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WEIGHT-FOR-STATURE REFERENCE DATA OF PREPUBESCENT EGYPTIAN CHILDREN

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Abstract: Weight-for-stature is widely used as an index of recent malnutrition. Aim: to construct weight-for-stature percentile curves of prepubescent Egyptian children and to compare these curves with the revised US growth charts. In addition, weight-for-stature mean values were generated for boys and girls. The study is a cross-sectional one including 7,254 healthy children (4,012 boys and 3,242 girls). Data of weight were calculated for each 3 cm interval of stature. The percentile points of weight-for-stature at 3rd, 5th, 10th, 15th, 25th, 50th, 75th, 85th, 90th, 95th and 97th percentiles were calculated and plotted on a graph at the midpoint of each 3-cm interval for stature. The current Egyptian curves were increasingly higher at 50th and the 97th percentiles than those of the US standards. However, the 3rd percentile in the present study coincides with the US percentile. Thus, Egyptian percentiles should be used in identifying Egyptian children at nutritional risk.

Keywords: weight-for-stature; percentile curves; nutrition.

INTRODUCTION

Weight-for-stature is widely used as an index of recent malnutrition and often forms the basis on which major policy decisions are made for nutrition interventions (Berkley et al., 2005). Weight-for-stature is a sensitive index of current nutritional status. The value of weight-for-stature standard as a screening tool is particularly marked in assessment of protein energy malnutrition and wasting. It reflects weight in relation to reference group of children of the same stature and sex but not necessarily of the same age as it is independent of age. So, it is useful especially in developing countries, where the age of the child is sometimes unknown (Flegal et al., 2002).

National Centre for Health Statistics (NCHS) growth reference included child weight-for-stature charts for the age range from birth to 10 years in girls and to 11.5 years in boys (Hamill et al., 1979). The CDC in 1978 produced a normalised and improved version of the 1977 NCHS percentiles (Dibley et al., 1987). World Health Organization (WHO) subsequently adopted these normalised curves as international reference CDC/WHO growth charts (Sullivan et al., 1991). However, researchers criticised these charts (Cole, 1985; van't Hof et al.,

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2000; Roche, 1992) which led to release of CDC 2000 growth charts for the USA (Kuczmarsk et al., 2002). Researchers have used these charts to define nutritional outcome and compare populations to evaluate the prevalence of malnutrition and assess methods of interventions (Dang et al., 2005; Nasirian and Tarvij-Eslami, 2006; Post and Victoria, 2001). Cuervo et al. (2005) used weight-for-stature index to investigate the nutritional status of children in a health district in southern Brazil and considered <3rd percentile as malnutrition and from 3rd to 10th percentile classified as nutritional risk.

International standards simplify comparisons between regions or countries, as they all have common reference (Cole, 1993). Goldstein and Tanner (1980) and Graitcer and Gentry (1981) suggested that if elite children in the region can achieve growth matching that of the standard, then the standard serves as a norm representing achievable growth for those who are less well off. However, the pattern of growth shown by the standard may be quite inappropriate in particular regions of the world. Cole (1993) advised that if clinical decision is needed or if a statistical analysis is used to adjust anthropometric measurements for age, then a local standard is probably more appropriate. Moreover, national standards can help in detecting long-term trend of weight and height parameters.

In practice, many countries have developed their own national standards which are used as local norms for clinical purposes (Hosseini et al., 1999; Kamel et al., 2004; Savva et al., 2001). However, no such plots existed so far for Egyptian children for the assessment of malnutrition and wasting.

The aim of the present study is to construct weight-for-stature percentile curves for Egyptian children aged 3–11.5 years, and compare them with other population percentiles.

SUBJECTS AND METHODS

Subjects

Data were derived from weight and stature measurements taken from the Egyptian Growth Curve reference data 2002 (Ghalli et al., 2008). This study was a cross-sectional study including 7, 254 healthy subjects (4, 012 boys and 3, 242 girls) aged from 3 years till the age of 11 years for boys and 10 years for girls to exclude the effect of puberty. The sample was collected from preschool children attending 72 private kindergartens and older children at 13 private primary schools and 4 private sports clubs living in Greater Cairo of upper middle socioeconomic status to provide optimum growth conditions.

