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Eyong ME
Ikobah JM
Ntia H
Eyong EM

Growth parameters of children in Calabar, a south-south Nigerian city: Are the CDC growth charts useful in clinical practice in this area?

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Eyong ME (✉)
Ikobah JM, Ntia H
Department of Paediatrics,

Eyong EM
Department of Obstetrics and Gynaecology,
University of Calabar Teaching Hospital, Calabar, Cross River State, Nigeria.
Email: meyong2000@gmail.com

Abstract *Background:* In countries that do not have national growth charts, the WHO or CDC growth charts are often used for growth assessment. How reliable or appropriate are these charts in monitoring growth of children in these countries?
Methods: A cross sectional study of children, aged 6-18 years in Calabar, South-South Nigeria was randomly studied. Heights and weights were measured using a portable stadiometer with a weighing scale. Body mass index (BMI) was then calculated. The data obtained was analyzed and plotted in the CDC growth charts.
Results: The mean height for boys and girls was 0.79 and 0.86 SD scores respectively above the 50th percentile points on the CDC growth chart for ages 6-11 years for boys and 6-12 years for girls; but 0.75 and 0.37 SD scores respectively below the 50th percentile for ages 12-18 years for boys and 13 -18 years for girls. The mean weight for boys and girls was 0.67 and 0.63 SD scores respectively at or above the 50th percentile point on the CDC growth chart for ages 6-11 years (for boys) and 6-15 years (for girls) but 0.58 and 0.42 SD scores respectively below the 50th percentile for ages 12-18 years (for boys) and 16-17 years (for girls). The mean BMI values for boys and girls was 0.58 and 0.55 SD scores respectively above the 50th percentile points on the CDC growth chart for ages 6-10 (for boys) and for all the ages studied for girls but 0.30 SD scores below it for boys 11-18 years.
Conclusion: The growth parameters (height, weight and BMI) of children in Calabar, South-South Nigeria compares closely to that of the CDC growth charts. The CDC growth charts can be used in this area for the assessment of children for growth and development.

Key words: Height, Weight, BMI, Children, Adolescence, CDC growth chart.

Introduction

Growth is an important physiologic process occurring during childhood. [1] Its assessment is essential in monitoring the health of children and detecting abnormalities.[2-4] The assessment of growth helps to formulate treatment strategies designed to preserve or restore normal growth potential.[2] Appropriate growth standards for the community or country are required for medical practitioners to make clinical judgments on patients for whom growth and developmental problems are a concern.[1, 2] The growth chart is one of the most important tools for assessing growth.[5] The interpretation of growth in a population depends on the growth reference used. [6, 7] The heights, weights and Body Mass Index (BMI) are plotted against the ages of these children according to their sex.[2, 3] The World Health Organization (WHO) and the Centre for Disease Control (CDC) growth charts are commonly used for such assessment and evaluation.[5] Secular changes in weight and height in countries of the Western world have been documented over the last two centuries with an increasing adult height over the decades in most European countries.[8] Secular changes occur because of inequalities in wealth and health within populations over time.[5,8] It is therefore suggested that national reference data for growth should be collected at 10-20 years intervals to reflect this changing trend in growth.[8]

There is paucity of literature on growth parameters in the South South of Nigeria. The absence of national growth charts further necessitates the need to evaluate children's growth against the background of acceptable standards like the WHO and CDC growth charts. The WHO growth charts was developed from data obtained from six different countries of the world (Brazil, Ghana, India, Norway, Oman and the USA) with wildely different ethnic backgrounds and cultural settings.[5] It

describes the growth of children living in conditions believed to support optimal growth of children. It was a longitudinal survey with height and weight measured at frequent intervals. The WHO charts are multiple for different ages of: birth to 5 years, 5 to 10 years, and 10 to 18 years. In contrast, the CDC growth chart is a single chart each for height, weight and BMI for all ages of 2 to 20 years and therefore more convenient to use in the clinic in assessing a child for growth problems or as follow up over the years.

This study therefore aimed at documenting a cross sectional age and sex specific height, weight, and BMI parameters of children in Calabar, South-South Nigeria and to plot the means into the CDC growth charts to see where they fall on the CDC means.

