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Underweight and Short Stature among Upper Egypt School Children Using National and International Growth Charts

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Abstract:
Background: *Many international and national growth references are used for assessing growth in children. These references may differ in practical applications and interpretations especially in different populations.*
Aim of the study *was to estimate underweight and short stature among primary school children in Upper Egypt by using Egyptian and Center for Disease Control and Prevention (CDC) growth charts.*
Subjects and method: *A survey was conducted on primary school children in 4 governorates of Upper Egypt namely; Assiut, El-Minia, Sohag and Qena. Twenty public (urban and rural) primary schools were included in the study. Height and weight of each child were assessed according to standard measures. Percentiles of weight and height for age were determined according to Egyptian and CDC growth charts.*
Results*: A total of 5458 children aged 6-12 years have participated in this study. Boys represented 51.2 %. By using Egyptian growth charts, the percentages of underweight and short stature for age were 4.2% & 7% in comparison to 14.8 % & 18.5% by CDC growth charts respectively. The Egyptian charts showed significant difference between boys and girls regarding underweight for age (3.3% in boys vs. 5.2%, for girls, p < 0.001), while CDC charts showed significant difference between boys and girls regarding short stature for age (17.1% in boys vs. 19.9% for girls, p<0.01).*
Conclusion: *School children showed different growth faltering depending on growth reference tool used for assessment.*
Recommendation: *School health programs should take into consideration the differences between growth references when nutritional status and interventions are evaluated.*
Keywords: *Underweight, short stature, school, national, international, growth charts*

I. Introduction

School age is the active phase of growth of childhood representing the dynamic period of both physical and mental development(1). Malnutrition of school-age children is usually underestimated problem particularly among developing countries as most of nutritional policies and interventions are directed towards infants and children in the pre-school years(2). Malnutrition, in school-age children, has long-lasting physiologic effects such as delayed development, poor school achievement, and metabolic disorders in adulthood(3). The most common indicator reflecting under nutrition is underweight and/or stunting(4).

Growth references are used by health care providers involved in the care of children (medical practitioners, pediatricians, and nurses) as a part of medical assessment to evaluate their growth and nutritional status and for the follow up of childhood diseases. Furthermore, they are used as a public health tool to summarize and compare anthropometry among groups of children(5).

Many studies have showed that the estimated unhealthy growth status can vary when different growth reference/standards are applied. Mei et al.(6) found that the United States children showed a higher prevalence in stunting but lower prevalence in wasting when using the World Health Organization growth standards 2006, versus the Centers for Disease Control and Prevention growth charts 2000. Al- shehri et al.(7) found that the use of National Center for Health Statistics growth reference was not appropriate for assessment of growth of Saudi children aged 3-18 years.

In Egypt, a national growth reference, Egyptian growth charts 2002(8), has been constructed from a sample size of 33189 girls and boys (birth - 21 years) from Cairo and Delta regions. Another growth charts have been constructed from a sample size of 8024 boys and girls aged 1 month to 15 years of north Egyptian people(9). A local growth reference for children in South Sinai at the north east region of Egypt was also constructed(10). In Upper Egypt, no growth reference was constructed and the national Egyptian growth charts were not tested on children there.

Upper Egypt is a geographic and cultural division of Egypt that extends from Cairo south to Lake Nasser on either side of Nile River. It represents about 70% of Egypt's surface area and is inhabited by 40% of Egyptian population(11). It consists of three big territories: the north Upper Egypt including 3 governorates, the

middle Upper Egypt including 2 governorates, and the South Upper Egypt including 5 Governorates. The population live in Upper Egypt has environmental, climatic and social specifications that are different from other areas in Egypt[12]. So it is important to know how comparable the results are if the national Egyptian growth charts 2002 and an international growth reference are applied on the same population to help understand and guide appropriate applications of such references.