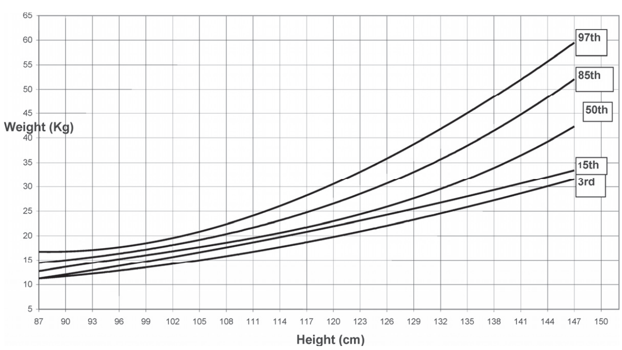

Figure 1 Weight-for-stature percentiles for Egyptian boys

Methods

The following was performed for each child: a questionnaire was directed to the parents. It included personal, socioeconomic data and medical history of the child with special emphasis on chronic disease or long-term systemic treatment.

Complete clinical examination to exclude any organic or genetic disorder that might interfere with normal growth.

Measurements included body weight; using Seca scale approximated to the nearest 0.01 kg with minimal clothes for which no correction was made; and body stature without shoes using Holtain stadiometer and approximated to the nearest 0.1 cm following the recommendations of the International Biological Program (Hiernaux and Tanner, 1969) and were recorded as the mean of three consecutive readings.

Statistical analysis:

The data for weight-for-stature were grouped by 3 cm intervals of stature. Means and SD of weight-for-stature were calculated for each interval and for each gender separately. The data points at 3rd, 5th, 10th, 15th, 25th 50th, 75th, 85th, 90th 95th and 97th percentile were calculated for each gender and plotted at the midpoint of each 3 cm interval for stature at 3rd, 15th, 50th 85th and 97th percentile. They were graphically smoothed using polynomial fitting equation. Comparison of the current Egyptian data with the corresponding revised US growth charts (NHANES I, II, III) from vital and health statistics of the CDC/NCHS (2000) were performed. The Statistical Package of Social Science 'SPSS/PC software version 11 Program was used.

Results

Means + SD and the smoothed percentiles and of the weight-for-stature values from 87 to 149 cm for boys (age ranged between 3 and 11.5 years) were presented in Table 1, and from 87 to 143 cm for girls (age ranged between 3 and 10.5 years) in Table 2. They showed a progressive increase in weight values in all stature intervals for both sexes. The increase in weight values between each two successive stature intervals ranged from 0.7 to 1 kg up to the stature intervals 123–125 cm for boys, and to 120–122 for girls, and then became greater up to about 3 kg. The smoothed percentiles of weight-for-stature for Egyptian prepubescent boys and girls were presented in Figures 1 and 2, respectively. It is obvious that boys are heavier than girls in all the percentiles for the same stature interval.

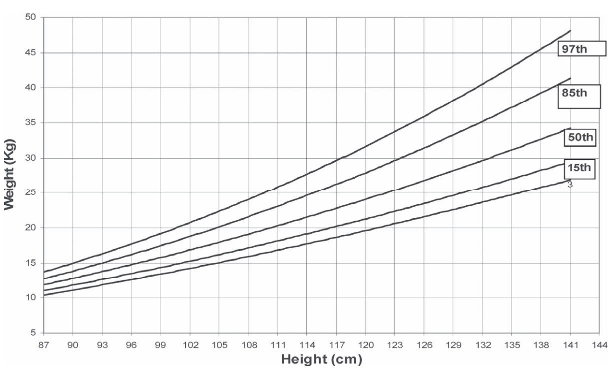

Figure 2 Weight-for-staturet percentiles for Egyptian girls

Table 1 Means, standard deviations and percentiles of weight (kg)-for-stature (cm) of prepubescent Egyptian boys (3–11 years)