Material and Methods

Study area

The study was conducted in Calabar, the capital city of Cross River State, south south geo-political zone, Nigeria. The residents are mostly from the tribes of Efik, Ibibio, the Quas, Ejagam, and Yakurr people. These tribes are the many of the minority tribes of Nigeria as distinct from the majority tribes in Nigeria - Northern Nigeria (Hausa), Western Nigeria (Yorubas) and Eastern Nigeria (Ibos). There are small number of the major tribes residing in Calabar.

Study design

The study was a cross sectional descriptive study

Study population

Children aged between 6 to 18 years without chronic diseases, growth abnormalities and use of long term medications like steroids were included in the study. Age was calculated based on their last birthday. Children of these age groups with chronic diseases, growth abnormalities and on long term medications were excluded from the study. Children who did not give assent to participate in the study as well as those whose parents refused to give consent were also excluded.

Sampling technique

Multistage sampling technique was used to recruit subjects for this study. A small proportion of study population are seen in Primary schools (6-9 years) while a larger proportion (10-18 years) are mostly seen in secondary schools in Calabar; therefore, the decision to use both Primary and Secondary schools in Calabar metropolis for this study. There are 15 public Secondary schools and 23 Primary schools in Calabar metropolis. In the first stage, Five Secondary Schools and two Primary schools, in Calabar metropolis were therefore randomly selected and used for the study. In the second stage, the population in each school was categorized into classes. The number of children to be recruited was proportionately allocated among the classes. The number of children to be recruited was again subdivided according to number of streams in each class such that all streams were involved. In the third stage, children were selected from each stream using a table of random numbers.

These public schools draw children from the lower social and economic class in the state. Children from the middle and upper class socioeconomic class mostly attend private Primary and Secondary schools (the private schools are more expensive).

The sample size where the population is above 10,000 for a cross sectional study was estimated from the following formula. [9]

$$n = \frac{Z^2pq}{d^2}$$

A total of 2830 subjects were recruited for the study.

Data analysis

Data was analyzed using EPI Info 2002 version. The data is presented in tables and figures with percentages, means and standard deviations for continuous variables and as proportions for categorical variables.

Ethical consideration

Ethical Clearance was obtained from the Ethics/ Research Committee of the University of Calabar Teaching Hospital, Calabar, Cross River State Ministry of Education, the school headmasters/principals and teachers of all the schools and a written consent was also obtained from the parents of the subjects.

Data Collection

Weights and heights were measured with a height-weight scale. Heights were measured with subjects without footwear and their heads in the Frankfurt plane using a portable stadiometer. Measurements were taken three times and the mean was used. Heights and weights were corrected to the nearest centimetre 0.5 and 0.5 kilogramme. Body Mass Index (BMI) was calculated from the height and weight data using the formula: BMI= weight in kg/height in mitre^2 The bio-data, presence of chronic illnesses, long term medications use were obtained through a questionnaire.

Results

The number of children studied according to age and sex is shown in Table 1. A total of 2830 children were seen, out of which 54.5% were males and 45.5% were females.

Table 1: Study population according to age and sex

Age(years)	Male (%)	Female (%)	Total (%)
6	92	88	180
7	55	40	95
8	53	56	109
9	82	76	158
10	188	196	384
11	256	264	520
12	194	200	394
13	194	134	328
14	144	100	244
15	130	76	206
16	76	40	116
17	46	16	62
18	32	2	34
Total	1542(54.4)	1288(45.5)	2830(100)

The mean weights, heights and BMI of the boys are shown in table 2. The means for height relative to the CDC growth chart for boys is represented graphically in figure 1. The mean height was above the 50th percentile at ages 6 to 11 years. From 12 years to 14 years, the mean fell below the 50th percentiles and even further to below the 25th percentile from 15 to 17 years. The means at 18 years fell further below the 10th percentile. On the average the mean heights was 0.79 SD scores above the 50th percentile for ages 6- 11 years while it is 0.75 SD scores below the 50th percentile for ages 12-18 years. The result of weight in boys relative to the CDC charts (figure 1) is similar to that of mean heights. The mean weights were above the 50th percentile at 6 to 11 years. The mean weights then fell below the 50th percentile from 12 to 18 years. On the average, the mean weights were 0.67 SD scores above the 50th percentile for ages 6-11 years and 0.58 SD scores below it for ages 12-18 years.

