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Original Article

Height and weight of school children of Shiraz in relation to the CDC growth charts and the previous study in shiraz (15 years ago)

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Abstract

BACKGROUND: This study aimed at presenting the updated growth reference data for height and weight of healthy school children aged 6.5-11.5 years in Shiraz (Iran).

METHODS: A total of 2397 healthy school children (1268 boys,1129 girls) aged 6.5-11.5 years were sampled from four educational districts of Shiraz (Iran) using a multistage random systematic sampling scheme. Their heights and weights were measured using a SECA stadiometer and recorded to the nearest 0.1 cm and 0.1 kg, respectively. Healy-Rasbash-Yang (HRY) distribution free method was applied to estimate aged related centiles of height and weight of children. Then, they were compared with CDC (Centers for Disease Control and prevention) growth charts and the smoothed curves of the previous study in Shiraz carried out 15 years ago, when our country was faced with the imposed war of Iraq against Iran during 1980-1988.

RESULTS: Our school children are now significantly taller and heavier for age than their peers born 15 years earlier. However, the statistical models for estimating the age-related centiles were consistent. A comparison of our data with the centers for disease control growth charts CDC 2000 shows that our height and weight medians correspond almost to the 40th centile of the latter, indicating less deficit than the previous growth study in Shiraz.

CONCLUSIONS: The paper concludes that the CDC 2000 growth charts seem inadequate and inappropriate for our subjects and supports the previous studies findings for using local growth standards for clinical work in Iran, which should be updated periodically due to changes and developments taking place. These charts are likely to be applied in school children of urban population of Iran.

KEY WORDS: Height, weight, school children, center for disease control and prevention, growth charts.

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Anthropometric parameters are important indicators of growth, health and nutritional status of children [1,2]. The world health organization (WHO) has recommended the adoption of the American growth charts where no local standard exists [3]. However, many countries develop their own growth standards, although the procedure requires extensive and expensive studies [4-8].

Several studies have been carried out in Iran in the recent decades to produce local standards for growth of infants [9,10] and children [11-14]. However, due to sharp nutritional, demographic and economic changes in Iran on the one hand and an apparent secular trend in the recent decade on the other hand, increase of height and weight in school children was seen [15,16,] which necessitates some of these growth charts to be updated.

Therefore, the purpose of this study was threefold:

1: To update the height and weight charts of

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primary school children of Shiraz (Iran) aged 6.5-11.5 years. 2: To compare the present Shiraz growth study (SGS 2003) with that of the old one carried out some 15 years ago (SGS 1988) [11,12] and evaluate the cease fire effect between Iran and Iraq on the growth of children who were born and grown up completely after the war cease. 3: To explore the relationships between the present growth charts with the centers for disease control and prevention growth charts [CDC 2000] [17,18].

Methods

Administratively, Shiraz is divided into four educational districts, each with discrete social, cultural, economic and health characteristics. Since an adequate sampling frame of population was unavailable, a multistage systematic random sampling was applied. A 10% systematic random sample of schools in each district was drawn from public and private schools. Within each selected school, a 1 in 5 sample of children aged between 6.5 and 11.5 years (grade 1 to grade 5) was selected, using tables of random numbers. Applying this procedure, 2397 healthy school attendees (1268 males, 1129 females) aged 6.5-11.5 years were selected in the 2003-2004 academic year, in a cross-sectional study, representing a 2% sample of school children in the city.

The anthropometric measurements included height and weight, measured by two trained auxologists using a digital stadiometer (SECA Model 707, Germany) and the methods given by Cameron [19]. Heights and weights were recorded to the nearest 0.1 cm and 0.1 kg, respectively. Children's weights were taken without shoes or heavy clothing. Standardized examination clothing with an approximate weight of 300 grams was used. Also the stadiometer was calibrated at each measurement session. Subject's ages were calculated exactly as the difference between the date of interview and the date of birth in days as recorded in their birth certificates, which are accurate.

In order to fit appropriate models for the sizes, the Healy-Rasbash-Yang (HRY) distribution free method was used to estimate age-related smoothed centiles [20]. This method has been implemented for the world health organization in the GROSTAT computer package [21]. As this method works best when the data are normal [22,23], first the data were normalized using appropriate transformations and p-p plots. Second, goodness of fit was assessed both graphically and numerically. Third, Z-scores (SD scores) of the measurements were calculated upon fitting smoothed age-related centiles.