Height (cm)	N	Mean	SD	Percentiles										
				3rd	5th	10th	15th	25th	50th	75th	85th	90th	95th	97th
87–89	42	12.8	1.09	10.9	11.2	11.6	11.7	12.0	12.7	13.4	14.2	14.5	14.7	15.6
90–92	99	13.9	1.37	11.8	12.0	12.4	12.7	13.0	13.7	14.3	14.8	15.9	16.8	17.4
93–95	124	14.6	1.33	12.3	12.6	13.0	13.2	13.6	14.4	15.5	15.9	16.3	17.0	17.4
96–98	165	15.3	1.27	13.0	13.3	13.7	13.9	14.4	15.1	16.1	16.5	16.8	17.8	18.1
99–101	167	16.0	1.29	13.4	13.9	14.4	14.7	15.2	15.9	16.9	17.4	17.7	18.2	18.9
102–104	233	16.9	1.36	14.7	14.8	15.2	15.5	15.9	16.9	17.9	18.2	18.8	19.2	19.8
105–107	197	17.7	1.58	15.0	15.2	15.7	16.1	16.6	17.6	18.5	19.3	19.6	20.4	20.8
108–110	207	18.7	1.65	15.6	16.4	16.7	17.0	17.5	18.6	19.7	20.4	21.0	21.5	22.3
111–113	207	19.7	1.78	16.6	17.1	17.5	17.9	18.6	19.6	20.7	21.5	22.0	23.2	23.7
114–116	213	20.9	1.99	17.5	18.0	18.6	19.1	19.5	20.6	22.0	22.8	23.3	24.7	25.4
117–119	233	22.1	2.34	18.5	19.1	19.5	20.0	20.5	21.7	23.2	24.4	25.0	26.8	27.5
120–122	229	23.7	2.78	19.9	20.0	20.8	21.1	22.0	23.1	25.0	26.5	27.5	28.1	30.5
123–125	246	24.8	2.43	21.1	21.4	22.1	22.6	23.1	24.3	26.3	27.4	28.3	29.4	30.8
126–128	299	26.8	3.32	22.0	22.5	23.2	23.8	24.6	25.9	28.4	30.4	31.5	33.3	34.0
129–131	237	28.9	4.36	23.0	23.8	24.7	25.2	26.0	27.7	30.8	33.5	35.2	37.1	39.2
132–134	235	30.3	4.42	24.2	25.1	25.7	26.1	27.4	29.3	32.4	35.1	36.9	39.5	41.7
135–137	251	32.8	5.25	25.8	26.7	27.5	28.3	29.1	31.5	35.0	37.8	40.0	42.6	45.4
138–140	206	35.5	5.87	27.7	27.8	28.5	29.3	31.2	34.3	38.9	42.3	43.8	46.0	48.2
141–143	185	38.0	6.54	29.1	29.6	30.5	31.7	33.5	36.0	42.7	45.8	47.7	51.3	52.5
144–146	134	40.4	6.70	30.5	31.1	32.4	33.5	35.3	39.4	44.5	48.0	50.3	52.9	56.8
147–149	103	43.2	4.15	30.8	32.2	33.9	34.9	38.4	42.4	47.2	51.6	54.1	56.1	58.2

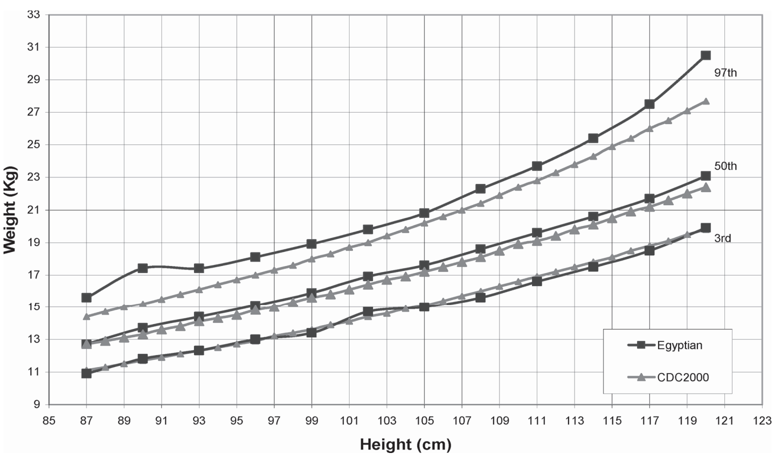

Figure 3 Comparison of the weight-for-stature percentiles between the Egyptian (2002) and the US (2000) boys

