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Construction of height-weight growth charts for 2-18 year old boys in Qayenat City in Iran: A comparison with NCHS

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ABSTRACT

This study aim was Construction of height-weight growth charts for 2-18 year old boys in Qayenat City and comparison with NCHS standard height-weight growth charts. The research methodology was descriptive and the data was collected via field procedure. The population of the study consisted of 2-18 year old boys in both urban and rural areas of Qayenat City, which were estimated to be 31353 people. In order to select the participants, Qayenat City was first divided into four regions so that all regions (clusters) were relatively similar in terms of climatic, economic and cultural conditions. Based on administrative divisions, Qayenat City is divided into four regions which relatively account for these similarities. Subsequently, schools, healthcare centers and classes were randomly selected. The sample size was determined using Morgan table (N=3200). In order to collect the data, the researcher along with eight interns of healthcare centers formed two teams and referred to the selected schools to measure the height and weight of the participants. Descriptive statistics including measures of central tendency and variability, frequency were used to analyze the data. The results showed that the height and weight percentiles of 2-18 year old boys in Qayenat City were below the respective weight percentiles of NCHS standard at all age levels.

Keywords: height, weight, growth charts, NCHS.

INTRODUCTION

Pediatricians and health experts are supposed to deal with children's affairs including concern for their appropriate growth and development. Measurement of children's height and weight is one of the most common methods used to study children's physical growth. Just as normal growth is an indicator of children's health, deviation from growth pattern also signals a nonspecific but significant symptom of severe diseases. Such deviation may be the first sign of a child's problem which may be left unnoticed even by parents. Periodical measurements are much more rewarding than once-for-all measurements because they allow for identification of any deviation from a specific pattern of growth even if the growth curve falls within a normal limit [1- 2].

It is of utmost importance to supervise and assess children's nutrition and development so as to warrant their normal development, maintain and improve their health, learning and physical fitness [3-4]. Measurement of body dimensions, particularly height and weight, is one the main sources of information on nutritional and developmental status of children [5]. Developed countries have constructed growth standards and studied the relationship between growth and environmental factors.

The early studies considered differences in physical growth between races, socio-economic statuses and geographical factors [6- 7]. Before the establishment of standard curves of American National Center for Health Statistics (NCHS), most of the growth charts could only be used temporarily since the research samples were not universal and the results not generalize able [8-9]. Before NCHS chart was developed, a rather enduring curve was

the result of a combination of Boston and Iowa studies, which was used in medical reports. Many studies in the U.S and other countries were conducted to compare their results with Boston-Iowa curves. The data in all these studies were collected from white north European children as well as middle class children of Boston and Iowa.

Longitudinal studies on child growth patterns were conducted in the U.S so as to construct percentiles and growth curves consistent with racial, socio-economic and geographical differences so that the findings could be generalizable to all regions of the U.S. Since then, NCHS standard curves came to be regarded as reference charts for monitoring children and adolescents' growth in many parts of the world. However, while the samples used for constructing NCHS curves were universal, differences in climate, economy and genetics between the U.S and other countries, particularly developing and third world countries, may render these charts inappropriate to correspond to the growth pattern in these countries. It is notable to mention that this lack of correspondence is not only peculiar to different countries but also exists among different regions of the same country due to different environmental, economic and cultural conditions as well as the amount of physical activity. Therefore, the growth curves need to be constructed separately for every region [10].

Regular measurement of height and weight and recording the results on appropriate curves may help diagnose growth disorders early so that proactive measures can be taken as such [11]. Therefore, it is becoming increasingly important to use normal height-weight growth charts to assure children's health [12-13]. The main reference of growth assessment is growth curves which usually follow the criteria of western countries including England [14], Sweden [15] and the U.S [16]. Various studies have shown that growth pattern varies over time [17]. For example, Dutch 8-10 year old children have grown as much as 22 mm in average height between 1965 and 1980 [18]. Therefore, considering the demographic differences, these charts cannot be used as real references for growth pattern in all societies.

American or English reference charts are used in Iran to assess children and adolescents growth patterns because Iranian children growth patterns in different developmental stages have not yet been studied comprehensively. Still, limited studies have been conducted in some regions (especially urban areas) including the investigation of children height and weight in Shiraz [16], Tehran [20], Isfahan [21], Mashhad [22], Gilan [23] and Kerman [24].