Aim of the study was to estimate underweight and short stature for age among primary school children in Upper Egypt measured by the Egyptian growth charts in comparison to Center for Disease Control and Prevention growth charts2000[13].

II. Subjects and methods

This survey was conducted on primary school children in Upper Egypt. The sample size was calculated using EPI info version 7 according to a previous reported prevalence of underweight among school students as being 12.9%[14]. An allowable error of 1% with a power of 80% and a confidence level of 95%, the sample size was estimated to be 5300 children. To obtain our target sample, we followed a multistage sampling technique. First, we select one governorate from North Upper Egypt (Elmenia), one governorate from Middle Upper Egypt (Assiut) and 2 governorates from South Upper Egypt (Sohag and Qena). Second, a list of all public primary schools was obtained for each governorate. As the class in these schools has between 40 – 50 children, 5 schools (2 urban and 3 rural) were selected randomly in each governorate, and for each school, one class from each grade (from 1st to 6th), were chosen randomly. All children in the selected classes were interviewed after exclusion of those with any known chronic diseases that might interfere with normal growth such as rheumatic heart, chronic renal diseases or diabetes mellitus.

For each child the collected data included age, sex, residence, birth date, school name, class and grade. Birth date was also verified from school records. The researchers and eight trained nurses collected the data during the academic year 2015/ 2016 (from 1st October to 31st May). Weight of each child was measured using an electronic scale to the nearest 0.1 kg with the child wearing light clothing and no shoes. The height of the child was measured to the nearest 0.1 cm using a wall-mounted stadiometer, while making sure that the child is shoeless, standing up straight looking directly forwards, with his/her heels, buttocks, and scapulae touch the wall.

Percentiles of weight and height for age and sex were determined by CDC growth charts by using the web site:www.infantchart.com/child/, and by manual plotting on Egyptian growth charts. Child with a percentile of weight for age or height for age < 3rd percentile on Egyptian charts or CDC charts were classified as underweight or short stature respectively.

Ethical considerations

The study was approved by research ethical committee of Assiut University. An official permission was obtained from the prime minister of Education and from public security to obtain data from schools. A verbal consent was obtained from children to participate in the study.

Statistical analysis

Data recoding and analysis were performed using SPSS version 20. Descriptive statistics were calculated. Chi-square and student t- test were used to evaluate the differences between categorical and numerical variables respectively. McNemar's chi squared test was used to evaluate the difference between proportions of underweight and short stature among the children according to Egyptian and CDC references. P-value was considered significant when it was < 0.05 (two-sided).

III. The Results

A total of 5458 primary school children aged from 6 – 12 years were included in the study. Boys represented 51.2% and rural children were 49.8%. Table (1) shows means and standard deviations of the weight and height of the studied children according to their age and sex. There were no differences between boys and girls regarding weight and height except in the age group of 7- where there was a significant difference in the height ($p < 0.001$). Table (2) shows that the percentage of the children falls below the 50th percentile of weight for age using CDC charts was higher compared to that with Egyptian growth charts (59.7% vs. 50.3%, $p < 0.001$). There were no significant difference between boys and girls except in age group of 7- when Egyptian charts are used. Regarding stature, table (3) shows that the percentage of the children falls below the 50th percentile of stature for age using CDC charts was higher compared to that with Egyptian growth charts (71.0% vs. 52.5%, $p < 0.001$). No significant differences between boys and girls except in age group of 7- when CDC reference was used. Tables (4) & (5) present the percentages of children classified as underweight for age and short stature for age among boys and girls in each age group with Egyptian growth charts in comparison to CDC

charts. Generally in all age groups the percentages were higher with using CDC charts than those with using Egyptian charts.

