Growth Indices for Children and Adolescents in Yanbu as Compared to WHO 2007 Growth References

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Abstract

Objectives: To determine the growth indices (Weight-, Height-, and BMI – for – age Z-scores) of the selected population, and to compare the growth indices of the selected population with those published by WHO in 2007.

Methods: In this cross-sectional study, a total number of 4885 (2439 males and 2446 females) children and adolescents were randomly selected from different schools in Yanbu, and the WHO-2007 Z-score charts were used to calculate their height, weight, and BMI-for-age Z-scores, then these growth indices of the selected population were compared to those published by WHO in 2007.

Results: Our finding demonstrated that distributions of weight-, height- and BMI-for-age Z-scores for Most of Yanbu children and adolescents were within the normal range with no significant differences from those published by WHO ($P = 0.76$).

Conclusion: Distributions of weight-, height- and BMI-for-age Z-scores were comparable to WHO -2007 growth references.

Keywords: Growth indices; Children; Adolescents; Growth references; Weight; Height; BMI; Eating disorders; Anthropometry; Obesity, Diabetes mellitus; Cardiovascular diseases; Chronic disorders; Overweight

Introduction

Children continue to grow and physically develop during the childhood and adolescent years in preparation for the physical changes of adulthood, in this stage of age eating disorders may begin [1]. Therefore, adequate nutrition and the establishment of healthy eating behaviors can help to prevent immediate health problems as well as promote a healthy lifestyle, which in turn may reduce the risk of developing chronic disorders, such as obesity, diabetes mellitus, and cardiovascular diseases later in adult life [1].

Anthropometry is the most single non-invasive technique for assessing the size and composition of the human body [2,3]. It reflects both health and nutritional status and maybe used to predict future health [2,3]. Growth references are used to compare anthropometric measurements among children to reference data [4,5] and to screen for possibly inadequate nutrition or growth that might be suggestive of adverse health conditions [4,6]. These indices are not ratios and are referred to as Z-score relative to appropriate reference data [7]. Before WHO child growth standards in 2006, estimates of the prevalence of malnutrition used old references such as the National Center for Health Statistics (NCHS) based on United States (US) population [2], and -based on a more representative US population- the 2000 Center for Disease Control (CDC) growth charts [8,9]. However, issuing of the new diverse WHO child growth references in 2006 provided a better standard for the growth of children and adolescents [4,10]. The WHO 2006 growth references developing process included 6 diverse countries from different geographical and ethnic regions: Brazil, Ghana, India, Norway, Oman and the United States [4,10]. Consequently, the WHO recommended the use of new standards in all countries. However, 'Typical' child growth patterns are neither constant within nor between various populations [11].

World Health Organization recommends using Z-scores for evaluating anthropometric measurements rather than the growth curves of the CDC [12], which are more specific for Americans, because Z-scores are calculated more accurately and independently from the original references [3]. Later, the WHO-2007 Z-score charts where generated by making some changes to the 2006 charts regarding the 5-19 years standards

[13] because of the concern of public health towards the rising of childhood overweight and developing obesity with its related complications later in adulthood [13,14].

The prevalence of underweight ranges from 1.3% and 40% in the US in Bangladesh and Yemen respectively. This range may be due to the diversity of economical status and available resources [15]. El Mouzan showed that the prevalence of underweight, wasting and stunting in Saudi children was 6.9%, 9.8% and 10.9% respectively. Another study in Saudi Arabia stated that there were significant differences in growth between different regions [16]. Although earlier studies based on the growth of children and adolescents have been conducted in Saudi Arabia [15-17], data about children and adolescents growth in Yanbu are not available.

Materials and Methods

In this cross-sectional study, a total number of 5014 children and adolescents were randomly selected from different schools in Yanbu, 4885 students (2439 males and 2446 females) were analyzed, and 129 subjects were excluded from the study because of missing data.

Only healthy children and adolescent students not taking any medications, between the ages of 5 and 19 years, were included in the study. Anthropometric measurements were performed following standard procedures [3,7]. Height was measured in centimeters ± 0.5 cm, using an international standard fixed stadiometer with a vertical backboard and a movable headboard (Detecto, Webb City, MO, USA). Weight was measured using an international standard digital scale in Kilograms ± 10 g, with light clothing and without shoes. Body mass index (BMI) was calculated according to the following formula: BMI = weight (kg)/ height squared (m2). Information for children less than 9 years were taken from the students' files, whereas students above 9 years were asked to take the information. All data were recorded in a previously designed questionnaire.

