

## Growth centile charts (anthropometric measurement) of Pakistani pediatric population

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### Abstract

**Objective:** To measure Anthropometric data (Height and Weight) of Pakistani school children (of different socio-economic and cultural background) 3-16 year, to develop growth centile charts, based on the above measurement and to document obesity and stunting in Pakistani Paediatric population, based on the above measurement.

**Methods:** A Cross-sectional study with multistage stratified sampling was done in a Nationwide project of Higher Education Commission (HEC, Ref no: 20-441/R&D/2008) to develop growth centile charts of Pakistani paediatric population. Study was conducted from 2006-2009. Children studying in private and government schools of the four provinces of Pakistan were included. Prior to starting the study permission from the principal of the respective school and parents was taken.

A total of 12837 children with normal birth weight, complete immunization, no history of chronic infection from 36-192 months (3-16 year) were included. Heights (cms), weight (kg), for Body Mass Index (BMI) (kg/m<sup>2</sup>), 24 hour diet recall was obtained. All socioeconomic groups were included. Food records of the children were subjected to USDA food exchange list.

**Results:** The average height (cms) of children was 139.11±18.44, average weight (kg) was 33.21±11.25 and average BMI was 16.76±3.22 kg/m<sup>2</sup> (range from 11.3-41.98).

The 95th centile according to CDC charts for the age groups 3-16 years were calculated. A total of 664 (5.1%) children were found to be obese. In the age group 3-5 years, >5-10 year and >10-16 year; 29 (8.1%), 272 (5.1%) and 363 (5.1%) were found to be obese, respectively.

CDC height and weight in the three groups of Pakistani children >3-5 year, >5-10 year, >10-16 year were at the 10-25 centile.

**Conclusion:** Overall, the prevalence of stunting was 14%. Height and weight was 10-25 centile of the CDC charts. Obesity was 5%. Pakistani centile charts of healthy children from Pakistan have been made.

**Keywords:** School children, Height and weight centile, BMI, Stunting, Obesity Pakistan (JPMA 62: 367; 2012).

## Introduction

Height and weight of healthy children varies in different parts of the world, due to a varied ethnicity and cultural background of families. Centile charts have been developed to represent the height and weight in a standard format. These centile charts represent the average population of children from certain areas along with standard deviations. CDC (centre for disease control), NCHS (national centre for health statistics) charts and the European charts are such examples of centile charts used world over.<sup>1</sup>

There is data available on the height and weight of children from selected areas of the world. Data from Asia has also been published on the height and weight, Body Mass Index (BMI), stunting and obesity in children.<sup>2</sup> WHO charts are also used for children according to the IMNCI (integrated management of neonatal childhood illness WHO-EMRO Child and adolescent health New growth charts developed for IMCI guidelines based on new guidelines;<sup>3</sup> these are only for children up to 5 years of age. Saudi Arabia, Iran, Turkey have designed their own growth charts and have compared their data with CDC reference values.<sup>4-6</sup> However, published data on the growth of children from Pakistan is scarce.<sup>7</sup> Thus this study was planned to document the height and weight of healthy school going children in the four provinces of Pakistan, to document obesity if any in these children and to determine the prevalence of stunting in the population studied. We have also compiled the centile charts for the Pakistani population and compared them with the CDC charts.

## Methods

Nationwide project of Higher Education Commission (HEC, Ref no: 20-441/R&D/2008) to develop growth centile charts. A cross sectional descriptive survey was done with multistage stratified sampling from 2006 to 2009. Children studying in private and government schools different randomly selected cities both urban and rural of the four provinces of Pakistan were included.

A structured questionnaire was constructed in English and translated into the local languages, was pilot tested (previous publications). The principal and co-investigators trained non-medical personnel to collect the data. However, a constant supervision was done by the primary investigators during collection of the data. Information collected included anthropometric measurements (height in cms, weight in kg), duration of breast feeding history from the mother, immunization status, education level of the parents, socio-economic

status, materials of the dwelling structure (pukka or kacha house) history of infection, feeding habits, and school being attended. Children from all socioeconomic class were included in this study, provided they were not admitted in a hospital with a chronic illness and their immunization was complete, according to the EPI (expanded programme of immunization) programme of Pakistan. Data on the nutritional status (quality and quantity of carbohydrates, proteins and fats) will be described in a separate paper.

Age of the School going children was calculated from date of birth. Age was confirmed from the school register as entered by parents based on the birth certificate of each individual child. At the start of the project, initial sample size calculated was 36,000 (18000 girls and 18000 boys). However, due to lack of funds and the law and order situation in certain areas of the country a sample size of 36000 could not be achieved. Despite all efforts on part of the primary investigators, about 1500 data sheets had to be excluded due to incomplete and improper data collection. A sample size of 12901 was collected of which 64 children less than 2 years were excluded for the centile graphs (age 2-16 years), hence, final sample size was only 12837. For the centile charts children 2 to 16 years were included. However, for stunting and obesity only children 3 yrs and plus were included.

Standard scales were used to measure the height and weight of healthy school children. Height was measured in the erect position, back and hips touching the wall without shoes to the nearest 0.1 cm using wall mounted portable stadiometers. Body was measured in light clothing to the nearest 0.1kg using a standard weighing scale. BMI was calculated using the body weight in Kg divided by the height in m<sup>2</sup>. For BMI center for disease control and prevention (CDC), clinical charts with 5th and 95th percentile for standard height and weight were used as described previously.<sup>1</sup> The means of the physical growth variables of the present study were compared with the CDC reference values for height, weight and BMI for boys and girls ages 2-16 years.