Fig. (1) and Fig (2) indicate that by using Egyptian charts the percentages of children being underweight for age and short stature were low compared to those by CDC charts (4.2% & 7% vs.14.8 % & 18.5% respectively), the differences were statistically significant ($p < 0.001$). The Egyptian charts showed significant difference between boys and girls regarding underweight for age (3.3% in boys vs. 5.2%, for girls, $p < 0.001$), while CDC chart showed significant difference between boys and girls regarding short stature (17.1% in boys vs. 19.9% for girls, $p<0.01$). Both Egyptian and CDC references demonstrated that the proportions of being underweight and short stature were significantly higher among rural children than those of urban children (Table 6).

Table (1): Means of Weight (Kg) and height (cm) of the studied boys and girls by age group

Age/ Years	Boys No. = 2796 (51.2%)			Girls No. = 2662 (48.8%)		
	No.	Weight Mean ± SD	Height Mean ± SD	No.	Weight Mean ± SD	Height Mean ± SD
6 -	294	21.8 ± 4.4	115.6 ± 8.6	298	21.5 ± 4.6	115 ± 6.7
7 -	425	23.6 ± 5.1	120.9 ± 7.7*	410	22.9 ± 5.3	118.5 ± 8.4*
8 -	468	26.1 ± 6.1	125.8 ± 6.8	398	26.0 ± 6.5	125 ± 7.1
9 -	442	30.5 ± 8.5	131.5 ± 7.3	440	29.5 ± 6.9	130.6 ± 7.3
10 –	542	35.0 ± 8.7	137.2 ± 7.7	539	34.7 ± 8.5	137.2 ± 8.1
11 – 12	625	39.2 ± 10.7	143.0 ± 8.1	577	38.6 ± 9.6	142.6 ± 8.3

SD: standard deviation, *p value < 0.001

Table (2): Percentage of studied children falls below the 50th percentile of weight for age in Egyptian and CDC growth charts by sex and age group

Age/ Years	Egyptian chart			CDC chart		
	Boys No. (%)	Girls No. (%)	Total No. (%)	Boys No. (%)	Girls No. (%)	Total No. (%)
6 -	90 (30.6)	97 (32.6)	187 (31.6)	181 (61.6)	183 (61.4)	364 (61.5)
7 -	179 (42.1)*	209 (51.0)*	388 (46.5)	256 (60.2)	270 (65.3)	526 (63.0)
8 -	230 (49.1)	204 (51.3)	434 (50.1)	306 (65.4)	253 (63.6)	559 (64.5)
9 -	230 (52.0)	241 (54.8)	471 (53.4)	266 (60.2)	272 (61.8)	538 (61.0)
10 -	270 (49.8)	271 (50.3)	541 (50.0)	271 (50.0)	299 (55.5)	570 (52.7)
11 – 12	381 (61.0)	346 (60.0)	727 (60.5)	358 (57.3)	344 (57.3)	702 (58.4)
Total	1380 (49.4)	1368 (51.4)	2748 (50.3) **	1638 (58.6)	1621(60.9)	*3259 (59.7) *

* Chi square test : $p < 0.05$ ** McNemer's test : $p < 0.001$

Table (3): Percentage of studied children falls below the 50th percentile of stature for age in Egyptian and CDC growth charts by sex and age group

Age/ Years	Egyptian chart			CDC chart		
	Boys No. (%)	Girls No. (%)	Total No. (%)	Boys No. (%)	Girls No. (%)	Total No. (%)
6 -	125(42.5)	140(47.0)	265 (44.8)	196 (66.7)	208 (69.8)	404 (68.2)
7 -	210(49.4)	228 (55.6)	438 (52.5)	300 (70.6)*	326 (79.5)*	626 (75.0)
8 -	247 (52.8)	216 (54.3)	463 (53.5)	343 (73.3)	301 (75.6)	644 (74.4)
9 -	227 (51.4)	218(49.5)	445 (50.5)	308 (69.7)	318 (72.3)	626 (71.0)
10 -	302(55.7)	289 (53.6)	591 (54.7)	370 (68.3)	360 (66.8)	730 (67.5)
11 – 12	333(53.3)	329 (57.0)	662 (55.1)	441 (70.6)	405 (70.2)	846 (70.4)
Total	1444(51.6)	1368(51.4)	2864 (52.5) **	1958 (70.0)	1918(72.1)	3876 (71.0) **