Table 2: Mean weights, heights and BMI of boys according to their ages

Age (years)	Sample size	Mean weight(kg)	Mean height(cm)	Mean BMI
6	92	21.9	117.6	15.7
7	55	26.8	126.8	16.6
8	53	28.9	131.9	16.6
9	82	31.0	136.5	16.6
10	188	34.2	140.1	17.5
11	256	36.0	144.5	17.1
12	194	38.9	148.1	17.6
13	194	42.6	153.3	17.9
14	144	45.5	157.8	18.2
15	130	50.7	160.8	19.7
16	76	57.1	167.6	20.3
17	46	57.2	168.3	20.1
18	32	58.2	165.6	21.2

The mean heights, weights and BMI of the girls are shown in Table 3.

A similar pattern of height curve was seen in girls (figure 2) where the mean heights was consistently above the 50th percentile from ages 6-12 years but was below the 50th from 13 years to 18 years. On the average, the mean heights of the girls was 0.86 SD scores above the 50th percentile for the ages 6-12 years and 0.37 SD scores below the 50th percentile from 13-18 years. In girls, the mean weight was consistently above the 50th percentile from 6 up to 14 years. At 15 years the mean weight was at 50th percentile and then fell below it at 16 and 17 years. The mean weight at 18 years was above the 50th percentile. On the average the mean weight was 0.63 SD scores above the 50th percentile for ages 6-15 years and 0.42 SD scores below it for ages 16 and 17 years.

Fig 1: Relationship between age and mean heights/weights of boys on the CDC growth charts

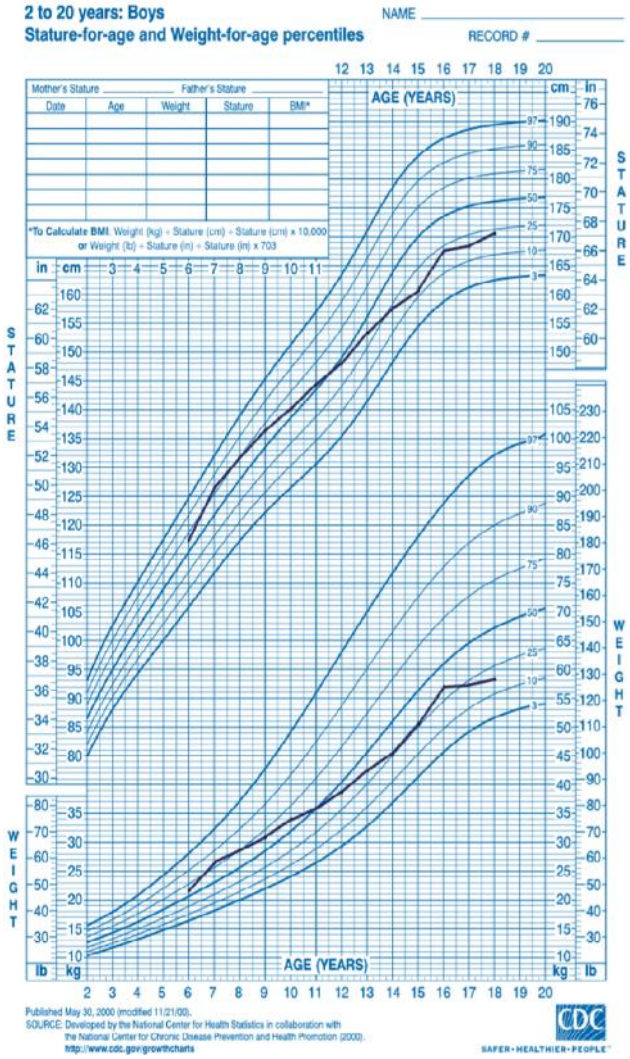


Table 3: Mean weights, heights and BMIs of girls according to ages

Ages (years)	Sample size	Mean weight(kg)	Mean height(kg)	BMI
6	88	20.9	116.0	15.5
7	40	26.1	128.2	15.8
8	56	27.6	129.8	16.2
9	76	34.9	138.1	18.0
10	196	34.8	143.1	16.9
11	264	39.4	146.8	18.0
12	200	43.2	152.5	18.6
13	134	45.7	154.2	19.0
14	100	50.9	156.8	20.6
15	76	52.0	159.2	20.2
16	40	51.6	156.2	21.2
17	16	51.6	155.1	21.4
18	2	61.5	161.5	23.5

Fig 2: Relationship between ages and mean heights/weights of girls compared with the CDC charts.