The CDC 2000 centiles [17] tabulated for corresponding ages were similarly processed using GROSTAT, and the resulting smoothed curves were used for comparison. In addition the smoothed curves were compared with the charts produced in the previous study of 1988.

Results

Twenty school children were not available for measurements (0.9%). Valid measurements for heights were available for 1161 boys (91.6%) and 1069 girls (94.7%) and for weight for 1141 boys (90%) and 1064 girls (94.2%). Normality of data was checked by p-p plots and one sample Kolmogorov-Smirnov test. Smoothed percentiles of height by sex and age which were obtained by fitting the following models are shown in table 1:

Boys:

$Y_{ip} = (67.885 + 3.2545\ z_i + .0744\ z_i^2) + (8.614 + 2534\ z_i)\ Age_i - .1829\ Age_i^2$

Girls:

$Y_{ip} = (82.563 + 8.95\ z_i) + (5.2214 - 1.2787\ z_i)\ Age_i + (.0132 + .1023\ z_i)\ Age_i^2$

A logarithmic transformation was made to remove skewness in weight the smoothed percentiles were calculated based on the following models. The results are shown in table 2.

Boys:

$Y_{ip} = EXP\ [(1.5864 + .0839\ z_i + .0194\ z_i^2) + (2726 + .009\ z_i)\ Age_i - .0092\ Age_i^2]$

Girls:

$Y_{ip} = EXP\ [(2.4895 + .236\ z_i) + (.0678 - .0295\ z_i)\ Age_i + (.0026 + .0025\ z_i)\ Age_i^2]$

Where Y_{ip} is the p^{th} smoothed measurement (height or weight) for the i^{th} subject and z_i is the corresponding standard score (SD score). EXP stands for the exponentiation of the equation.

Figures 1 and 2 compare growth charts of the present study (SGS 2003) with the old one (SGS 1988) and the CDC 2000 for height and weight by sex. The improvement of growth in our data in relation to the previous study and deficits in relation to CDC 2000 can be seen obviously.

Table 1. Smoothed percentiles of height (cm) by age (years) and sex.

Sex and Age*	n	Smoothed percentiles 3	5	10	25	50	75	90	95	97
Boys										
6.5	104	107.2	108.3	110.0	112.9	116.2	119.5	122.6	124.4	125.6
7.0	107	110.0	111.2	112.9	115.9	119.2	122.6	125.8	127.7	128.9
7.5	100	112.8	113.9	115.7	118.8	122.2	125.7	128.9	130.9	132.2
8.0	111	115.4	116.6	118.4	121.6	125.1	128.7	132.0	134.0	135.3
8.5	128	118.0	119.2	121.1	124.3	127.9	131.6	134.9	137.0	138.3
9.0	105	120.4	121.7	123.6	126.9	130.6	134.4	137.8	139.9	141.3
9.5	126	122.8	124.1	126.1	129.4	133.2	137.1	140.6	142.7	144.1
10.0	116	125.1	126.4	128.4	131.9	135.7	139.7	143.3	145.5	146.9
10.5	143	127.3	128.6	130.7	134.2	138.2	142.2	145.9	148.1	149.6
11.0	121	129.4	130.8	132.9	136.5	140.5	144.6	148.4	150.6	152.1
Girls										
6.5	87	107.7	108.9	110.7	113.7	117.1	120.4	123.4	125.2	126.4
7.0	83	110.3	111.5	113.3	116.4	119.8	123.1	126.2	128.0	129.2
7.5	115	112.8	114.0	115.9	119.0	122.5	125.9	129.0	130.9	132.1
8.0	86	115.3	116.5	118.4	121.6	125.2	128.7	131.9	133.8	135.1
8.5	96	117.6	118.9	120.9	124.2	127.9	131.6	134.9	136.9	138.2
9.0	109	119.6	121.2	123.3	126.8	130.6	134.5	138.0	140.0	141.4
9.5	123	112.0	123.4	125.6	129.3	133.4	137.4	141.1	143.3	144.7
10.0	111	124.1	125.6	127.9	131.8	136.1	140.4	144.3	146.6	148.1
10.5	135	126.1	127.7	130.1	134.3	138.8	143.4	147.6	150.0	151.6
11.0	124	127.9	129.6	132.3	136.7	141.6	146.5	150.9	153.5	155.3

Table 2. Smoothed percentiles of weight (kg) by age (years) and sex.

