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Anthropometric Measurements of Under- five Sudanese Children in *Wad Medani*, Central Sudan in Comparison with Center for Disease Control and Prevention Standards

Sahla Mohammed Ahmed Mohammed[1], Mansour Abdulgadir Ballal[2], Hydar Elhadi Babikir Saad[3], Ghada Tajelsir Abdoun [4].

1. Department of Physiology, Faculty of Dentistry, University of Gezira.
2. Department of Physiology, Faculty of Medicine, University of Science and Technology.
3. Dean of Faculty of Medicine, University of Gezira.
4. Department of Biochemistry and Nutrition, Faculty of Medicine, University of Gezira.

Abstract:

A normal growth pattern is a gold standard by which clinicians assess the health and well being of children. The main goal of this study is to assess the growth pattern of healthy Sudanese children under the age of five in Medani city, Central Sudan and compare it with the CDC/NCHS Reference, also to evaluate some environmental factors that influence child growth. Cross sectional sample of 1500 Sudanese children were obtained from five areas, which statistically selected to represent the city. Questionnaire was designed to include, personal data, parental factors, socioeconomic status, nutrition and anthropometric measurements. The study revealed that, the mean weight and length of infants included in the data depicted a similar pattern to that of CDC/NCHS reference during the first six months. After six month, the distribution of length, height, weight and BMI for age were shifted below median of the CDC reference. Weight for length of the data depicted a similar pattern to that of the CDC curves while there is a notable deviation of weight for height of data below the CDC reference, on the other hand, there was a positive association of age with weight, length, height and BMI indicating that, it's a normal data . Based on CDC cut offs, the prevalence of underweight and overweight were 20.7% and 18.9% respectively. Many factors have been found to influence length and weight, these factors include gender, race, hypertension during pregnancy, father education and occupation, family income, number of meals per day and all food types, while mother's age at delivery, nutrition during pregnancy, mother's education and occupation and family size were significantly related to child weight. Diabetes mellitus in pregnancy affected child length. Meat and bread intake was found to be significant variables in child height. Mother's occupation, number of meals per day and food groups had significant effect on child BMI. Important differences in weight, length, height and BMI were found between children above six months included in this study and CDC/NCHS reference, therefore interpreting their growth by comparing them to CDC/NCHS reference may not be appropriate. The reference values obtained in this study is recommended to be used in the medical practice as well as the field of medical education in Sudan.

Introduction:

It is well known that, children make a significant proportion of human population and their healthy growth and development ensure the future health of society. Childhood is the most important life stage for growth and health at other stages. (Moridi and Fathi, 2009). Childhood growth is considered as a best indicator of

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child health and nutritional status. (Lack et al, 2008) In the individual child, growth mirrors health or illness. At the child population level, growth may be used to monitor living conditions. Continued deviations may indicate somatic disorders or psychosocial problems. (Gelander et al, 2002) Understanding the normal pattern of growth enables the early detection of pathologic deviation and can prevent the unnecessary evaluation of children with acceptable normal variation in growth. There is a significant amount of evidence that links exposure during growth to later morbidity and mortality. (Cameron and Demerath, 2002) During childhood, growth is regulated and depends on the proper functioning of multiple systems. It is influenced by prenatal factors, including maternal nutrition and uterine size, genetic growth potential inherited from parents and nutrition throughout childhood. In addition growth is affected by the interplay of multiple hormones, including growth hormone (GH), thyroid hormone, insulin, and sex hormones, all of which have varying influence at different stages of growth.

(Weintraub, 2011)

The pattern of growth of children changes with time. (Khadilkar et al, 2011) It was observed that the rates and patterns of growth in weight of European and North American infants have changed over the past 100 years; there is an increase in the weight of 1-year old of about 1 kg. Taking into account the higher past rates of infant morbidity and mortality, and poorer quality of artificial feeds, this change is likely to be another expression of the secular increase in physical stature consequent on improved hygiene and nutrition. (Weaver, 2011)

Globally around 200 million children less than five years of age are affected by poor growth and stunting (height-for-age >2 sd. below reference population mean). That is due to many causes including poor nutrition and micronutrient deficiencies during infancy. (Branca and Ferrari, 2002) Poor growth in developing countries is assumed as a major public health problem which is associated with mortality, morbidity and developmental delay. (Bryce et al, 2005,

Caulfield et al, 2004)

Taha, 1978 suggested that, in view of varying socioeconomic differences that exist between and within countries, there is a need for standards to be established for the Sudan.

This study is designed to assess growth of Sudanese children less than five years of age, and to see if it represents better the Sudanese children growth compared to the CDC reference and to estimate the prevalence of underweight and overweight among children less than five years of age using the CDC reference.