It is evident that growth in height and weight in a society is affected by factors peculiar to that society. These factors may include genetics, race, nutrition, type and intensity of physical activity and cultural and economic status [25-13]. Considering the variable effects of these factors in different countries, a reference height-weight chart constructed for a developed country may not adequately account for children growth patterns in every society [10]. These factors may not only exert variable effects on children growth but they may also bring about different growth rates in different regions of the same country. Using foreign reference charts may result in the identification of some children as underdeveloped thought they be normal in terms of the standards of their own society.

In developed countries, measurement of anthropometric characteristics of individuals has helped develop norms for the assessment of children and adolescents growth. However, no comprehensive norms have yet been developed in Iran, which could be used in different regions of the country. Therefore, lack of local or national reference charts is one the sources that inspired the conduction of the present study. The question is that whether or not using foreign reference charts results in the misconception of Iranian children and adolescents rate of growth. Therefore, the present study aims at compiling tables and plotting normal curves of height and weight growth for 2-18 year old boys in Qayenat City. Then these curves will be compared with NCHS standard curves, which are used as the reference charts for monitoring children growth in Iran, so as to determine whether or not NCHS charts can be used as references for the assessment of children and adolescents growth in Qayenat City.

MATERIALS AND METHODS

Due to objective, realistic and regular characterization of the existing properties, the method of the present study is descriptive. In this type of research, the data should be objectively collected and reported with no subjective abstraction [26]**.** The population of the study consisted of 2-18 year old boys in both urban and rural areas of Qayenat City, which were estimated to be 31353 people. In order to select the participants, Qayenat City was first divided into four regions so that all regions (clusters) were relatively similar in terms of climatic, economic and cultural conditions. Based on administrative divisions, Qayenat City is divided into four regions which relatively account for these similarities. Subsequently, schools, healthcare centers and classes were randomly selected (N=3200).

In order to collect the data, the researcher along with eight interns of healthcare centers formed two teams and referred to the selected schools to measure the height and weight of the participants. Descriptive statistics including measures of central tendency and variability, frequency charts and relative frequency were used to analyze the data.

RESULTS

Comparison of participants' height and weight with NCHS standard charts

Table 1 illustrates the statistics of height and weight in 2-18 year old boys in Qayenat City. The table also displays the number of participants in each age group.

Table1. Statistics of height and weight in 2-18 year old boys in Qayenat City

Statistic Age	Number	Height (Cm)			Wight(Kg)		
		Mean± Std. D	Min	Max	Mean± Std. D	Min	Max
2	108	85.1±3.6	79	96	11.8±1.4	9	18
3	108	92.5±4.6	85	106	13.2±2.06	10	21
4	108	97.9±4.1	91	110	16.5±2.9	10	25
5	216	108.9±6.2	93	121	16.9±3.4	10	29
6	216	114.5±5.3	100	131	19.1±4	12	35
7	108	117.7±4.9	107	130	20.1±2.3	15	26
8	186	125.5±6.2	114	142	23.4±3.1	17	31
9	186	128.7±5.2	111	141	24.9±3.2	19	43
10	108	135.2±5.6	123	151	28.6±4.7	22	51
11	216	137.8±7.4	121	160	30.6±6.1	23	51
12	216	139.1±6.9	125	160	31.3±4.8	23	58
13	214	142.4±7	127	161	33.8±5.9	22	51
14	216	150.1±10.5	128	175	39.4±8.9	26	66
15	251	157±9.4	132	177	44.8±9.6	27	75
16	216	166.3±8.8	146	185	52.7±9.9	34	93
17	180	167.2±7.5	145	183	55.1±10.4	38	106
18	144	170.7±6.1	154	193	58.2±9.2	39	93