Sex And Age*	n	Smoothed percentiles 3	5	10	25	50	75	90	95	97
Boys										
6.5	103	15.9	16.2	16.7	17.8	19.5	21.6	24.1	25.9	27.3
7.0	107	17.0	17.3	17.9	19.2	21.0	23.4	26.1	28.2	29.6
7.5	101	18.1	18.4	19.1	20.5	22.5	25.1	28.2	30.4	32.0
8.0	105	19.1	19.5	20.3	21.8	24.0	26.9	30.3	32.7	34.5
8.5	127	20.2	20.6	21.4	23.1	25.5	28.6	32.3	35.0	36.9
9.0	102	21.1	21.6	22.5	24.3	26.9	30.4	34.4	37.2	39.4
9.5	124	22.1	22.6	23.5	25.5	28.3	32.1	36.4	39.5	41.8
10.0	113	22.9	23.5	24.5	26.6	29.7	33.7	38.3	41.7	44.1
10.5	141	23.7	24.3	25.4	27.7	30.9	35.2	40.2	43.8	46.4
11.0	119	24.4	25.0	26.2	28.6	32.1	36.7	41.9	45.8	48.6
Girls										
6.5	86	15.8	16.3	17.3	18.9	20.9	23.2	25.4	26.8	27.8
7.0	83	16.5	17.1	18.1	19.9	22.0	24.4	26.8	28.4	26.4
7.5	115	17.3	18.0	19.0	20.9	23.2	25.8	28.4	30.1	31.2
8.0	84	18.1	18.8	20.0	22.0	24.5	27.4	30.2	32.0	33.2
8.5	97	18.9	19.7	20.9	23.2	25.9	29.0	32.2	34.2	35.5
9.0	107	19.8	20.6	21.9	24.4	27.5	30.9	34.4	36.6	38.1
9.5	124	20.6	21.5	23.0	25.7	29.1	32.9	36.8	39.4	41.1
10.0	111	21.5	22.5	24.1	27.1	30.9	35.2	39.6	42.4	44.4
10.5	134	22.4	23.5	25.3	28.6	32.8	37.7	42.6	45.9	48.2
11.0	123	23.3	24.5	26.5	30.2	34.9	40.4	46.1	49.9	52.5

(*6.5, 7.0 ,7.5 . . . indicate 6.5-7.0 , 7.0-7.5 , 7.5-8.0 , . . .)

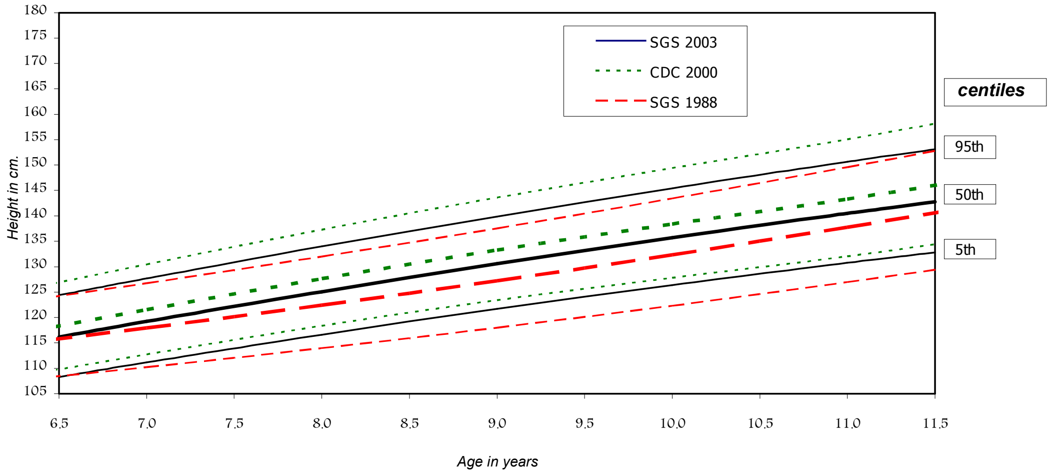

Figure 1a. Comparison of heights of boys ; Shiraz Growth Study (SGS) 2003 vs1988 and CDC 2000.