For the measurement of overweight and obese children, the CDC defines normal weight for height as a BMI greater than the 5th percentile but less than the 85th percentile. A BMI between the 85- 95th percentile is called at risk for overweight and a BMI greater than 95th percentile is usually specific for increased body fat and is called obese. Obesity is referred to a child being overweight and accompanied with adverse physical or psychological issues.<sup>8,9</sup> The definitions used in this final paper with sample size 12837 are the same as that used in the previous pilot study done of this major project.<sup>10</sup>

Stunting was defined as having a height (or length)-for -age more than 2 SD below the median of the NCHS/WHO international reference. Computation: the indicator can be calculated as a simple percentage, as follows:  $100 \times (\text{Cstunt}/\text{Ctot})$ , where Cstunt is the number of children aged 0-4 years who are stunted (i.e more than two SD below the reference height-for-age or length-for-age reference); Ctot is the total number of children aged 0-4 years surveyed.<sup>1,11</sup>

For the data related to height, body weight and BMI, we initially used descriptive statistics (mean and standard deviation) for each sex and age. The two way analysis of variance was used to check the difference between sexes and age. Student t test was used for one sample to compare the mean values of each growth variable with the CDC reference values. For all analysis the significance level was set at 5%.

Breast feeding, socio-economic status of the children was also looked at in this cohort of the population. Data excluded, were outlier values, because the measurement values and sampling weights were extreme. Statistical curve smoothing procedure was done for the graphs.

### Statistical Analysis:

Statistical package for social science SPSS-17.0 was used for statistical data entry and analysis. Continuous data like children's age, height, weight and BMI were presented

as age in years, weight in kilograms and height in centimeters. Z-scores were calculated and presented in terms of Mean  $\pm$  SD. The stunting cutoff was set if  $Z > -1.96$  and normal weight if  $Z < -1.96$ . Growth charts were also established in epi-info software.

### Results

Among 12901 children, 8207 (63.6%) were males and 4694 (36.4%) were females with male to female ratio (M: F = 1.75: 1). Mean age of children was  $10.93 \pm 2.87$  (ranging from <1 year to 16 years). The average BMI was  $16.76 \pm 3.22$  (ranging from 11.3-41.98).

Initially a total of 12901 data of the children was collected. Of these 64 children were less than 2 years, these were excluded in the centile graphs. Out of the final total 12837 children studied, 8152 (63%) were males, while 4685(36.4%) were females. Age group of the children was 2 to 16 years of age.

Majority of the families belonged to middle or low socioeconomic status. More than 80% of the mothers had breast fed their children for minimum of 6 months. In about 30% breast feeding was continued till 2 years along with added nutrition. Weaning was started in the majority between 4 to 6 months of age.

Mean  $\pm$  SD of the height, weight and BMI of the children is shown in Table 1-2. The difference between mean Z score for height, weight and BMI were

**Table-1: Prevalence of stunted children 3-16 years of under height, weight and BMI according to their age groups.**

Measurement	Age groups (years)					
	>3-5		>5-10		>10-16	
	Male (n=117/178)	Female (n=78/182)	Male (n=1770/3065)	Female (n=1074/2239)	Male (n=2624/4909)	Female (n=1290/2264)
Height to age	27 (15.2)	21 (11.5)	459 (15.0)**	260 (11.6)	735 (15.0)	325 (14.4)
Weight to age	49 (27.5)**	24 (13.2)	621 (20.3)**	340 (15.2)	890 (18.1)	416 (18.4)
BMI to age	41 (23.0)	33 (18.1)	690 (22.5)	474 (21.2)	999 (20.4)	549 (24.2)**

Key: Values given in parentheses are percentages.

\*\*Shows significantly higher average at  $p < 0.05$  level of significance.

Legend: Stunted children in age group > 3-5 years were male: 117/178, female 78/182; in >5-10 yrs were 1770/3065 male, 1074/2239 female and >10-16 years were male 2624/4909 female 1290/2264. Overall stunting based on height for age was 14%.

in term of Mean  $\pm$  SD. Categorical data like gender, obesity and underweight were presented in terms of frequency and percentage.

Inferential analysis was done by employing two-way analysis of variance ANOVA by taking factor ages, group comparison gender and test variables weight, height and BMI.

Epi-info version 6.0 was used for analysis stunting data of children's weight and height according to the nutritional standards of CDC 2000. Variables were matched

statistically significant ( $p < 0.0001$ ), compared with the CDC charts.

The centile charts of the Pakistani boys and girls between the ages 2 to 16 years are shown in Figure-1-4. Comparisons of the Pakistani children mean height, weight and BMI with CDC charts is shown in Figure 5-7. Pakistani children had lower values than CDC reference values.