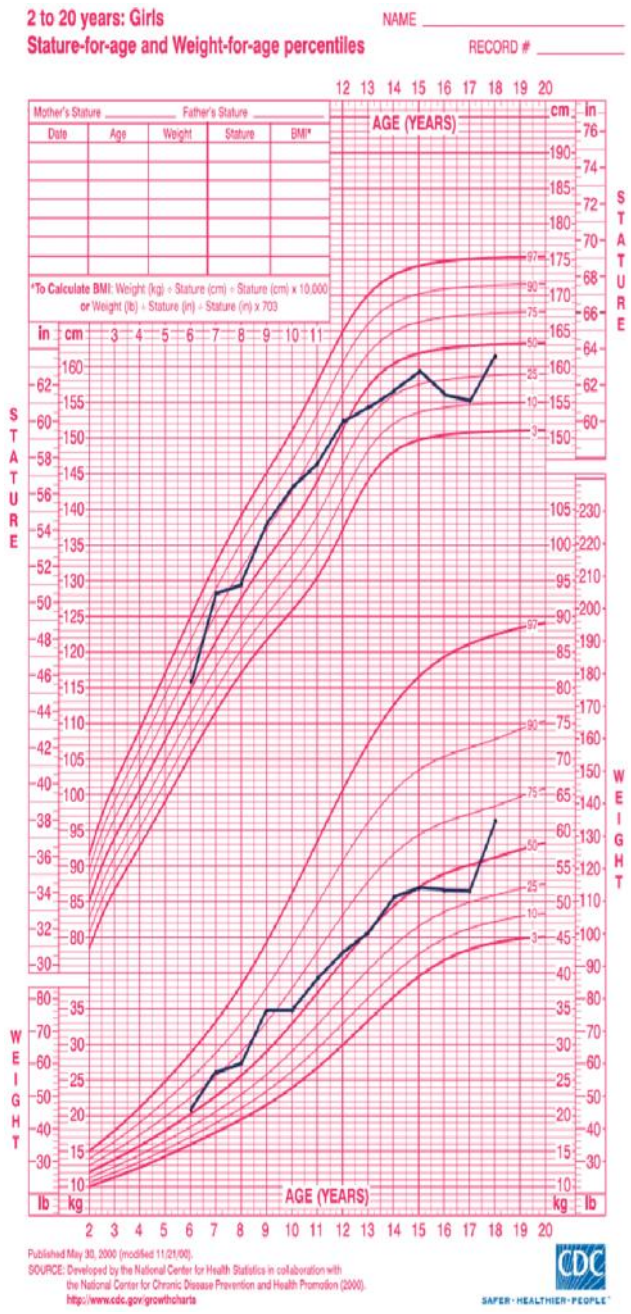
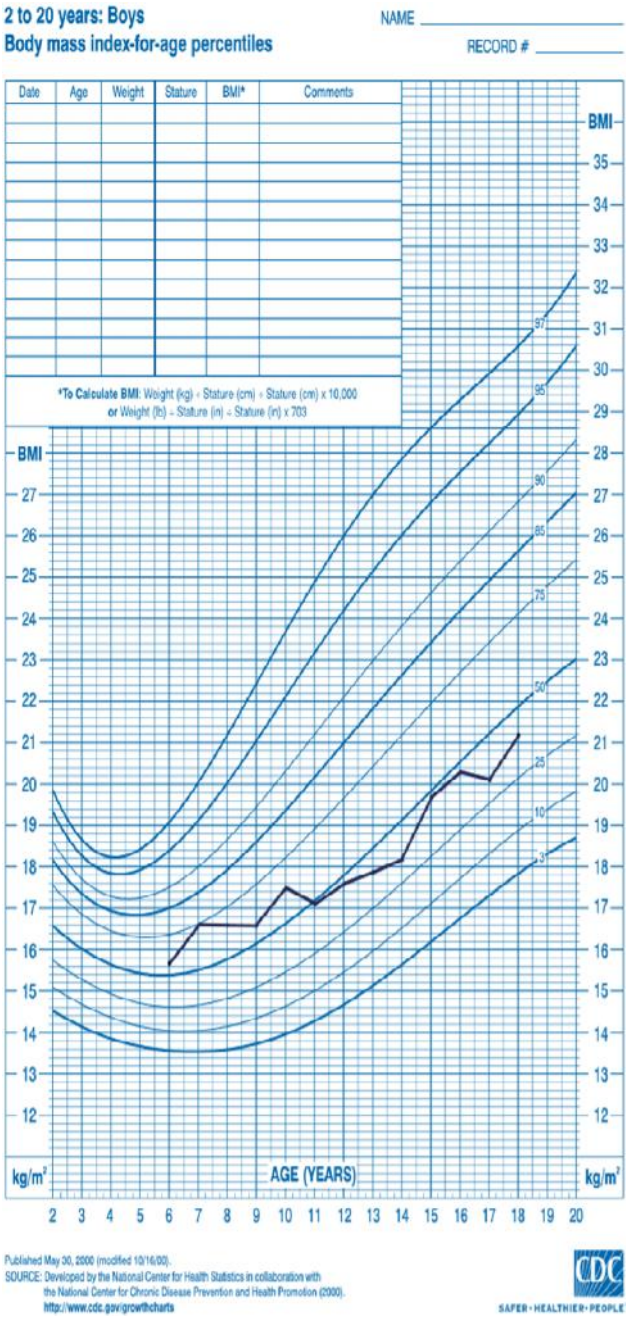