Patients and Methods:

Study area: This study was conducted in Wad Medani city, Gezira state, about

180 Km south east of Khartoum, during the period of September 2011 to April 2012. The state is one of heavily populated states of the country. According to estimation of 2008, the Gezira state population is 289482. (Central Bureau of Statistics, 2008) **Study design:**

It was a cross-sectional study of anthropometric data among healthy breastfed children under the age of five. To get data statistically representing all the children in Wad Madeni city, stratified sampling method was used and five areas were selected according to the main geographical directions, each area represented special direction in the study area; El Debaga (northern), Marnjan (southern) , Derdeg (eastern), El Waha (middle) and El Andulus (western) **Sample size:**

Children under the age of five were estimated to be about 35911 in Wad Medani city (Central Bureau of Statistics, 2008),

The sample size was determined statistically by the following equation:

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$$N = \frac{N\sum_{j=1}^{L} N_j P_j q_j}{N^2 A + \sum_{j=1}^{L} N_j P_j q_j}$$

Where

N: population size

N_j : Stratum j size

P_j:proportion of children under five

q_j . proportion of other population

$$A = \frac{B^2}{4} = \frac{(0.04)^2}{4} = 0.0004$$

Where B expected size of error.

P = 50% q =50% (assumed)

N = (35911){ (0.25)(35911) (35911) (0.0004)+(0.25)(35911)

=(322399980.25) $\div (515839.97) + (8977.75)$

=322399980.25 $\div 524817.72 = 614$

The minimum sample size is 614 child, but for more statistical precision (the design effect), the sample size was multiplied by 2; the sample size required is 1228 child. The actual collected data was 1500 child.

Inclusion criteria:

Individual inclusion criteria were:

- No known health or environmental constraints to growth
- Mothers followed MGRS feeding recommendation (i.e exclusive or predominant breast feeding for at least 4moths, introduction of complementary foods by the age of 6 months, and continued partial breastfeeding up to at least 12 months).
- No maternal smoking before and after delivery.
- Single term birth
- Absence of significant morbidity that affect growth.
- Questionnaire

Structured questionnaire was designed to include;

Personal data, Parental factors, socioeconomic status. Nutrition and Anthropometric measurements.

All the houses in the five areas were visited; the families after thanking them were informed by the study and questionnaire, the questionnaire was filled by researcher. Some of the data were obtained from vaccination and nutrition section in Marnjan, El Debaga, Derdeg and Abo Sonoon health centers to facilitate the anthropometric measurements of infants 0-9 month of age.

Recumbent length: children under 2 years of age were obtained in the recumbent position using infantometer

The height of child older than 2 years of age was measured, with a Holtain stadiometer without shoes

Weight of children under 2 years was measured on a leveled pan scale with a beam and movable weight scale

For children older than 2 years the body weight was measured using electronic digital scales.

Statistical analysis:

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The data was computerized for statistical analysis. Statistical calculations were done using SPSS version 10. Values were presented as mean ± standard deviation of all measured variables by using descriptive test.

The values of weight, height and body mass index (BMI) were transformed into percentiles based on the National Centre for Health Statistics - 2000 (CDC/NCHS) framework using the software EpiInfo 3.3.2 Nutrition February 2005. Cutoff values commonly used in the United States, on the basis of the 5th percentile of weight-for-age to define underweight, and the 95th percentile of weight-for-height or body mass index-for-age to define overweight. (Mei et al, 2008) . Analysis of variance (ANOVA) was used to test significance for mean values of growth variables (weight, length, height and BMI) according to environmental factors.

Results;

The growth data and related information were gathered from 1500 healthy breastfed infants and young children from Wad Medani city, Gezira state in Central Sudan, during the period of September 2011 to April 2012. It was a large sample in comparison to data enrolled by WHO, 2006 and can be more representative for Sudanese children.

Growth Charts: All measured values were compared to CDC (Center for Disease Control and prevention) anthropometric reference dataset with the software called Growth, version 1.4 (last update of the growth data was May 30, 2000). Percentile curves of weight, length, height, and BMI were all calculated using the same software.

Weight for age: Fig (4.2) (4.3) compare the distribution of data and CDC weight for age percentile curves for males and females (from birth to 36 month) respectively. The mean weight of infants included in data depicted a similar pattern to that of the CDC curves during the first 6 month, after six month a notable deviation from the CDC curves appeared and remained below the median up to 36 month.

For children 2-5years fig (4.4) (4.5) show the comparison between the distribution of data and CDC weight for age percentile curves for males and females respectively. There was a clear deviation of data below the CDC median curve up to 5years. In general for age groups above six months the weight seemed to be less than CDC reference.