Table 1: Criteria used for Z-Score Interpretation.

Index	Z-Score	Description
Weight-for-age	Z-score ≤ -3	Sever Underweight
	Z-score ≤ -2	Underweight
	Z-score ≥ +2	At risk of overweight
	Z-score ≥ +3	Overweight
Weight-for- height	Z-score ≤ -3	Sever Wasting
	Z-score ≤ -2	Wasting
	Z-score ≥ +2	At risk of overweight
	Z-score ≥ +3	Overweight
Height-for-age	Z-score ≤ -3	Sever Stunting
	Z-score ≤ -2	Stunting
	Z-score ≥ +2	Tall
	Z-score ≥ +3	Very Tall
BMI-for-age	Z-score ≤ -3	Sever Wasting
	Z-score ≤ -2	Wasting
	Z-score ≥ +2	At risk of overweight
	Z-score ≥ +3	

The WHO-2007 Z-score charts were used to calculate the height, weight, and BMI-for-age Z-scores, using the published Anthroplus software by World Health Organization software in 200712. After obtaining the data, statistical analysis was performed using Statistical Program for Social Studies (SPSS) version 18 for windows (SPSS Inc, Chicago, USA). Weight-,

height-, and BMI-for-age Z-scores was determined and labeled as shown in table 1. Subjects within the following range +2 > Z-score > -2 were considered normal in all indices.

Underweight and wasting suggests acute malnutrition, whereas stunting is usually related to chronic malnutrition.

Results

Social characteristics of the study group

Table 2: Social Characteristics of the Study Group.

Character		Gender N (%)		Total N (%) 4885 (100)
		Males	**Females**	
Age Group	Children*	1929 (53.0)	1710 (47.0)	3639 (74.5
	Adolescents*	511 (41.0)	735 (59.0)	1246 (25.5)

The study group included 4885 subjects; 2439 males (49.9 %) and 2446 females (50.1 %). Children constituted 74.5% of the total sample (53% males and 47% females), while adolescents represented 25.5% (41% males and 59% females). The social characteristics of the study group are shown in table 2.

Weight-for-age Z-score distribution

Table 3: Weight –for-Age Distribution by Gender§.

Weight-for-Age	Children* N (%) 3639 (74.5)		Adolescents* N (%) 1246 (25.5)		Total 4885 (100)
	Male 1929 (53.0)	Female 1710 (47.0)	Male 511 (41.0)	Female 735 (59.0)	
Overweight Z-score ≥ +3	17 (0.9)	10 (0.6)	7 (1.3)	16 (2.2)	50 (1.0)
At risk of overweight Z-score ≥ +2	129 (6.7)	106 (6.2)	26 (5.0)	54 (7.4)	315 (6.4)
Normal +2 ≥ Z-score ≥ -2	1756 (91.0)	1565 (91.5)	467 (91.4)	655 (89.1)	4443 (91.0)
Underweight Z-score ≤ -2	21 (1.1)	29 (1.7)	11 (2.1)	6 (0.8)	67 (1.4)
Sever underweight Z-score ≤ -3	6 (0.3)	0 (0.0)	0 (0.0)	4 (0.5)	10 (0.2)

§: There was no Significant Differences Between Sample and WHO Growth Standards (P > 0.05).
*Children: 6-15.5 y for Males and 6-14.5 y for Females; Adolescents: 15.5-19 y for Males and 14.5-19 y for Females.

Table 3 shows that only 1% of the study sample were overweight. Around 6.4% of children and adolescents were at risk of overweight. On the other hand, 91 % of were in the normal range. About 1.4 % were underweight. Only 6 male children and 4 female adolescents were severely underweight in the studied sample.

Height-for-age Z-score distribution

Only 0.6% of female children were very tall. However, no male children, neither adolescent males nor females were very tall. The percentage of tall children was 1.7% of the children sample (2.1% males and 2.6% females). Among children 92.3% were within the normal range of height-for-age (93.3% males and 91.2% females), and 95.6% of adolescents were also within the normal rang (98% males and 93.9% females). Stunted subjects represented 4.2% of both children (4.1% males and 4.7% females) and adolescents (2.0% males and 6.1% females). Severely stunted subjects were only found in children (0.7%). Results are shown in table 4.