Table2. Height percentiles in Qayenat City and NCHS standard height percentiles

Statistic Age	5^{th}		25^{th}		50^{th}		70^{th}		95^{th}	
	NCHS	Qayenat	NCHS	Qayenat	NCHS	Qayenat	NCHS	Qayenat	NCHS	Qayenat
2	82.5	81	85.3	82.5	86.8	84	89.2	87	94.4	94
3	89	86	92.6	89	94.9	92	97.5	95	102	103
4	95.8	92.4	100	94	102.9	97.5	105.7	100	109.9	107
5	102	99	106.5	104	109.9	109	112.8	114	117	119
6	107.7	105.8	112.5	111	116.1	115	119.2	118	123.5	123
7	113	109	118	114	121.7	118	125	121.7	129.7	125
8	118.1	116.3	123.2	121	127	125	130.5	129	135.7	138
9	122.9	121.4	128.2	124	132.2	130	136	132	141.8	138
10	127.7	127.4	133.4	131	137.5	135	141.6	139	148.1	144
11	132.6	126	138.7	133	143.3	137	147.8	142.7	154.9	151
12	137.6	128	144.4	134.2	149.7	139	154.6	144	162.3	151
13	142.9	131	150.5	138	156.5	142	161.8	148	169.8	154
14	148.8	132	156.9	143	163.1	150	168.5	159	176.7	166
15	155.2	142	163.3	150	169	157	174.1	165	181.9	172
16	161.1	149.8	168.7	160	173.5	167	178.1	173	185.4	179
17	164.9	152	171.9	163	176.2	167.5	180.5	172	187.3	178
18	165.7	160	172.3	167	176.8	171	181.2	174	187.6	179

Table 2 illustrates percentiles of participants' height and NCHS height standard. The table displays the 5^{th}, 25^{th}, 50^{th} (median), 75^{th} and 95^{th} percentiles. The results showed that the height percentiles of 2-18 year old boys in Qayenat City were below the standard height percentiles of NCHS at all age levels. However, the degree of variation between the participants' height percentiles and NCHS height percentiles differs at different age levels.

Table 3 illustrates percentiles of participants' weight and NCHS weight standard. The table displays the 5^{th}, 25^{th}, 50^{th} (median), 75^{th} and 95^{th} percentiles. It is notable to mention that 25^{th} percentile corresponds to the first quarter, 50^{th} percentile is the second quarter and the 75^{th} percentile equals the third quarter of participants' weight. As shown in Table 4, the weight percentiles of the 2-18 year old boys in Qayenat City were below the standard weight percentiles of NCHS at all age levels. However, the degree of variation between the participants' weight percentiles and NCHS weight percentiles differs at different age levels.

Table3. Weight percentiles in Qayenat City and NCHS standard weight percentiles

Statistic	5th		25th		50th		70th		95th	
Age	NCHS	Qayenat	NCHS	Qayenat	NCHS	Qayenat	NCHS	Qayenat	NCHS	Qayenat
2	10.49	10	11.55	11	12.34	12	13.36	13	15.50	14.5
3	12.5	10	13.52	12	14.62	13	15.78	14	17.77	17
4	13.64	12.4	15.39	14	16.69	16	17.99	17.5	20.27	20
5	15.27	11	17.22	14	18.68	16	20.14	18	23.09	23
6	16.93	15	19.07	17	20.69	18	22.4	20	26.34	25
7	18.64	16	21	18	22.85	20	24.94	22	30.12	27
8	20.4	18	23.09	21	25.30	23	27.91	26	34.51	28
9	22.25	20	25.4	23	28.13	25	31.46	26	39.58	29
10	24.33	23	28.07	25	31.44	27	35.61	31	45.27	36
11	26.8	24	31.25	27	35.30	29	40.38	32	51.47	44
12	29.85	25	35.09	28	39.78	31	45.77	34	58.09	40
13	33.64	25	39.74	30	44.95	33	51.79	37	65.02	46
14	38.22	27	45.21	32	50.77	38	58.31	43	72.13	55
15	43.11	32	50.92	38	56.71	42	64.72	50	79.12	63
16	47.74	38.8	56.16	46	62.10	52	70.26	57	85.92	70
17	51.5	42	60.22	50	66.31	53	74.17	59	91.31	74
18	53.97	47	62.61	52	68.88	57	76.04	63	95.76	75

DISCUSSION

The results showed that the weight percentiles of 2-18 year old boys in Qayenat City were below the respective weight percentiles of NCHS standard at all age levels. The greatest difference was noticed at the age of 11 so that, after the age of eleven, the 50th percentile of participants' weight inclines to the 5th percentile in NCHS standard and in some cases (the ages 12-15) coincides with the 5th percentile in NCHS standard. All percentiles of participants' height were below the respective percentiles in NCHS standard and the difference becomes greater after the age of eleven so that, at the age of eleven, the 50th percentile of participants' height inclines to the 5th percentile in NCHS standard and in some cases (the ages 12-14) coincides with the 5th percentile in NCHS standard.