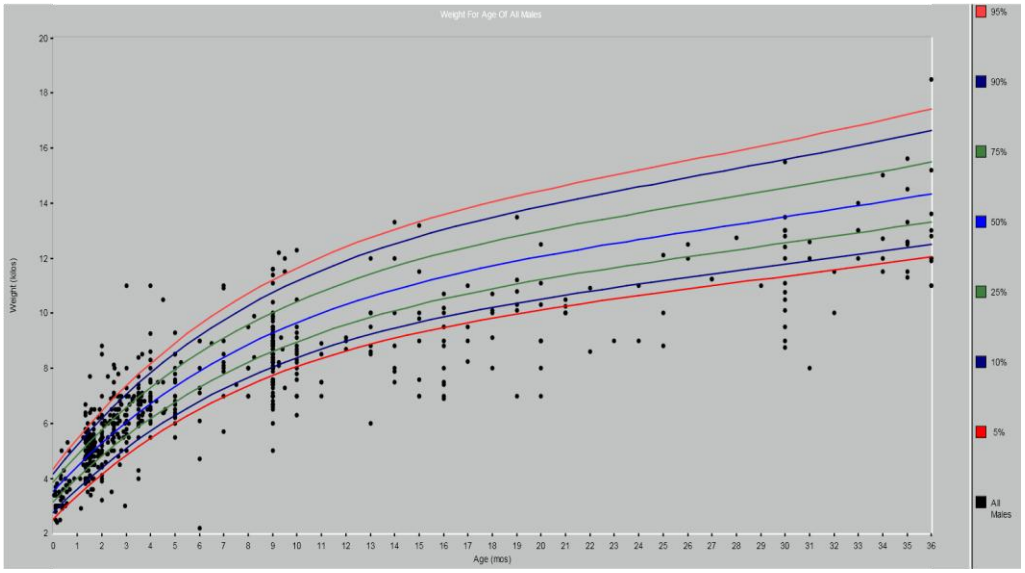

Figure (4.2) Weight for age (0-36month) percentile curve for males

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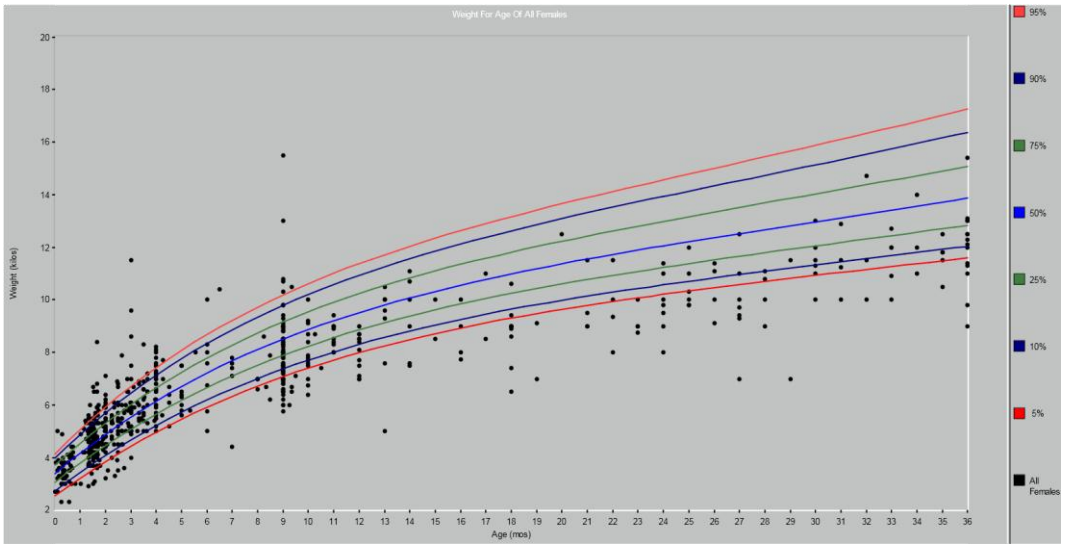