Table 4: Height-for-Age Z-Score Distribution among study Age Groups by Gender§.

Weight-for-Age	Children* N (%) 3639 (74.5)		Adolescents* N (%) 1246 (25.5)		Total 4885 (100)
	Male 1929 (53.0)	Female 1710 (47.0)	Male 511 (41.0)	Female 735 (59.0)	
Very tall Z-score ≥ +3	0 (0.0)	10 (0.6)	0 (0.0)	0 (0.0)	10 (0.2)
Tall Z-score ≥ +2	41 (2.1)	44 (2.6)	0 (0.0)	0 (0.0)	85 (1.7)
Normal +2 ≥ Z-score ≥ -2	1800 (93.3)	1560 (91.2)	501 (98.0)	690 (93.9)	4561 (93.4)
Stunting Z-score ≤ -2	79 (4.1)	70 (4.7)	10 (2.0)	45 (6.1)	204 (4.2)
Sever stunting Z-score ≤ -3	10 (0.5)	15 (0.9)	0 (0.0)	0 (0.0)	25 (0.5)

*Children: 6-15.5 y for Males and 6-14.5 y for Females; Adolescents: 15.5-19 y for Males and 14.5-19 y for Females.
§: There were no Significant Differences Between Sample and WHO Growth Standard (P > 0.05).

Body mass index Z-score distribution

As shown in table 5, overweight was observed in 36 subjects of children group (0.8% males and 1.2% females) and 17 adolescents (2.0% males and 1.0% females). Two hundred sixty-one subjects of the children group (7.3% males and 7.0% females) were at risk of overweight, whereas only 95 adolescents (5.9% males and 8.8% females) were at risk of overweight. And 88.4 % of the total sample were within the normal range. Of the children group (2.3% males and 3.5% females), and only 15 (2.9%) male adolescent were considered underweight. Only 40 children (1.0% males and 1.2% females) and no adolescents were severely underweight.

Discussion

Health examination of children and adolescents has been an important concern in disease prevention programs in many countries [18]. This examination requires assessing height-, weight-, and BMI-for-age for children. Growth charts are usually used to diagnose stunting, overweight and underweight [4]. As far as we know this study is first to assess how well Yanbu children and adolescents match with, or diverse from World Health Organization (WHO)-2007 growth references.

Our finding demonstrated that distributions of weight-, height- and BMI-for-age Z-scores for Yanbu children were comparable with WHO-2007 reference data (P = 0.76). Most of children and adolescents were within the normal range. Our findings were in agreement with El Mouzan et al. [19] who showed, when compared with the CDC percentile, the growth charts for children and adolescents are shifted downwards. Another study by Alhaidari et al. [20] on children 1 month to 7 years old, showed that the growth parameters for children in Riyadh region of Saudi Arabia is shifted downwards [21]. However, our findings were in contrast with those studies and another study by El Mouzan et al. [22] who found that applying

WHO standards in Saudi Arabia increases the prevalence of undernutrition, stunting, and wasting. In another study by El Mouzan et al. [22] the authors compared three different regions in Saudi Arabia that did not include the western region, neither Yanbu city. Moreover, El Mouzan et al. [22] was comparable with previous studies [23-25] that were conducted 10 years earlier on Saudi children under 5 years old, their findings of growth parameters were shifted upwards, which would indicate better growth for children. It is likely that this trend of shifting the growth parameters would continue, which, nowadays could be comparable to the WHO standards. This is probably due to improved lifestyle patterns and health education among the Saudi population, which would be reflected on improved growth parameters for children and adolescents. This variation in results maybe because of the diversity of Yanbu population, improved lifestyle patterns in Yanbu region, especially in the recent years, more comfortable way of living, and the little bet higher income compared to other Saudi cities. Our study highlight the importance of updating the growth charts suggested by El Mouzan et al. [17], which would help pediatricians and dietitians alike on assessing the growth parameters of children in Saudi Arabia [26,27].

Conclusions and Recommendations

Distributions of weight-, height- and BMI-for-age Z-scores were comparable to WHO -2007 growth references. Recent data about growth patterns for children and adolescents is lacking from the records of many countries of the world, which is needed to assess the risk of global pandemic of obesity.

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Conflict of Interest

The authors would like to declare that on conflict of interest exists.

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