Prevalence of childhood stunting was greater in children less than 5 years compared to age group of

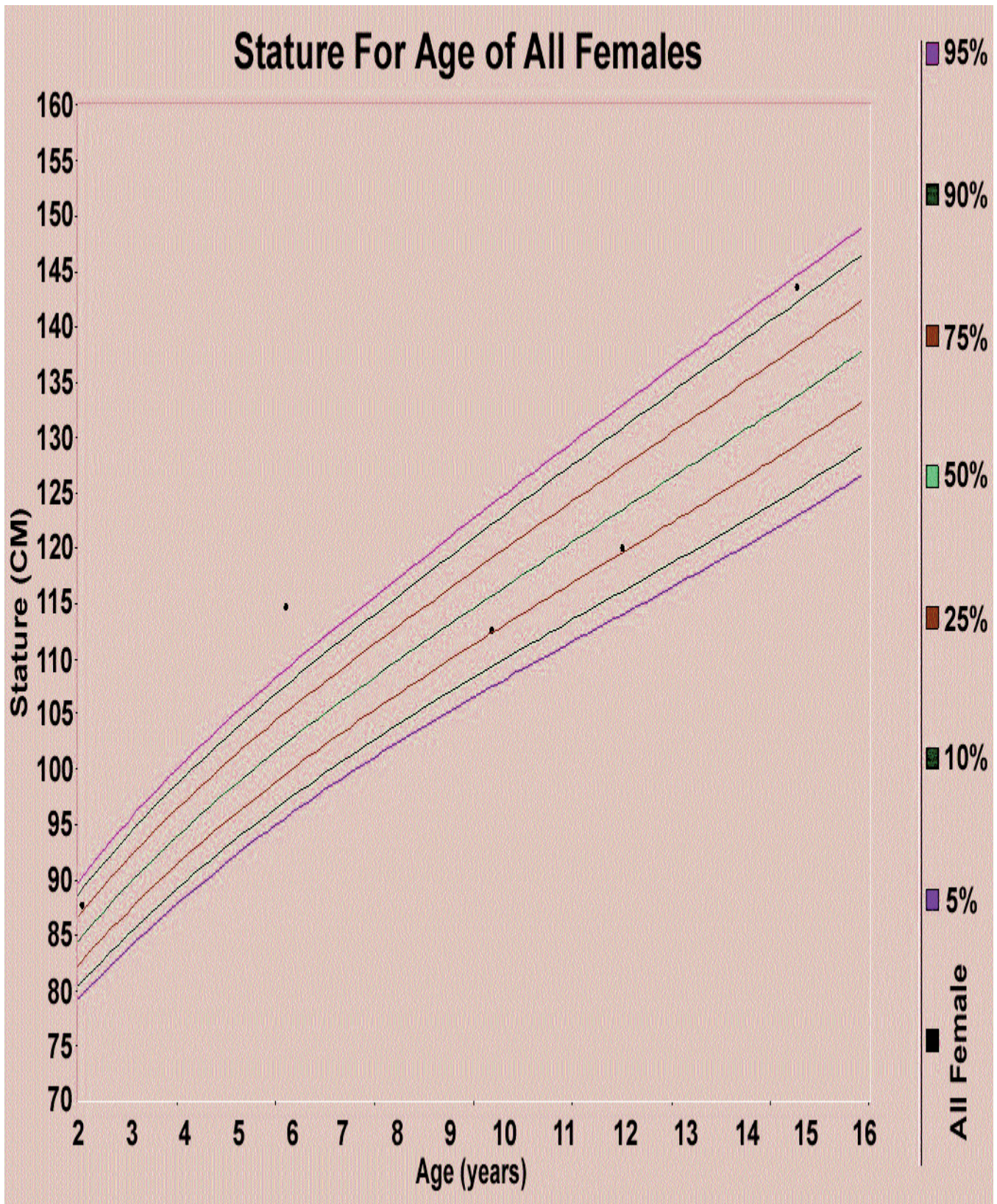


Figure-1: Centile chart, height for age of Pakistani girls, 2 to 16 years of age.