Figure (4.3) Weight for age (0-36month) percentile curve for females

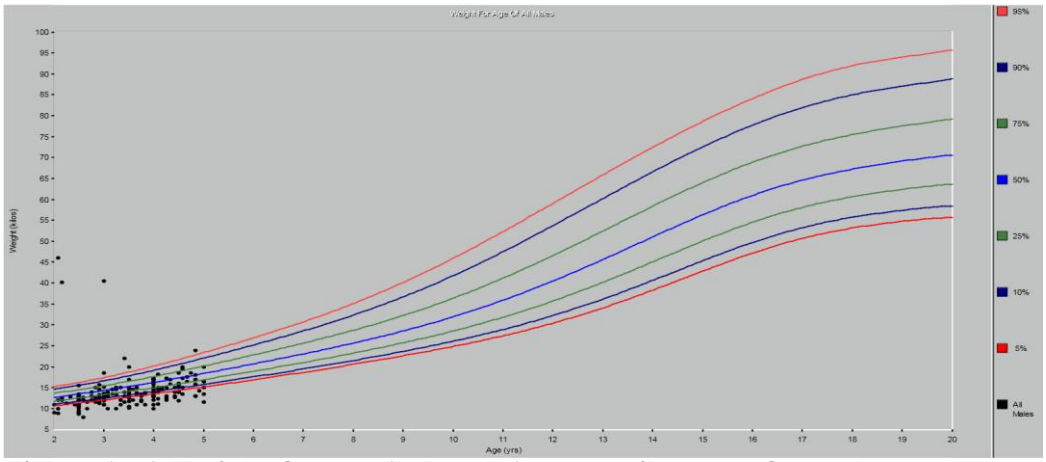

Figure (4.4) Weight for age (2-5 years) percentile curve for males

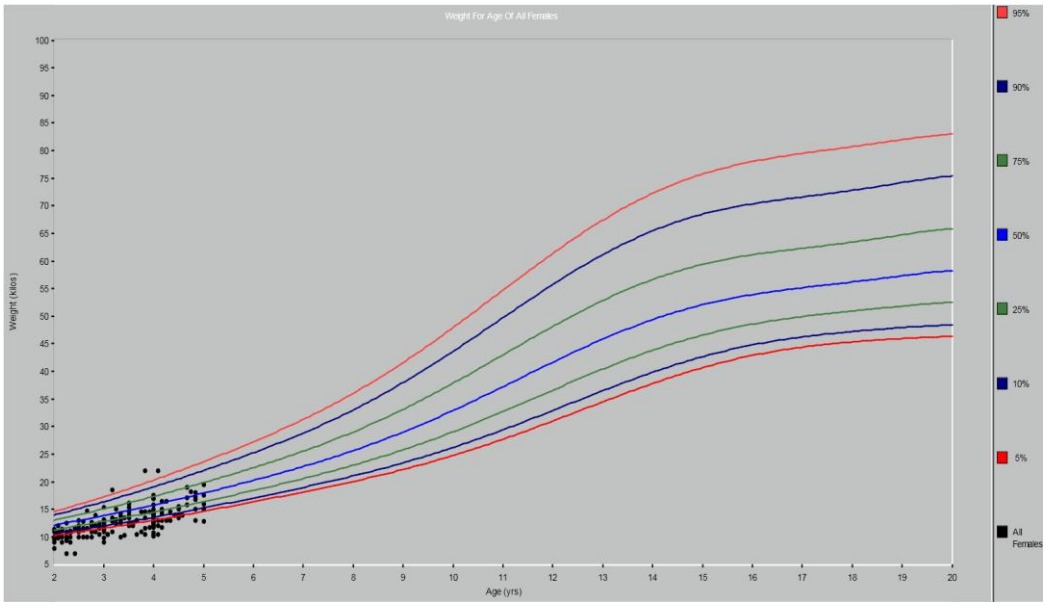

Figure (4.5) Weight for age (2-5 years) percentile curve for females

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Length\height for age:

The comparison between the data length for age and CDC percentile curves is represented in fig (4.6) (4.7) for boys and girls respectively. It was very clear that, distribution of data from birth to 9 month in line with reference curves, then a notable distinction between the data and CDC curves was evident at age ten month and the data remained below the median curve up to 24 month.

Fig (4.8) (4.9) illustrate the comparison between the data height for age and CDC percentile curves for boys and girls. The distribution of most data was below the median curve of CDC reference.

Weight for length and weight for height:

Fig (4.10) (4.11) compare the data and CDC weight for length percentile curves for males and females respectively, the mean weight for length of data depicted a similar pattern to that of the CDC curves.

On other hand fig (4.12) (4.13) show the weight-for-height charts for boys and girls respectively, there was a notable deviation of the mean weight for height of data below the median curve of CDC reference

Body mass index for age:

The BMI-for-age curves begin at 2 years of age on the CDC chart. From fig (4.14) (4.15) it was shown that, the mean BMI of data was compared with percentiles of the CDC reference for boys and girls respectively. Obviously the mean BMI of data was below 50th percentiles of the CDC reference up to 5years.

The patterns described were same for boys and girls for all comparisons presented.

A Pearson Coefficient of Correlation of 0.00 for Weight, 0.00 for length, 0.00 for Height and 0.00 for BMI was documented indicating positive association of age with weight, length, height and BMI also that mean the data fit the CDC references.

Prevalence of underweight and overweight:

The prevalence of underweight and overweight were 20.7% and 18.9% respectively based on CDC cut offs, the 5th percentile of weight-for-age for underweight, and the 95th percentile of weight -for-height for overweight. (Mei et al, 2008)

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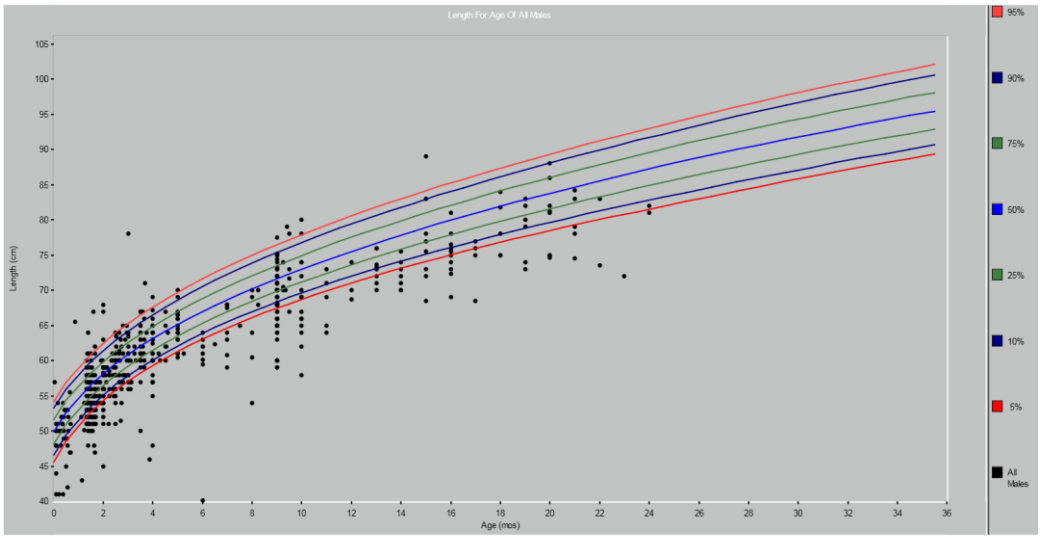