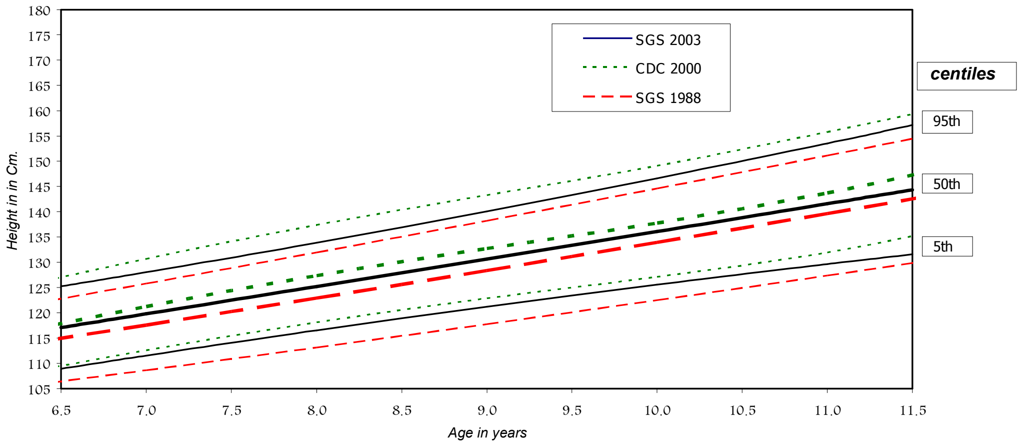

Figure 1b. Comparison of heights of girls ; Shiraz Growth Study (SGS) 2003 vs1988 and CDC 2000.

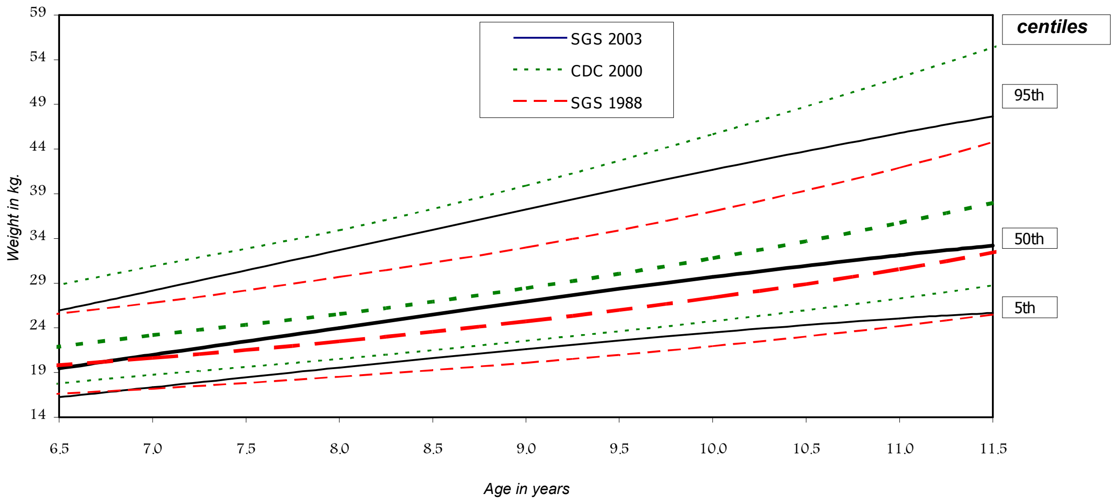

Figure 2a. Comparison of weights of boys ; Shiraz Growth Study (SGS) 2003 vs1988 and CDC 2000.

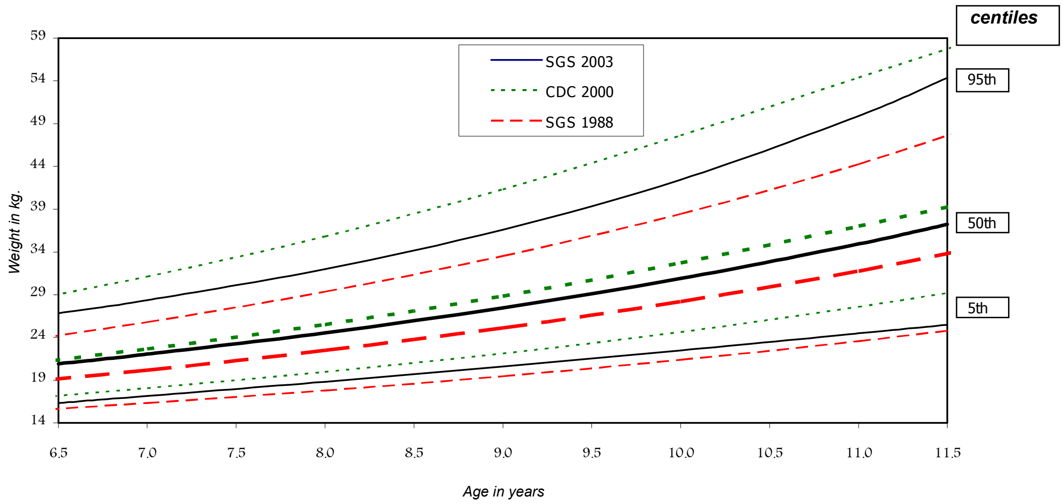

Figure 2b. Comparison of weights of girls ; Shiraz Growth Study (SGS) 2003 vs1988 and CDC 2000.