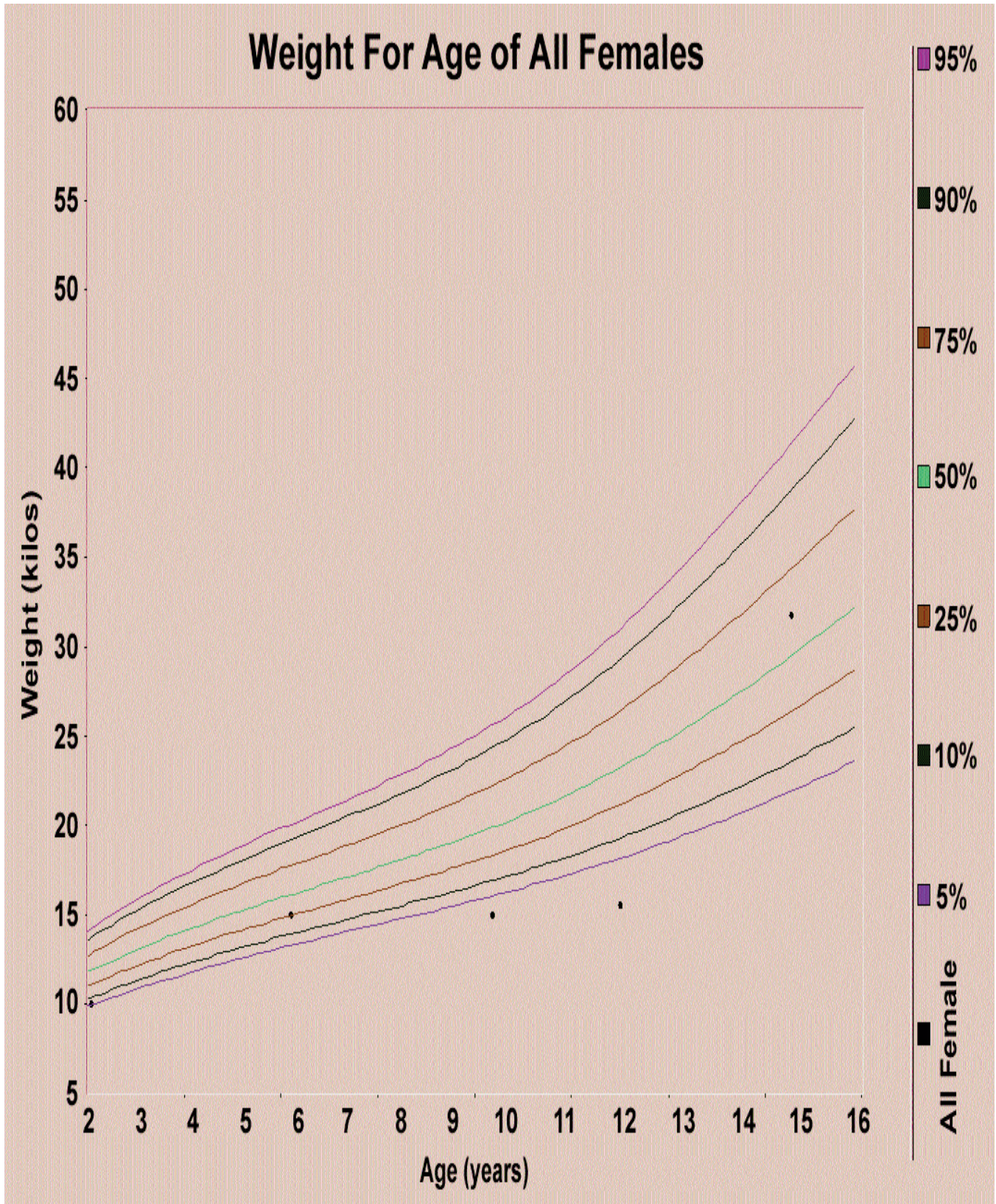


Figure-2: Centile chart, weight for age of Pakistani girls, 2 to 16 years of age.

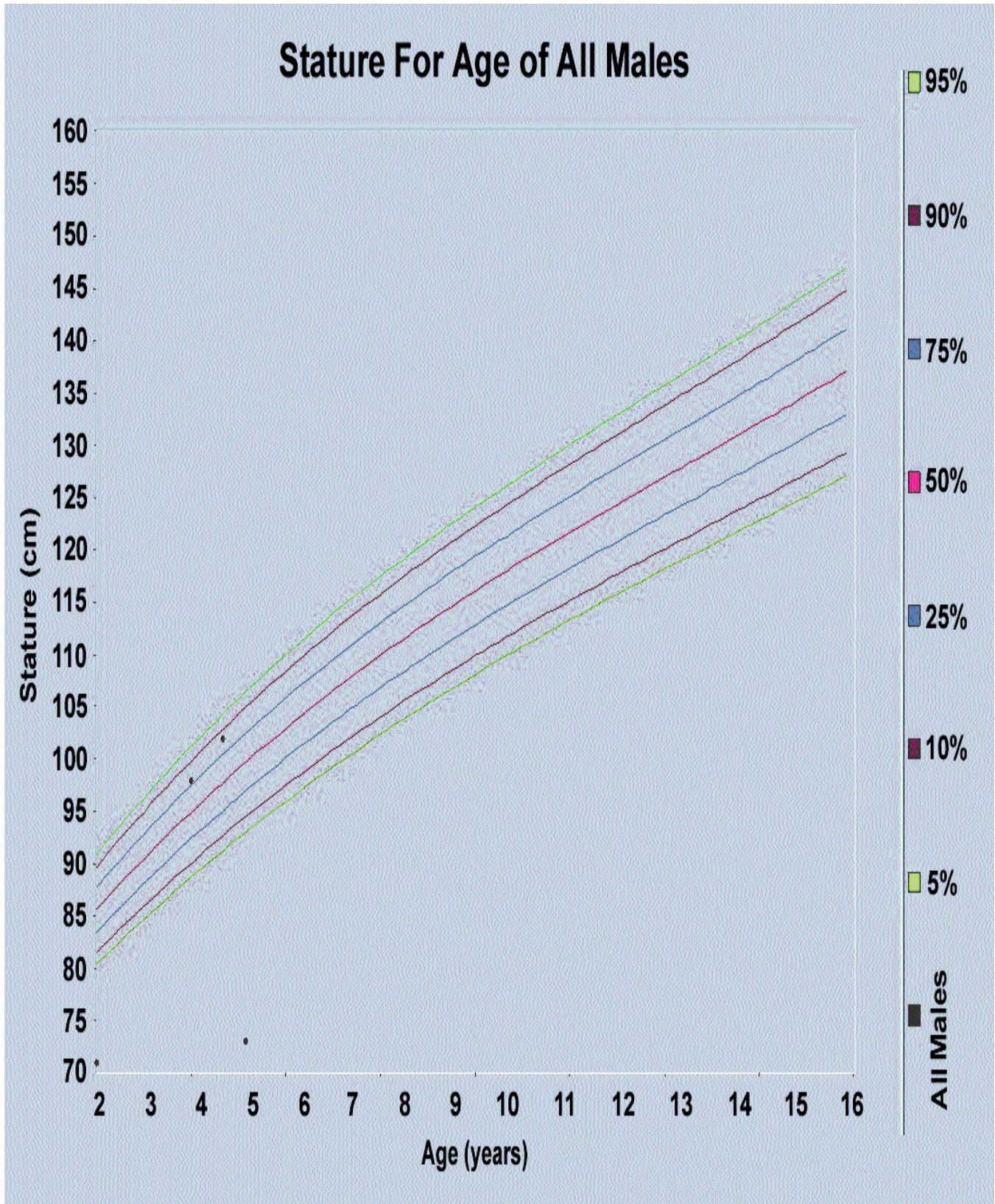


Figure-3: Centile chart, height for age of Pakistani boys, 2 to 16 years of age.