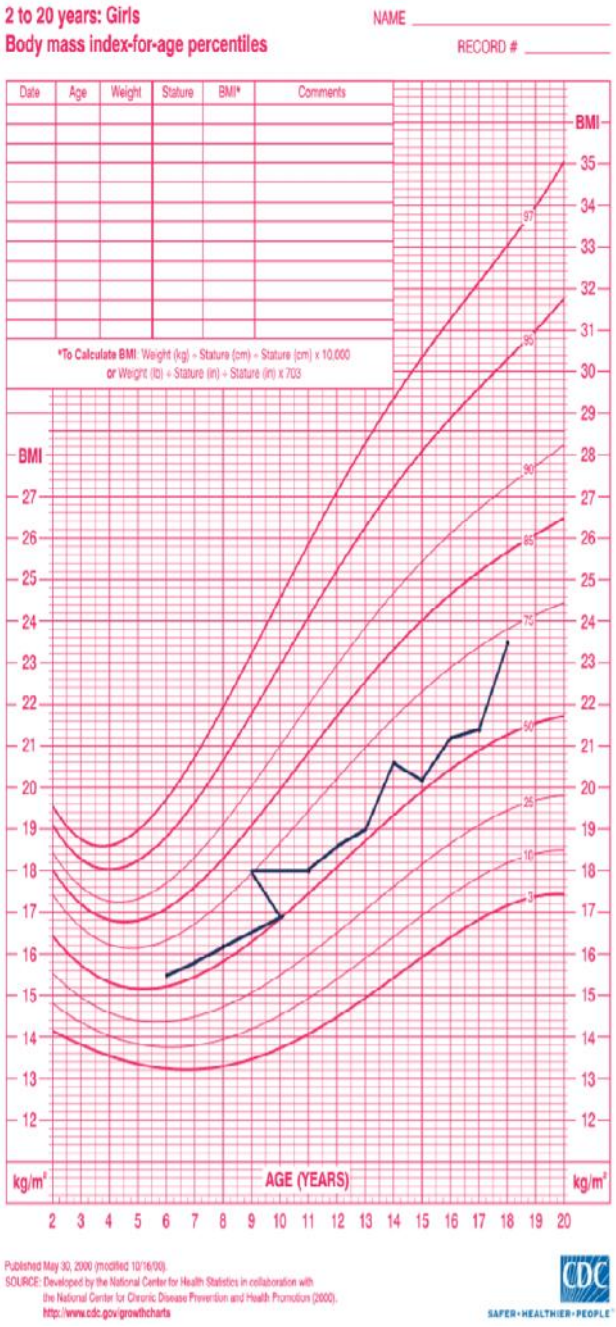