Table 2 Means, standard deviations and percentiles of weight (kg)-for-stature (cm) of prepubescent Egyptian girls (3–10 years)

Height				Percentiles										
(cm)	N	Mean	SD	3rd	5th	10th	15th	25th	50th	75th	85th	90th	95th	97th
87–89	43	12.7	0.88	11.3	11.4	11.8	11.9	12.0	12.5	13.2	13.8	14.2	14.7	14.7
90–92	81	13.6	1.39	11.3	11.6	11.7	12.0	12.5	13.5	14.4	14.9	15.1	15.9	16.9
93–95	120	14.1	1.25	12.0	12.1	12.5	12.8	13.3	14.0	14.9	15.5	15.8	16.3	16.5
96–98	152	15.0	1.44	12.3	12.8	13.2	13.4	14.0	15.1	15.9	16.6	16.9	17.4	17.9
99–101	155	15.8	1.38	13.6	13.8	14.1	14.3	15.0	15.8	16.7	17.1	17.5	18.3	18.9
102–104	176	16.6	1.55	13.8	14.1	14.6	14.9	15.5	16.7	17.7	18.0	18.7	19.2	19.6
105–107	204	17.6	1.74	14.7	15.1	15.6	15.9	16.4	17.4	18.6	19.5	20.0	20.6	21.7
108–110	183	18.5	1.85	15.5	15.7	16.2	16.7	17.2	18.2	19.8	20.3	20.7	21.9	22.6
111–113	210	19.5	2.01	16.2	16.8	17.3	17.5	18.2	19.4	20.7	21.5	22.1	23.1	23.6
114–116	227	21.1	2.26	17.5	18.0	18.7	18.9	19.5	20.8	22.2	23.2	24.2	25.7	26.6
117–119	214	22.1	2.61	18.0	18.4	19.4	19.8	20.3	21.6	23.6	24.8	25.4	26.8	27.8
120–122	233	23.4	2.84	19.2	19.9	20.2	20.7	21.2	23.1	24.9	26.5	27.6	28.6	30.0
123–125	238	25.1	3.47	20.7	20.9	21.4	21.9	22.7	24.3	27.0	28.6	29.8	32.3	33.0
126–128	215	26.8	3.67	21.0	21.5	22.4	23.0	24.1	26.2	29.0	30.7	32.3	33.8	34.9
129–131	221	29.6	4.73	23.1	23.4	24.2	24.7	25.9	28.5	32.4	34.2	37.1	39.0	40.0
132–134	205	30.9	4.83	24.2	24.7	25.5	26.0	27.2	30.2	34.0	36.0	37.6	39.9	42.3
135–137	154	33.2	5.44	24.8	25.9	26.9	27..5	29.1	32.5	37.2	39.9	41.0	42.9	44.0
138–140	126	35.2	6.22	25.9	26.7	27.6	29.1	30.8	34.1	39.0	42.1	44.2	46.6	48.4
141–143	85	37.5	6.10	28.6	28.8	29.7	31.2	33.0	36.7	41.4	43.5	45.9	50.0	51.7