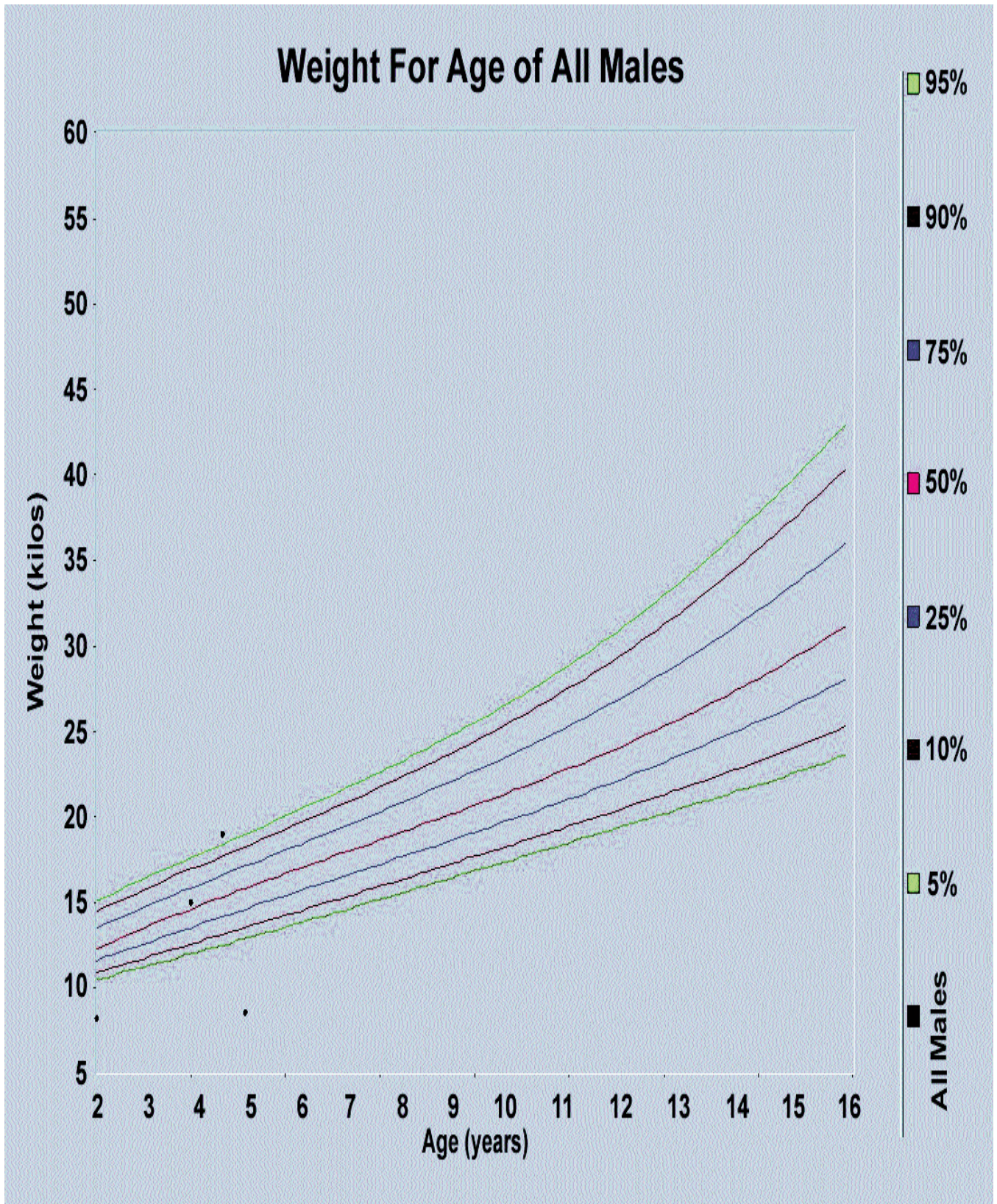
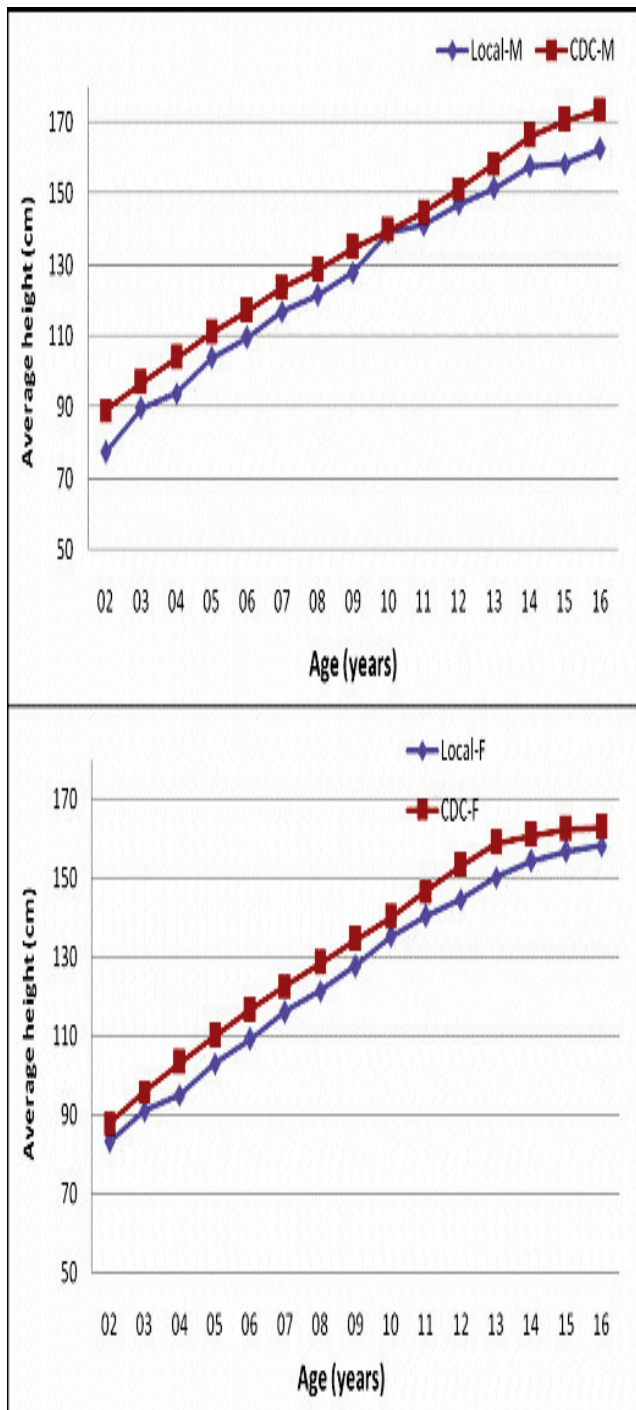