* Chi square test : $p < 0.05$ ** McNemer's test : $p < 0.001$

Table (4): Prevalence of underweight for age among studied children with Egyptian growth chart in comparison to CDC chart

Age/ years	Underweight by Egyptian chart			Underweight by CDC chart			% of difference	
	Boys No. (%)	Girls No. (%)	p-value	Boys No. (%)	Girls No. (%)	p-value	Boys (%)	Girls (%)
6 -	7 (2.4)	5 (1.7)	0.544	37 (12.6)	38 (20.5)	0.951	10.2	11.1
7 -	18 (4.2)	22 (5.4)	0.444	80 (18.8)	78 (25.1)	0.941	4.6	13.6
8 -	12 (2.6)	12 (3.0)	0.687	89 (16.9)	77 (22.4)	0.347	14.3	16.3
9 -	14 (3.2)	32 (7.3)	0.006	58 (13.1)	70 (19.1)	0.240	9.9	8.6
10 -	4 (0.7)	23 (4.3)	0.000	50 (9.2)	54 (15.4)	0.658	8.5	5.7
11 -12	36 (5.8)	44 (7.6)	0.195	98 (15.7)	88 (15.3)	0.837	9.9	7.7
Total	91(3.3)	138 (5.2)	0.000	402 (14.4)	405 (15.2)	0.384	11.1	10.0

Table (5): Prevalence of short stature for age among studied children with Egyptian growth chart in comparison to CDC Chart

Age/ years	short stature by Egyptian			short stature by CDC			% of difference	
	Boys No. (%)	Girls No. (%)	p-value	Boys No. (%)	Girls No. (%)	p-value	Boys (%)	Girls (%)
6 -	7 (2.4)	17 (5.7)	0.040*	52 (17.7)	61 (20.5)	0.389	15.3	14.8
7 -	30 (7.1)	33 (8.0)	0.588	69 (16.2)	103 (25.1)	0.002*	9.1	17.1
8 -	33 (7.1)	32 (8.0)	0.582	87 (18.6)	89 (22.4)	0.169	11.5	14.4
9 -	43 (9.7)	31 (7.0)	0.151	79 (17.9)	84 (19.1)	0.641	8.2	12.1
10 -	42 (7.7)	39 (7.2)	0.749	81 (14.9)	83 (15.4)	0.835	7.2	8.9
11 - 12	32 (5.1)	45 (7.8)	0.058	109 (17.4)	111 (19.2)	0.421	12.3	11.4
Total	187 (6.7)	197 (7.4)	0.304	477 (17.1)	531 (19.9)	0.006*	10.4	12.5