Figure (4.6) Length for age percentile curve for males

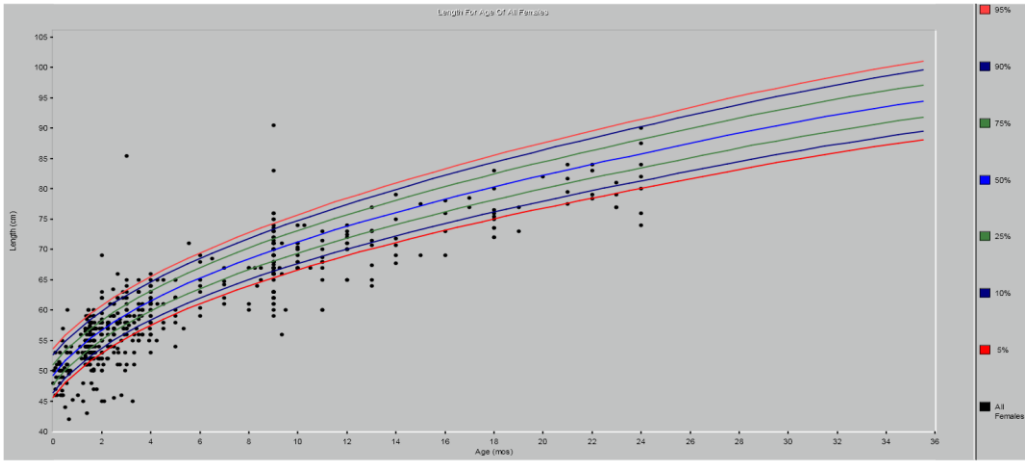
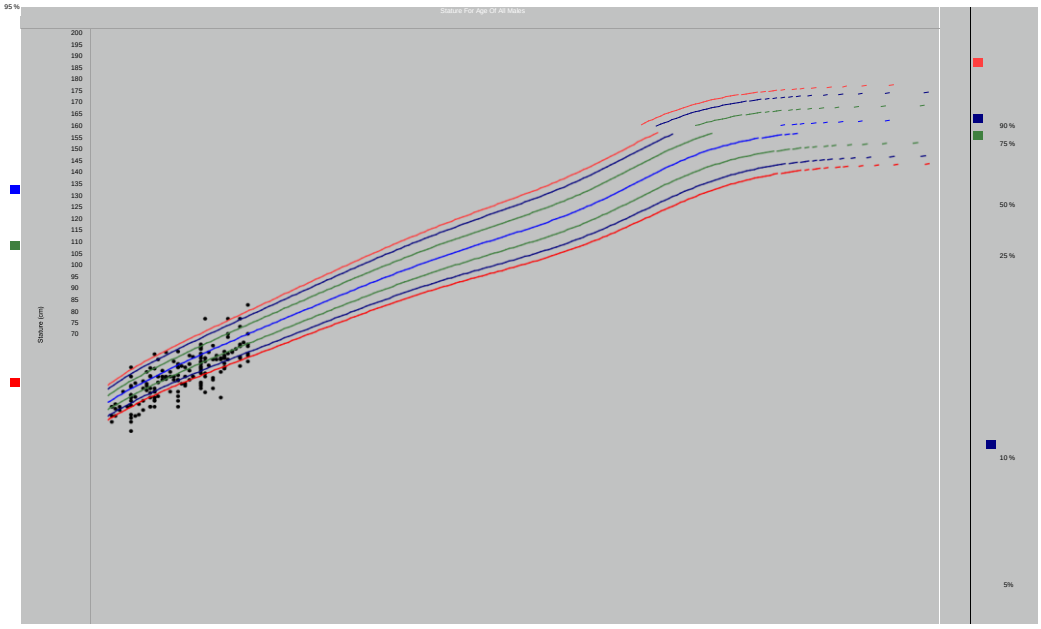


Figure (4.7) Length for age percentile curve for females



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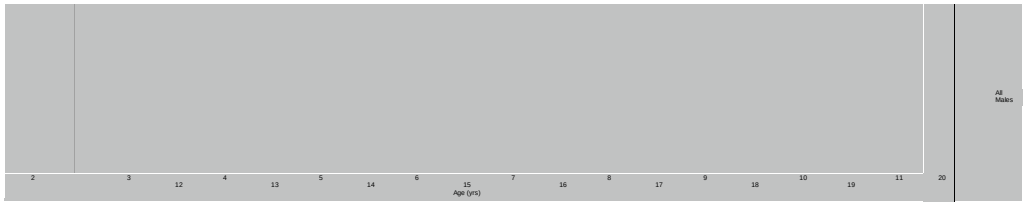