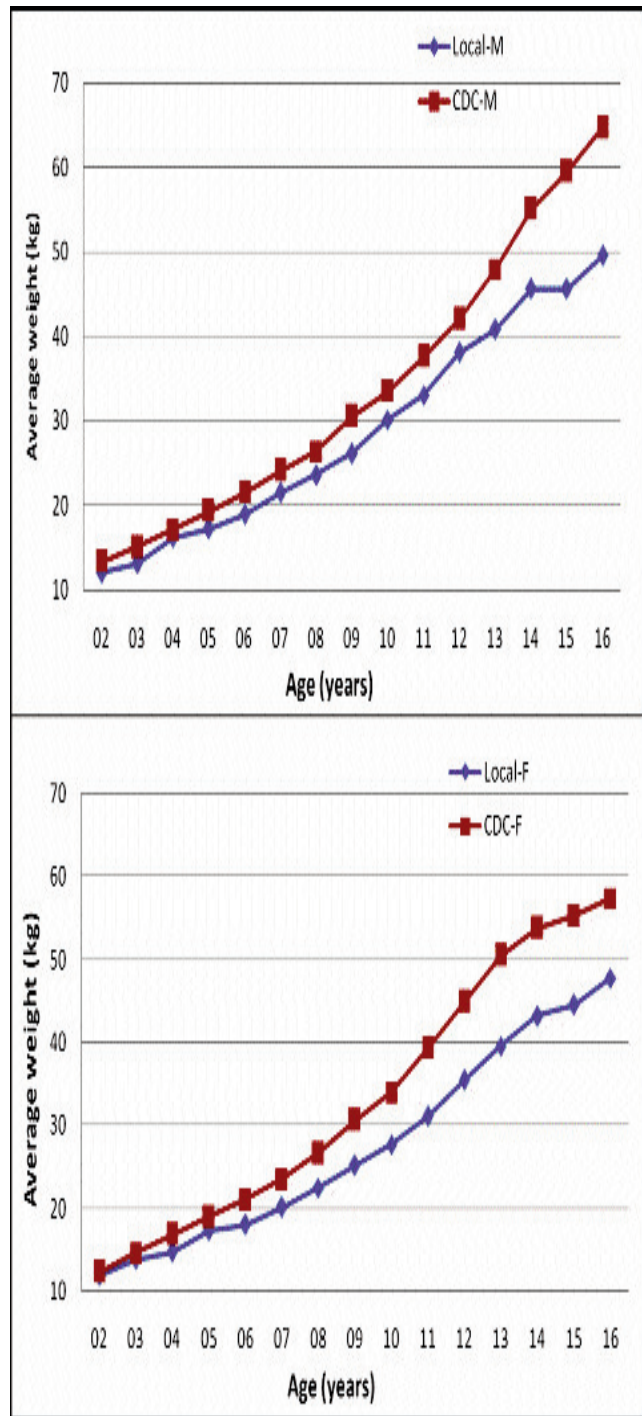