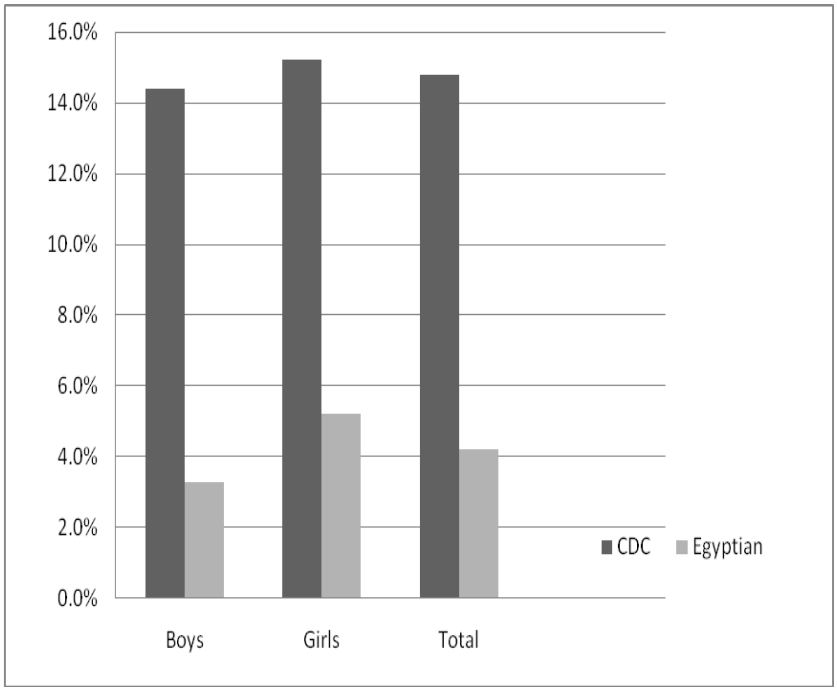

Fig. (1): Prevalence of underweight-for-age in the studied children according to the Egyptian and CDC growth references

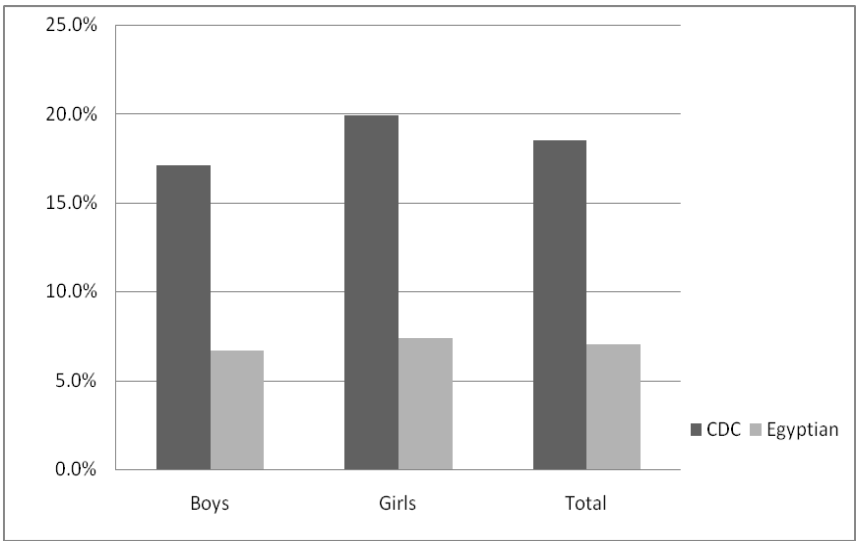

Fig. (2): Prevalence of short stature-for-age in the studied children according to the Egyptian and CDC growth references

Table (6) Prevalence of underweight and short stature for age among urban versus rural children with Egyptian and CDC growth charts

	Urban children No. = 2740		**Rural children No. = 2718**		**p- value**
	No.	**%**	**No.**	**%**	
With Egyptian chart					
Underweight for age	87	3.2	142	5.2	0.000
Short stature	169	6.2	215	7.9	0.012
below 50th percentile of weight	1168	42.6	1580	58.1	0.000
below 50th percentile of stature	1378	50.3	1486	54.7	0.001
With CDC chart					
Underweight for age	274	10.0	533	19.6	0.000
Short stature	432	15.8	576	21.2	0.000
below 50th percentile of weight	1422	51.9	1837	67.6	0.000
below 50th percentile of stature	1825	66.6	2051	75.5	0.000