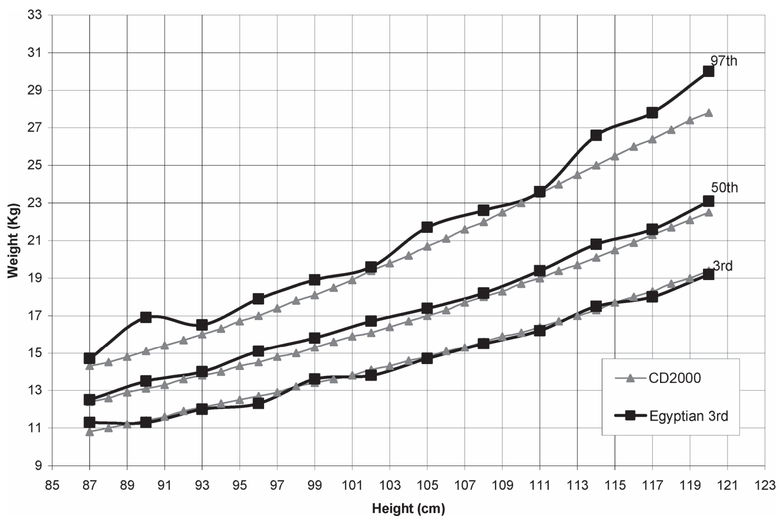

Figure 4 Comparison of the weight-for-stature percentiles between the Egyptian (2002) and the US (2000) girls

Comparison of the 3rd, 50th and 97th percentiles of the current Egyptian study and the black Americans of CDC (2000) of weight-for-stature up to stature 120 cm are presented in Figures 3 and 4 for boys and girls, respectively. For both sexes, the 50th and 97th percentiles of the Egyptians reveal higher values of weight-for-stature than those of the CDC (2000) standard, which reflect that the Egyptians are heavier than the international standard. However, the 3rd percentile in the present study coincides with the US percentile.

DISCUSSION

Scientists have been using growth assessment because it, best, defines the health and nutritional status of children while serving as a useful indirect measurement of a population's overall socioeconomic status (Foster et al., 2005). Measurements of stature and weight are an important data source relating to growth and development, puberty and nutritional status of children (Aminorroaya et al., 2003). The development of a simple anthropometric index closely related to child survival prognosis can enhance the treatment of severely malnourished children (Prudhon et al., 1996).

The WHO defines severe malnutrition requiring hospital admission as weight-for-height *z* scores (WHZs) of less than or equal to −3 or as less than or equal to 70% of the reference median using US NCHS /WHO reference values (severe wasting) or symmetrical oedema involving at least the feet (oedematous malnutrition, kwashiorkor).

The current database included population-based survey that fulfil common inclusion criteria related to frame and procedure, sample size and standard measurement techniques according to WHO (2003). Ideally, national growth curves would be based on a sample representing all areas of Egypt. The great majority of Egyptians live in the valley and a geographical gradient supposedly exists in the genetic constitution of Egyptians. The number of inhabitants of Cairo amount to one-fifth of the Egyptian population. Most Cairo settlers came from all parts of Egypt. For these reasons Greater Cairo area was a single site to represent most of the Egyptians. To establish a growth curve from which comparisons to normal can be made, it would be necessary to obtain data from subjects with optimum growth opportunities. Therefore, subject selection was confined to children from the upper middle socioeconomic group where it presumed that these children would provide optimum anthropometric data and present minimal possibility of malnutrition.

To avoid the effect of puberty on the validity of weight-for-stature tables, the maximum stature allowed in this study corresponds to the median stature of 10.5 years old girls and 11.5 years old boys. Beyond these ages the likelihood of puberty increases and with it a possible change in the weight-for-stature relation can be noticed (Franklin, 1999). Hosny et al. (2005) recorded that second stage of breast and pubic hair for Egyptian girls occur at the age of 10 years, while Hassan et al. (2005) recorded that second stage of pubic hair for Egyptian boys occur at the age of 11 years.