Figure-4: Centile chart, weight for age of Pakistani boys, 2 to 16 years of age.



Local-M: Line presenting the average height of males of local data  
 CDC-M: Line presenting the average height of males of CDC standard measurement  
 Local-F: Line presenting the average height of females of local data  
 CDC-F: Line presenting the average height of females of CDC standard measurement.

Figure-5: Comparison between average height of Pakistani male children versus CDC normal range according to age.



Local-M: Line presenting the average weight of males of local data  
 CDC-M: Line presenting the average weight of males of CDC standard measurement  
 Local-F: Line presenting the average weight of females of local data  
 CDC-F: Line presenting the average weight of females of CDC standard measurement.

Figure-6: Comparison between average weight of Pakistani male children versus CDC normal range according to age.

greater than 5 years. Stunting was seen more in boys as compared to girls  $p < .005$  (Table-3). Overall prevalence of stunting (height to age) was 14% in the Pakistani paediatric population.

The prevalence of overweight and obesity in this study was calculated according to the

WHO/CDC standards based on the 85th and 95th centiles. The 95th centile for the age groups 3-16 years were calculated and total 664 (5.1%) children were found obese. In the age group 3-5 years, 29 (8.1%) were obese, 272 (5.1%) obese children in the age group 5-10 years and 363 (5.1%) in the age

**Table-2: Anthropometric data according to age.**

Age (years)	Male N	Female N	Anthropometric data of Males			Anthropometric data of Females		
			Height	Weight	BMI	Height	Weight	BMI
0	30	-	48.4±7.1	5.20±1.2	23.0±8.4	--	---	--
1	14	2	49.2±7.3	6.1±1.6	25.7±7.0	46.5±0.7	5.0±0.71	23.2±4.0
2	10	6	77.5±9.3	12.0±1.2	21.2±6.9	83.2±8.0	11.9±0.8	17.7±3.9
3	17	6	89.8±5.2	13.1±1.2	16.5±3.2	91.0±1.1	13.8±0.75	16.7±1.1
4	30	37	94.1±14.6	16.2±1.6**	19.8±7.3*	94.9±9.1	14.8±1.5	16.9±4.2
5	131	139	104.0±7.0	17.3±2.2	16.1±2.6	102.9±7.1	17.4±1.9	16.6±2.7
6	252	239	109.8±5.2	18.8±2.9**	15.9±3.1*	109.2±5.6	18.1±2.6	15.3±2.8
7	389	292	116.9±5.6	21.8±3.2**	15.9±3.8**	116.4±5.7	20.1±3.2	15.0±2.8
8	629	412	121.9±6.4	23.6±3.7**	16.0±2.6**	121.5±6.1	22.5±3.4	15.3±2.5
9	541	475	128.0±5.5	26.2±4.0**	16.0±2.4**	127.7±5.1	25.2±4.3	15.5±2.4
10	1255	822	139.1±9.2**	30.0±5.4**	15.6±2.4**	135.0±7.8	27.7±5.1	15.1±2.3
11	943	495	141.1±8.2	33.0±6.0**	16.6±2.6**	140.5±7.2	31.1±6.0	15.7±2.5
12	1240	592	147.2±9.8**	38.1±8.8**	17.5±3.3**	144.6±7.3	35.5±7.3	16.9±3.0
13	805	434	151.9±9.6**	40.9±8.4**	17.7±3.4	150.2±7.5	39.67±7.1	17.5±3.0
14	944	210	157.8±9.5**	45.6±8.7**	18.3±3.5	154.5±7.0	43.2±7.0	18.2±2.9
15	505	211	158.5±11.6*	45.7±8.4	18.3±3.7	156.7±8.5	44.6±7.0	18.2±2.9
16	472	222	162.7±11.3**	49.5±8.3**	18.8±3.6	158.1±9.0	47.8±5.7	19.3±3.1

\*\*Shows significantly higher average at  $p < 0.01$  level of significance. Height is in cms. Weight is in kg.

\*Shows significantly higher average at  $p < 0.05$  level of significance.

**Table-3: Z score in school children 3-16 years of age for height, weight and their BMI.**

Measurement (Z-score)	Age groups (years)					
	>3-5		>5-10		>10-16	
	Male (n=178)	Female (n=182)	Male (n=3065)	Female (n=2239)	Male (n=4909)	Female (n=2264)
Height to age	-0.89±1.69	-0.61±1.15	-0.82±1.33**	-0.46±1.38	-0.77±1.38	-0.73±1.35
Weight to age	-1.11±1.31**	-0.71±1.29	-1.01±1.20**	-0.66±1.28	-0.85±1.21	-0.87±1.34
BMI to age	-0.93±1.48*	-0.60±1.65	-0.88±1.54**	-0.69±1.65	-0.71±1.58	-0.78±1.70

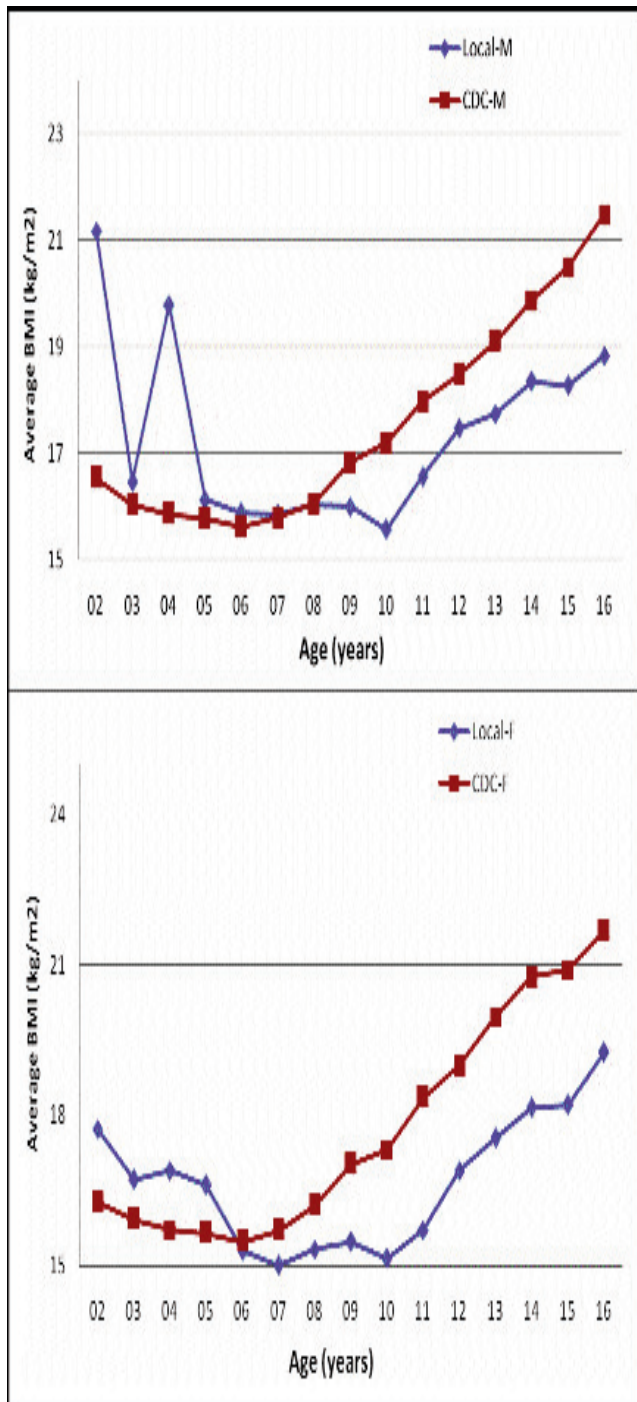
Key: Results (Z-scores) are presented in terms of Mean ± SD.

