (cm)	Maximum head length (cm)
					Right	Left	Right	Left	Right	Left				
Date of birth.														
January														
February														
March														
April														
May														
June														
July														
August														
September														
October														
November														
December														