Means and standard deviations were presented in tables to track child health and to be used as a tool for monitoring and assessment of the rapid and changing rate of nutritional status of Egyptian children. The results show a progressive increase in weight values in all stature intervals for both sexes, and boys are heavier than girls in all the percentiles for the same stature interval. Comparing these results with those of black Americans CDC (2000), revealed that for sexes, the 50th and 97th percentiles of the Egyptians are higher, which reflect that the Egyptians are heavier than the black American. So, if the CDC standard of the black American is used to evaluate obesity in Egyptians, it will overestimate the cases. However, the 3rd percentile of the two studies coincides. This latter comparison, however, should not be interpreted too strictly because the CDC relations were derived from boys of similar stature but different ages, whereas the current percentiles were derived from boys of similar age but different statures and different genetic pool. The CDC revised charts were developed for children aged 2–5 years (the age was calculated as a year + 11 months), and in practice they may accommodate some shorter children with chronological ages >5 years. While, the current Egyptian study was developed for children aged 3–10.5 for girls and 3–11.5 for boys (the age was calculated as a year + 6 months). This comparison also showed difference in stature for age, where at stature interval 120–122 cm, 41% of the Egyptian children were aged 7 years and 25% aged 8 years. So, for the same stature the Egyptians have the same value of the 3rd percentile of weight as the CDC charts, but they are older than the children included in the CDC charts. Comparison of the 3rd, 50th and 97th percentiles between the current Egyptian study and the study of Fredriks et al. (2000) in the Netherlands of weight-for-stature showed that, for both sexes, the 3rd, 50th and 97th percentiles of the current Egyptian study are of higher values of weight-for-stature than those of the Dutch standard. This reflects that the Egyptians are heavier than them.

In India (Sugarman et al., 1990) and in Nigeria (Ukoli et al., 1993) compared weight-for-stature for school children with NCHS reference data. They concluded that the NCHS reference data are inadequate for their populations. In Argentina (Oyhenart and Orden, 2005), evaluated the use of an international growth reference (first and second National Health and Nutrition Examination Survey (NHANES I and NHANES II)), versus a national growth reference leads to differences in the prevalence of low weight-for-stature (wasting) and low stature-for-age (stunting) in a sample of 1,470 schoolchildren (both boys and girls) aged 8–14 years. The differences in the prevalence of wasting and stunting calculated according to the two references used indicate a different nutritional status for the population studied. De Onis et al. (2007) compare new growth charts released by the US CDC and the WHO, in May 2000 and April 2006, respectively and evaluated the growth performance of healthy breastfed infants according to both. They found important differences between the WHO and CDC charts that vary by age group, growth indicator and specific Z-score curve. Overall, the CDC charts reflect a heavier, and somewhat shorter, sample than the WHO sample. This results in lower rates of under nutrition (except during the first six month of life) and higher rates of overweight and obesity when based on the WHO standards. Shorter measurement intervals in the WHO standards result in a better tool for monitoring the rapid and changing rate of growth in early infancy. Differences are particularly important during infancy, which is likely due to differences in study design and characteristics of the sample, such as type of feeding. Onyango et al. (2007) compared children's length/height-for-age and weight-for-length/height based on the standards of the WHO (2006) with clinician assessments of the same children in two affluent populations (Argentina and Italy) and two less-affluent ones (Maldives and Pakistan). They found as expected, Pakistan and the Maldives had higher rates of stunting, wasting and underweight than Italy and Argentina, and the reverse was true for overweight and obesity.

The need to develop an appropriate Egyptian weight-for-height growth reference for the screening, surveillance and monitoring of school aged children and adolescents has been stirred by the increasing public health concern over childhood obesity. As countries proceed with the implementation of growth standards for children under five years of age, the gap across all centiles between these standards and existing growth references for older children has become a matter of great concern.

CONCLUSION

Egyptian weight-for-stature percentile curves are useful and meaningful for clinical tasks as they are independent of age. The present percentiles will help in assessment of nutritional status of Egyptian children, provide more accurate estimates of undernourished (<3rd percentile) and permit identifying children at risk rather than waiting to diagnose malnutrition after a static point is attained.

BIOGRAPHY

Moushira E. Zaki is a Professor of Human Genetics she was a Head of Department of Biological Anthropology, National Research Centre, Cairo, Egypt (2001–2008). Her research interest includes skeletal biology, biological anthropology, epidemiology, biostatistical genetics and population genetics. She was a Principal Investigator and participated in many projects in the field of growth and development among Egyptian children, bone mineral density and palaeopathology of Ancient Egyptians. She has more than 75 publications.

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