Figure (4.8) Height for age percentile curve for males

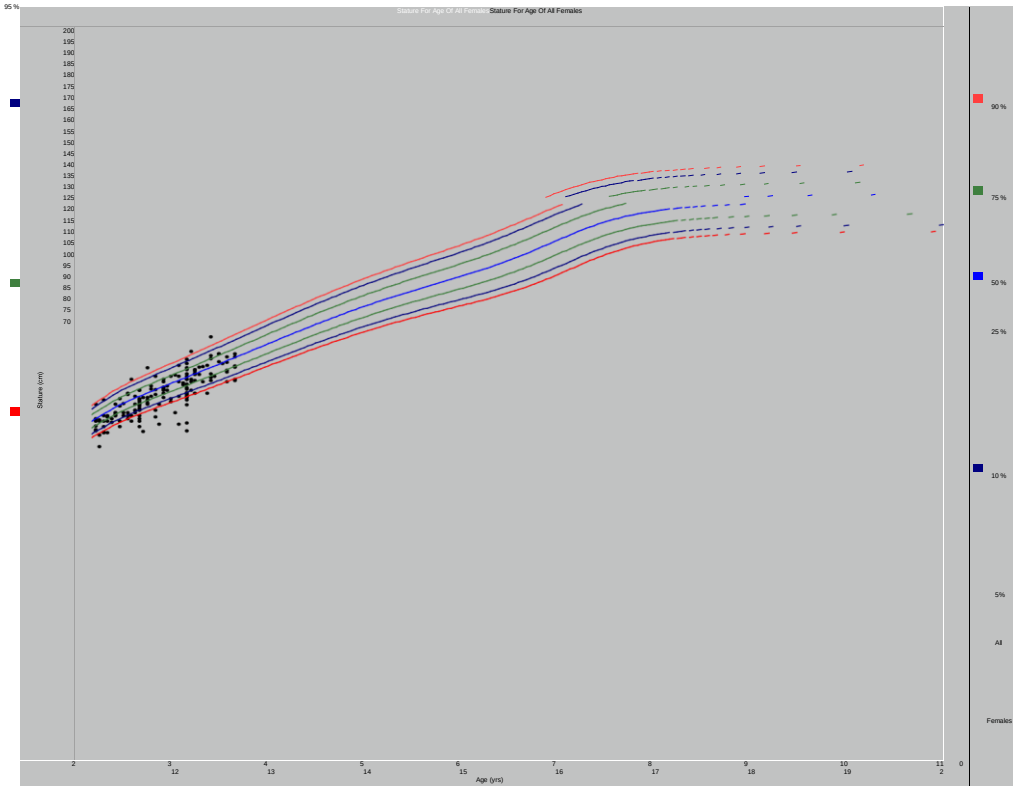

Figure (4.9) Height for age percentile curve for females

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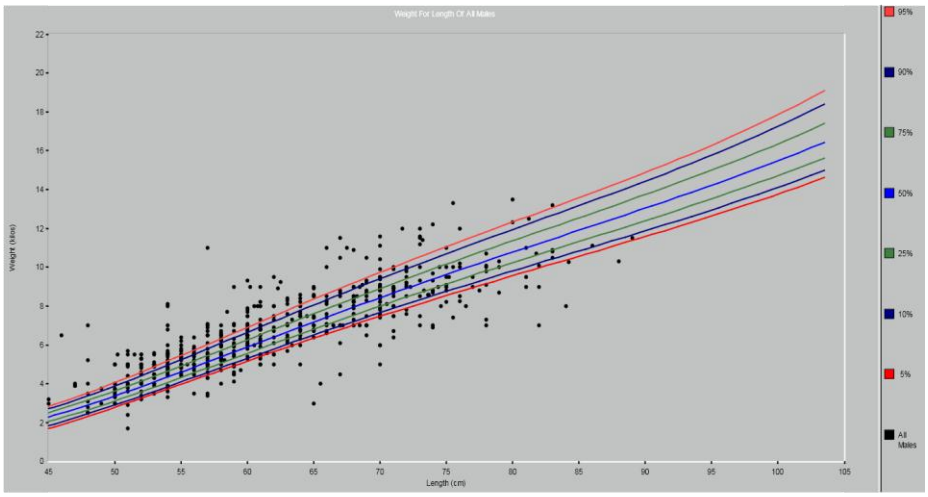