IV. Discussion

Pediatric growth charts have been widely used globally by researchers, pediatricians, nurses and parents to assess the growth and nutritional status of children, but often users might not be aware of their limitations[15]. Developing many growth charts have raised questions about which growth charts to be used for children in Upper Egypt as a practice guideline for nurses, clinical and community health professionals. The present study was conducted on primary school children in Upper Egypt and the results indicated that by using Egyptian charst, the prevalence rates of children being underweight or short stature for age were significantly low compared to those by CDC 2000 charts (4.2% & 7.0% vs.14.8 % & 18.5%, $p < 0.001$, respectively), with percentage differences of 10.6% for underweight & 11.5% for short stature. Mushtaq et al.[16] suggested that the US CDC growth charts over-estimate the under-nutrition and under-estimate the over-nutrition. This finding was supported by Fetuga et al[17] who found that for children aged 6 to 10 years, the prevalence of underweight and stunting was higher in both sexes when using the CDC standards compared to WHO standards. Kulaga et al.[18], also reported higher prevalence for stunting using WHO 2006 and CDC 2000 compared to their local growth references. In Libya, Al- Sharbati et al.[19] reported that growth pattern (weight/age and height/age) of public primary school children was similar to the international standards at early school age but it dropped down with increased age. The differences between the Egyptian and CDC growth reference are likely to stem from the curve construction where the median (50th percentile) of CDC charts is higher than that of Egyptian charts. This is noticed from our findings that the percentage of the children falls below the 50th percentile of weight and stature for age using CDC charts were higher compared to that with Egyptian growth charts (59.7% &71.0% vs. 50.3% & 52.5%, $p < 0.001$, respectively); these higher rates were observed in all age groups.

Both the Egyptian and CDC growth charts showed that underweight and short stature were more prevalent among girls than boys. The difference in weight was significant in Egyptian charts while difference in the stature was significant in CDC charts. On a closer look to Egyptian growth charts, girls were significantly higher of being underweight than boys especially in age group 9-10 years. This finding is in accordance with Neyzi et al.[20] who stated that girls were more underweight in age group 9 and not in age 10. Similar finding was evidenced by Srivastava et al.[21]. However, many researchers found that girls had lower underweight prevalence than boys while the reverse was true for overweight and obesity[22,23,24,1]. Our finding could be explained by gender discrimination and preference of boys which was observed in Upper Egypt.

Regarding prevalence of short stature CDC has higher prevalence than Egyptian growth charts in both boys and girls in all age groups. On a closer look to Egyptian growth charts, girls were significantly shorter than boys in age group 6 and12. This is in agreement with Neyzi et al[20] who found that girls were shorter than boys at age 12, but no difference was found at age 6.

We found that the prevalence of underweight and short stature for age was statistically higher among rural children than urban children by using both Egyptian and CDC charts with the later had a higher percentage of children with the previous growth indices. Many factors may contribute to these results; rural areas are characterized by high poverty rate, increased level of ignorance, in addition to the increased consumption of junk and fast food among urban children. This explanation was also supported by El-Zanaty and associates[12] who reported that the population in rural Upper Egypt is especially concentrated at the lower end of the wealth index in the Egyptian Demographic Health Survey (EDHS). A similar finding was obtained by Bahreynian et al.[25] who found that underweight and short stature were more prevalent in low socioeconomic status regions in Iran. Urban and rural difference as a factor contributing to nutritional status was evidenced in other studies[26, 27]. The controversial results of assessing nutritional status of children by different growth charts, clinicians must not depend on growth charts only as a single tool, but they must rely more on a comprehensive assessment including clinical and laboratory investigations. It has been suggested that growth charts were not designated as

a sole diagnostic instrument, instead, they contribute to forming an overall clinical impression of the child being measured.

V. Conclusion and recommendation

School children showed different growth faltering depending on growth reference tool used for assessment. The findings in this study imply that by using the CDC standard, more children are likely to be classified as short or underweight thus requiring unnecessary clinical evaluations and interventions in an under-resourced setting. **Recommendation:** School health programs should take into consideration the differences between growth references when nutritional status and interventions are evaluated. This study has brought to the fore, the need to comparatively evaluate other growth charts with that of the Egyptian growth charts in other settings. Also, new national growth reference for school children is needed to represent the growth pattern of all geographical areas in Egypt.

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