Fig 3: The mean BMI of the boys in relation to the ages on the CDC growth chart.



The result of BMI curves relative to the CDC growth chart for boys and girls (Figure 3 and 4) were similar to that obtained for weights alone. The mean values for boys were above the 50th percentile from 6-10 years and then fell below it from 11-18 years. On the average, the mean BMI was 0.58 SD scores above the 50th percentile from 6-10 years and 0.30 SD scores below it from 11-18 years. For girls, the result was different as the mean BMI curve was consistently above the 50th percentile throughout all ages. Overall, the mean BMI values were 0.55 SD scores above the 50th percentile.

Fig 4: Relationship between the mean BMI in girls to age in the CDC growth chart.



Discussion

In this study, the mean height for both the boys and girls plotted into the CDC growth charts was slightly above the 50th percentile curve until 11 to 12 years of age when it fell to between 50th and the 25th percentile. In this study, the mean heights compared well with the CDC growth charts until pubertal age when growth slowed down to below the average heights of their counterparts in America. Some previous reports from Nigeria concerning growth tend to show mean heights and weights of the children lower than the mean of their European counterparts and below the NCHS/WHO/ CDC 50th percentile curves. [10-12] The reason for this difference compared to other Nigerian studies is not so clear. The differences in design/analysis of the results may be contributory as Elusiyan *et al*[11] used children from the three major ethnic tribes of Nigeria (Hausa, Ibo and Yoruba) in an attempt to reflect a national reference standard for Nigeria. In this study, the minority ethnic tribes of Cross River State were used. It is an established fact that growth potential differ across populations and ethnic groups reflecting differences in genetic potential and environmental influences.[8, 13] It is possible that the children in this study in addition to an improved nutrition as a result of an improved economic growth witnessed over the past two decades, [14, 15] may have genetic factors that may contribute to their improved heights in this part of Nigeria. It could also be that there is a secular trend of increasing height in children in this region.

This finding is also in agreement with findings of Nto *et al*[16] in the neighboring state of Ebonyi, South eastern Nigeria. He observed median heights of urban and rural boys and girls to be above the CDC reference standard until 15 to 18 years (urban) and 13 to 18 years (rural), when the heights deviated below the reference values. The slower tempo of growth from 11 to 12 years observed in this study may be that the tempo of pubertal growth spurt for these Nigerian children is less intense and probably related to genetic factors rather than only nutritional or environmental factors. This observation was similar to that in the previous Nigerian studies.[11,12,17] The timing and tempo of puberty are said to be largely under genetic control [8,13] and may explain the difference with the United States children on the CDC charts. These may actually be the reason for the heights deviating below the reference standards of the CDC from ages 11 years in this study.

Similarly, the weights of these children compared well with the CDC growth charts being slightly above the 50th percentile until 11 to 12 years when they deviated below it. Nto *et al* [16] also reported a similar pattern with the median weights of urban males and females being higher than the CDC reference points. There is a reported secular trend of increasing weight and obesity even in developing countries. [18, 19] Whether this higher weight than the CDC reference is related to this trend of increasing weights in urban cities cannot be ruled out. However, this observation is in contrast to the observed lower weights below the reference values on the CDC growth charts reported by Elusiyan *et al*, [11] Fetuga *et al*, [12] Ayoola *et al*, [17] for all the age groups of children in their studies.

The reason for the observed deviation of weights below the 50th percentile after 11-12 years of age in this study is also not clear but may probably be related to genetic and to some extent, cultural and physical activity of the children. Weight, fat mass, and fat distribution are also said to be influenced to a larger extent by environmental factors, with genetic factors also having a significant effect. [13] In this part of Nigeria, children at these ages are given more responsibilities that involve more physical activity, at home and at school (for example running of errands such as fetching of water from public taps,

going to market, household chores, cutting of grass, playing football and increase play with peers). Also, many children at these ages have to walk few kilometers to and from school on daily basis. This may partly explain the drop in weights seen after 12 years of age in this study.

The mean BMI of the children in the study as with the weights showed they are not particularly obese or thin. The boys tend to be heavier in childhood with both mean weight and BMI slightly above the 50th percentile. A drop below the 50th percentile occurred at 11 to 12 years and from there onwards the boys became leaner. The girls on the other hand were heavier throughout all the ages. The reason for this difference between boys and girls is not so clear. However the observed higher BMI compared to the CDC reference is similar to that reported by Nto *et al* [16] but in contrast to that of other authors.[11,12] The secular trend of increasing weights and urbanization with changing lifestyles, diet and physical activity may partly explain these observations.

Conclusion

The growth parameters (height, weight and BMI) of South South Nigerian children compares closely to values in the CDC growth chart (USA) until early adolescence where the values drop slightly below the CDC values. Until National growth standards for Nigeria is developed, the CDC growth charts can be used for screening, surveillance and monitoring of childhood growth and development in this region.

Recommendation

There are conflicting data concerning growth parameters from different regions of Nigeria and the authors therefore recommend the development of a nationally representative growth reference for Nigeria.

Author's Contributions
Eyong M conceived and designed the study and also wrote up the manuscript Ikobah J, Ntia H, Eyong E participated in data collection and had an overview of the manuscript. All authors reviewed and approved the final manuscript.

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