Figure (4.10) Weight for length percentile curve for males

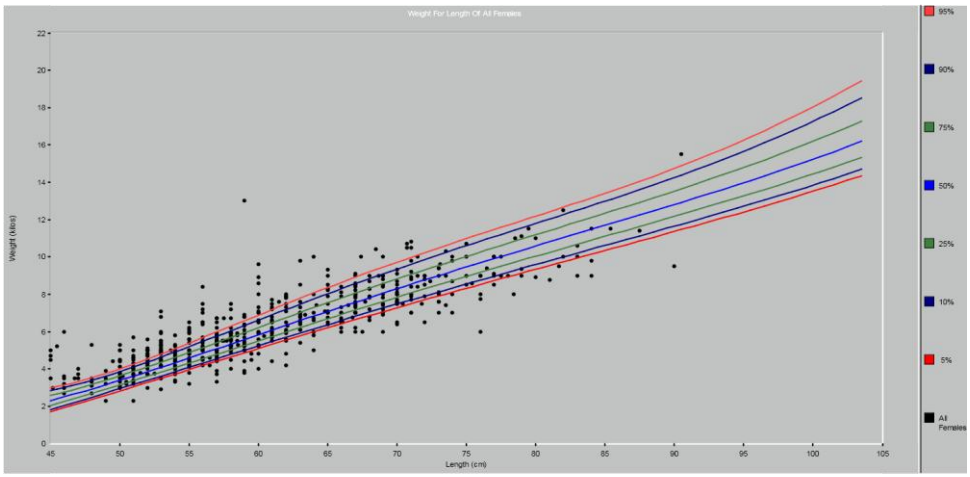

Figure (4.11) Weight for length percentile curve for females

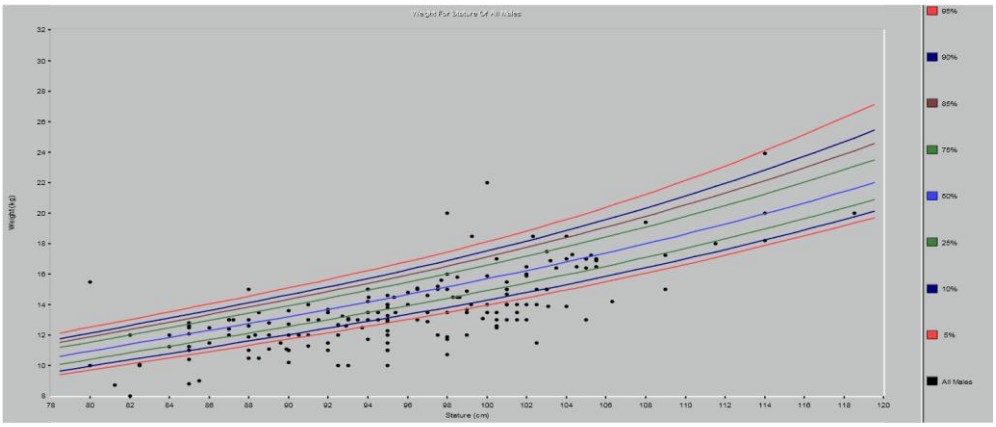

Figure (4.12) Weight for height percentile curve for males

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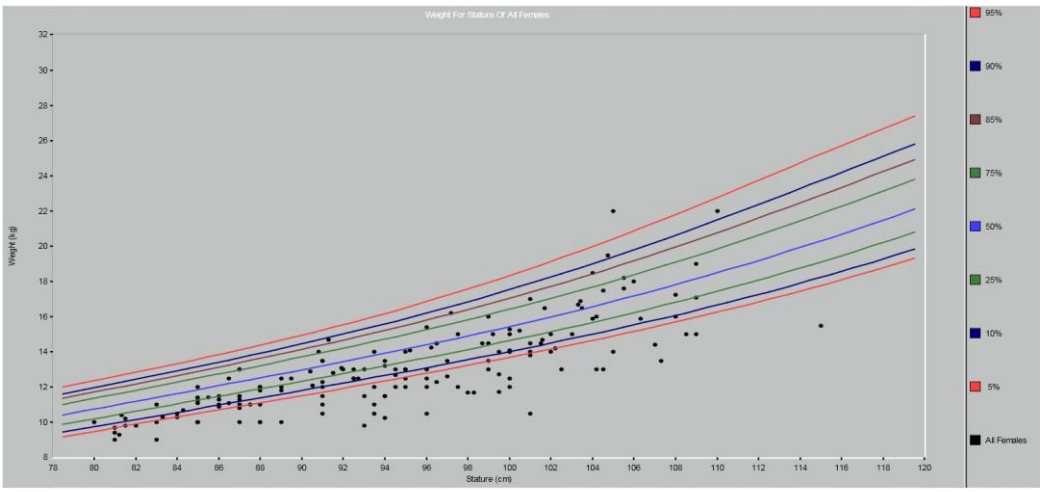