Discussion

This study presents the updated height and weight-by-age charts of school children of Shiraz (Iran) who were born at least two years after the ceasefire between Iran and Iraq, two neighboring countries, in 1988. The results show that the children are now significantly taller (on the average 1.5 cm, P<0.02) and heavier (on the average 2 kg, P<0.005) than their peers born during and prior to the 8-year war [1980-1988] [11,12]. Similar results were obtained when we compared our findings with that of Iran National Health Survey (INHS) carried out in 1990-1992 [13]. On the average, children are now taller than their pears in INHS study by 4.5 cm for boys and 4.1 cm for girls showing a significant difference (P<0.001). Also, they are heavier than their counterparts from INHS subjects by 3.2 kg for boys and 4.8 kg for girls, indicating a significant positive difference (P<0.001). These differences may be attributed to improvements in socioeconomic, health and cultural conditions in the period between the two surveys.

Centiles of the subjects of both Shiraz studies lie below their American counter parts. However, the median of present study (SGS 2003) corresponds almost to the 40th centile of the CDC 2000 growth charts for both measurements and sexes, while the median of the old study (SGS 1988) lay on the 25th centile of the National Center for Health Statistics growth charts (figures 1 & 2) [12]. This indicates that growth of Iranian children has improved in relation to the CDC 2000 growth charts recommended by WHO than their counterparts of 15 years ago. This can be explained by improvement in socioeconomic status the Iranian population after the ceasefire between Iran and Iraq and the developments in the reconstruction period that affected the growth pattern in our children. Table 3 compares the changes by age and sex in detail.

The analyses reinforce an almost general perception that growth deficits in relation to the CDC 2000 should not always be interpreted as the outcome of nutritional deficits, especially if we take this fact into consideration that no widespread malnutrition is reported and the subjects were all healthy school children. Rather, this supports using local growth standards for Shiraz.

A comparison of growth in boys and girls shows that centiles corresponding to girls lie below those for boys up to around the age 9, with the direction reversing later on, indicating the effects of pubescent ages on the growth indices which start around this age in girls. This concurs with our earlier findings [11,12]. The present study is based on a representative sample of healthy school children of various socioeconomic and culture backgrounds in Shiraz

Table 3. Smoothed percentiles of weight (kg) and height (cm) for Iranian boys and girls expressed as NCHS 1979 and CDC 2000 percentiles.

Age (year)	Boys: CDC percentile of Iranian median (2003)	Boys: NCHS percentile of Iranian median (1988)	Girls: CDC percentile of Iranian median (2003)	Girls: NCHS percentile of Iranian median (1988)
Weight (kg)				
7	41.1	21.0	44.6	29.9
8	40.0	19.6	43.6	27.1
9	41.2	20.1	43.0	24.2
10	40.3	20.9	42.3	22.4
11	36.1	21.6	38.5	21.9
Height (cm)				
7	39.4	24.6	43.1	30.1
8	39.2	21.2	40.8	29.2
9	39.4	20.2	41.6	28.7
10	40.1	20.1	43.7	26.8
11	40.9	21.0	42.7	23.7

(Iran) and the size of the sample was almost twice that of the older study (SGS 1988) 2397, as compared with 1207, giving more reliable results.

Quadratic polynomials were best fitted to model our height and weight data in both studies carried out in Shiraz, 15 years apart, and the same transformations adequately normalized the measurements for best fitting.

The representativeness of our data suggests that the local growth standards produced in our study are likely to be applied to urban population of school children of Iran. However, we suggest that a national survey be carried out in two decades from now representing different parts of the country and various backgrounds to take the forthcoming changes into consideration.

The growth standards of Shiraz [11-14] and Iran [13] are now out of date and inappropriate for clinical assessments as they do not manifest the changes that have taken place in the population in the past 15 years. Also the CDC 2000 growth charts are inadequate and inappropriate for use in clinical work in Iran.

Therefore, the present study supports that Iranian children need their own updated growth standards. This concurs previous studies in Iran [9-14] as well as the Iran's neighboring countries [5] and other Asian [24,25], European [26-30] and American nations [6,31], which contradicts with a study from a Middle East country [32] of the well offs.

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