\*\*Shows significantly higher average at  $p < 0.01$  level of significance.

\*Shows significantly higher average at  $p < 0.05$  level of significance.

**Table-4: BMI of 12837 children 3 to 16 years based on CDC (centre for disease control) charts, showing the normal and the BMI above the 95 percentile.**

	Child age group			
	> 3-5	>5-10	>10-16	Total
BMI_P95 Normal	331	5032	6810	12173
	91.9%	94.9%	94.9%	94.8%
Above percentile	29	272	363	664
	8.1%	5.1%	5.1%	5.2%
Total	360	5304	71173	12837
	100.0%	100.0%	100.0%	100.0%



**Local-M:** Line presenting the average BMI of males of local data  
**CDC-M:** Line presenting the average BMI of males of CDC standard measurement  
**Local-F:** Line presenting the average BMI of females of local data  
**CDC-F:** Line presenting the average BMI of females of CDC standard measurement.

Figure-7: Comparison between Average BMI of Pakistani male children versus CDC normal range according to age.

group 10-16 years (Table-4).

## Discussion

This study is the first of its kind from Pakistan involving a sample of school children from all the four provinces of the country. The objective of the study was to develop centiles for Pakistani school children, document obesity and stunting and to compare the growth of Pakistani school children with international reference.<sup>1</sup>

In this study, the difference between mean Z score for height, weight and BMI were statistically significant compared with the CDC charts, similar to data published previously.<sup>12</sup> However, individual anthropometric measurements of Pakistani children were less compared to the CDC charts.

There are 559 million children under 5 years in developing countries, 156 million of whom are stunted and 126 million are living under absolute poverty. These children are referred to as being disadvantaged. Most disadvantaged children, 89 million are in south Asia. Pakistan is one of the top ten countries of disadvantaged children 7/10. These ten countries account for 145 (66%) of the 219 million disadvantaged children in the developing world.<sup>13</sup>

Stunting was seen predominantly in male children less than 5 years when compared with female children of the same age P value <.001. This is similar to data previously published of the 10 countries in sub-saharan Africa.<sup>14</sup> The presence of stunting in early childhood will have a disastrous effect on the learning ability and these children will do poorly in schools. The child's development which includes several domains such as the sensory-motor, cognitive and social all of which are likely to be affected. In countries such as ours if a large proportion of our children are affected, the national development is likely to be affected. Education of the female child appeared to be less, as depicted by the fact that only 36% of children attending schools were girls.

There have been similar studies done in other countries such as Poland where a comparison of the local children with WHO standard charts was done.<sup>16</sup> Also, a study from south East Asia was conducted i.e Bangladesh, however this study looked at only the aspects of obesity in the local affluent population.<sup>17</sup> Hence very few studies pertaining to the development of centile charts of their country (with comparison to CDC charts), BMI, Obesity and stunting together in a large cohort population have been done. To our knowledge this is the first kind of study from Pakistan and our region.

Limitations of this study include that the

population sample calculated was 18,000 of which 50% were girls and remaining boys. This was based on the total population of the country which is 120 billion (Total Population: 162,419,950 (2005 estimate) of which the pediatric population is about 45%. Based on these figures our sample size was calculated. However, due to the law order situation, floods, frequent blasts etc, the schools were closed and the appropriate sample size could not be achieved. Dearth of data was especially from Pakhtoon and Balochistan. However, the sample size achieved among these healthy children is still sufficient to estimate the prevalence of stunting in healthy school going children. Insufficient data was collected in children less than 2 years, as these children were not going to school. Hence, for early infancy (1 to 24 weeks) growth data, further, cross-sectional multicenter, hospital based study is suggested. Infants should be selected (as in the present study), keeping in mind national variation and ethnicity. The target sample should be appropriately calculated. Data collected should include weight, recumbent length, head circumference, feeding history (breast, formula etc). We are now in process of planning such a study.

Majority of the children were ages 2 years and above. Also the number of girls in this study was only 36%, probably due to the fact that overall, school going girls in Pakistan are less in number compared to boys of a similar age, due to cultural and ethnic restrictions.

### Conclusion

This study has developed growth centile charts for the Pakistani paediatric population, which may now be used in the country. Overall, the prevalence of stunting 14% and obesity 5% was high. Height, weight were 10-25 centile of the CDC charts.

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