Figure (4.13) Weight for height percentile curve for females

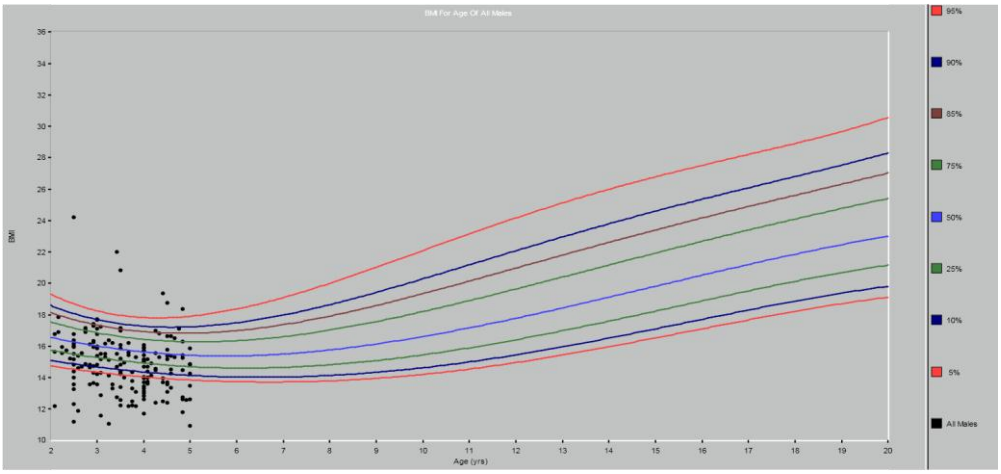

Figure (4.14) BMI for age percentile curve for males

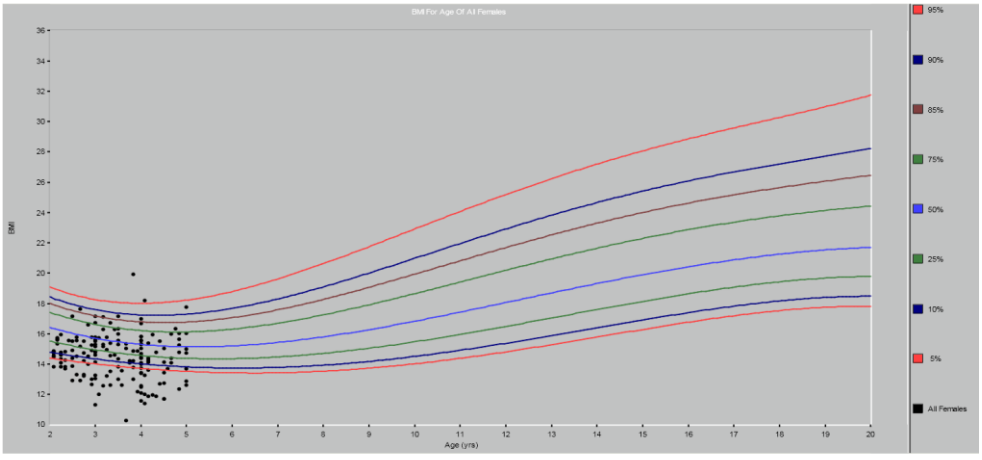

Figure (4.15) BMI for age percentile curve for females

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Factors affecting child growth:

It was found that gender; race, hypertension during pregnancy, father education and occupation, family income, number of meals per day and all food types had significant effects on length and weight. Mother's age at delivery, nutrition during pregnancy, mother's education and occupation and family size had effect on child weight, while Diabetes mellitus in pregnancy affect length, on the other hand meat intake significantly influence height. Mother's occupation, number of meals per day, milk, meat, vegetables and bread intake had significant effects on child

BMI.

Discussion:

The current study showed distinctive patterns of growth associated with different early life influences in a large sample of Sudanese children.

Growth indicators in the form of weight, length, stature, weight for length and body mass index (BMI) for age are important tools for the assessment of growth of children (El Mouzan et al, 2009).

There were important differences between the data and the CDC chars that vary by age group and growth indicator. Concerning weight for age, during the first 6 months when the sample depended on breastfeeding, the data depicted a similar pattern to that of the CDC charts. Differences appeared after 6 months; the deviation of the data below the median curve is likely due to issues related to study design and characteristics of the sample, mainly differences in type of feeding. Concerning the study design, CDC sample ˃ 36 month based on longitudinal data while the sample of the current study was cross sectional data which is similar to that of WHO standard (2006). In cross sectional data mothers of children did not receive assistance to ensure that the children received optimal nutrition.

Differences in feeding types are also likely to contribute to the divergent growth patterns in weight-for-age during early childhood. From the results it was clear that, the food group consumption per day of most children was less than dietary reference intakes.

Regarding length\height for weight, the important finding is that children above 9 months in the data were shorter than those in the CDC chart, children might fail to meet their potential for growth because of marginal intakes of energy, protein, and/or other nutrients.

The comparison of the weight-for-length and weight-for-height charts showed that the children included in data were generally thinner than those included in the CDC reference. This applied to all the older children, which may likely reflect greater skewness in the the data of children weights.

The BMI-for-age curves begin at 2 yeas of age on the CDC chart, which were dramatically different, reflecting underweight in the data sample.

Children included in this study born with weight similar to that of infants used in the creation of the CDC growth curves and remain depicted a similar pattern of growth during first 6 months, then a notable deviation below the median curve appeared coupled the introduction of complementary food. These findings indicate that, many children do not live in ideal environmental conditions and did not receive optimal nutrition. These results are supported by Abdalla and Sulieman, 2009 who reported that, Sudan is similar to many other developing countries, in that, most supplementary food offered to children are cereal-based stuffs which are naturally deficient in protein constituents. On the other hand Anderson et al, 1999 stated that, in Sudan as well as in developing countries children suffer from high risk of death due to poor infant feeding and malnutrition.

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From the results, the prevalence of underweight was 20.7%, this finding in line with WHO, (2013) which reported that , in 2011, an estimated 17%, or 99 million children under five years of age in developing countries were underweight (low weight-for-age according to the WHO child growth standards). Underweight is most common in the UN regions of South-central Asia (30%), followed by Western, Eastern, and Middle Africa (22%, 19% and 17%, respectively) and South-Eastern Asia (17%). The situation is better in other UN regions of Eastern and Western Asia, Northern Africa and Latin America and the Caribbean, where less than 10% of children were underweight. Regarding overweight it was found that, the prevalence of overweight was 18.9 %. This result is supported by WHO, (2013) which stated that, in 2011, more than 40 million children under the age of five were overweight. Once considered a high-income country problem, overweight and obesity are now on the rise in low- and middle-income countries, particularly in urban settings. More than 30 million overweight children are living in developing countries and 10 million in developed countries. In Northern Africa, an estimated one in six preschool-aged children is overweight or obese, the highest rate in the world, and triple that in 1990. There's quite a bit of variability from country to country, however: About 20 percent of Egypt's preschoolers were overweight or obese in 2008, compared with 5 percent in Sudan. (de Onis et al, 2010)

Conclusion:

Weight and length of infants included in the data depicted a similar pattern to that of CDC reference during the first six months. After six month, the distribution of Length, height, weight and BMI for age were shifted toward lower values compared to the CDC curves, more pronounced in weight for age. Weight for length of data depicted a similar pattern to that of the CDC curves, while there was a notable deviation of weight for height of data below the median curve of CDC reference. In general children included in the data above six month seemed to be shorter and of lesser weight than CDC reference.

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