The results show that, with increasing age, the risk of malnutrition significantly increases in the participants. Sudden dramatic increase in difference between participants' average height and weight and NCHS standard curves at the age of eleven may relate to differences in puberty age between the samples. That is, American children reach puberty sooner than their peers in Qayenat City. This may be accounted for by reduction in the differences as children's age increase. Research has shown that temperature may affect the puberty age so that children who live in cold climates reach puberty at older ages comparing with those who live in warm regions [27]. Since Qayenat is located in a cold region, the sudden dramatic difference in height and weight at age 11 between the present participants and their American counterparts may relate to differences in their puberty age. Besides, other factors such as environment, socio-cultural conditions, customs, genetics and nutrition may also reflect the difference in puberty age.

The present findings correspond to similar studies on Iranian children and adolescents in other cities including Isfahan, Ahwaz, Tonkabon, Kerman, Shiraz, Babol, Rasht [23-24-27-29-30-31-32]. Labbaf Ghasemi et al (1996) reported that 50th percentile of elementary students' height and weight corresponds to the 25th percentile of NCHS standard, and, from the age 10 onward, it moves below the 25th percentile of NCHS standard. This is consistent with the present findings [28]. Ansari (1998) reported that 44.6% and 14% of female elementary students in Ahwaz are below the 5th standard percentile in terms of weight and height, respectively [29]. Nasiri et al (1999) showed that there is a small difference in 50th percentile of height and weight at the ages 7 and 8 between students in Tonkabon and NCHS standard; however, the difference increases with increasing age [30]. Ahmadi (1998) reported that 6-11 year old boys and girls in Kerman have significantly less average height and weight comparing with their American peers, and the difference increases with increasing age[31]. Hajian (2000) showed that the 50th percentile of height and weight in both male and female elementary students in Babol remains close to the 25th percentile of NCHS standard up to the age 11 where it remains below the 25th percentile of NCHS standard. Besides, the 50th percentile of both male and female height and weight falls between the 25th and 50th percentile of NCHS standard. However, from the age 10 onward, it falls below the 25th percentile of NCHS standard.

Delshad et al (1998) studied the growth rate of girls and boys in Hamadan and reported that the 50th percentile of children height and weight corresponds to similar percentiles of NCHS standard up to the age eleven; however, differences were noticed at the onset of puberty between the participants and NCHS standard [33]. Aminoroaya (2003) reported that height-weight growth curves of 6-18 year old students in Isfahan correspond to NCHS height-weight growth curves [20]. Research on school children growth rates in developing countries shows that almost 10%

to 50% of children are below the 5th percentile of NCHS standard in height and weight [34]. Walker et al (1997) reported that 31.8% of African school children were below the 5th percentile of NCHS standard in weight [34]. Zaman et al (1997) reported that 75% of Bengali children suffered from malnutrition in terms of weight for age and height [35].

The results suggest that though intensive longitudinal studies have been carried out on children height and weight in the U.S and the resulting charts are considered as valid international reference charts, Iranian children and adolescents' growth rates and patterns differ considerably from NCHS standard.

A comparison between the present findings and those of the studies in east Tehran, Rasht and Isfahan showed that 2-18 year old boys in Qayenat City have lower average height and weight than their peers in other regions of the country. This may be regarded as a serious warning to the officials of Qayenat City.

Overall, the results of comparison between the growth charts of boys in Qayenat and NCHS standard charts revealed that Qayenat boys are shorter than their American peers at all age groups. The difference was more noticeable in weight and the difference in both height and weight increased with increasing age. This indicates the inappropriate nutrition of families in Qayenat City. The slow rate of growth with increasing age often relates to nutrition and economic status of families. Although physical growth is influenced by genetic and environmental factors, nutrition and socio-economic factors play more significant roles. Therefore, since Qayenat City is considered as one of the disadvantaged regions with inappropriate economic status, the differences between the height-weight growth rates in Qayenat children and NCHS standard rate may be attributed to malnutrition. In this regard, genetic and climatic factors may be less important. Further longitudinal cohort studies or cross-sectional studies with specific time intervals are required to illuminate other potential factors. The present findings showed that children and adolescents in Qayenat significantly differ from their American peers in growth rates. Thus, the height-weight growth charts of North American children may not be applicable to the Qayenat population. In this regard, local and national growth standards should be developed consistent with nutritional conditions of Iranian children.

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