HEIGTH, WEIGHT AND BMI CENTILES OF SCHOOLCHILDREN OF ULAANBAATAR, MONGOLIA: COMPARISON WITH WHO AND CDC GROWTH REFERENCES

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[1]Munkhzaya M, [2]Khuderchuluun N, [3]Chimedsuren O, [4]Undram L*

[1]Department of Nutrition and Environmental Health, School of Public Health, Mongolian National University of Medical Sciences

[2]Department of Epidemiology and Biostatistics, School of Public Health, Mongolian National University of Medical Sciences

[3]Department of Cyber training, Graduate School, Mongolian National University of Medical Sciences

[4]Department of Health Policy, School of Public Health, Mongolian National University of Medical Sciences

**Corresponding author:*
Dr.Undram Lkhagvaa, PhD
Department of Health Policy, School of Public Health, Mongolian National University of Medical Sciences

ABSTRACT

Background: In Mongolia, children's growth monitored by WHO and CDC growth charts. The purpose of the study was to compare the growth of UB school children with the WHO and CDC growth reference curves.

Methods: 8046 pupils aged 6-17 years old participated in the study. The subjects were sampled 4044 boys and 4002 girls. Height and weight were measured with Physician Beam Scale. Growth references were generated by the LMS method.

The centiles were compared to the WHO and CDC. The 3rd, 50th and 97th centiles were plotted along with the corresponding values of WHO and CDC.

Results: In Mongolian children the overall height was below compared to both WHO and CDC references, with the highest differences at 12-17 years, 14-17 years and 13-17 years of age at P3, P50 and P97 respectively. Body weight in girls of UB city was slightly heavier compared to the WHO and CDC counterparts on the 3rd and 50th centiles, but on the 97th centile the WHO and CDC counterparts became significantly heavier than Mongolian girls, especially at the 12-17 years of age. Body weight in boys of UB city was lighter than the WHO and CDC references at 12-17 years old age. In Mongolian children BMI was greater on the 3rd centile. But on the 50th centile the BMI of Mongolian boys became smaller at 14-17 years old compared to WHO and CDC references

Conclusion: The height, weight and BMI values of developed growth curves for Mongolian school children differ compared to the WHO and CDC growth references, especially for schoolchildren aged 12 years and upwards.

Keywords: height, weight, BMI, growth chart, schoolchildren, WHO2007, CDC2000

BACKGROUND

Cole TJ describes a growth curve as "powerful graphical tool, as it displays both the size of the child at a series of ages, and at the same time their growth rate or growth velocity over time, based on the slope of the curve" [1]. Moreover, using it health professionals monitor children's physical development and assess the nutritional status of children. Many countries have established their own reference growth charts for children and adolescents [2-5]. In Mongolia, growth charts of the World Health Organisation (WHO), from birth to 5 years [6] and also from 5 to 18 years [7] and Centers for Disease Control and Prevention (CDC), from birth to 20 years [8], are commonly used, based on the recommendation of the Ministry of Health of Mongolia (MoH). The WHO calculated a set of normative curves from the Multicentre Growth Reference Study (MGRS). Study participants came from single cities in six countries such as Brazil, Ghana, India, Norway, Oman and the USA whereas the CDC growth charts were developed with data from five national health examination surveys and limited supplemental data.

Although countries have been strongly encouraged to adopt WHO and CDC charts at a national level, epidemiological and clinical consequences of such adoption need to be evaluated. Differences have already been described between the French references and the WHO growth charts for children under 5 years [9] but no information is available on whether the growth of French children born in recent decades conforms to the WHO growth charts, from birth to 18 years. As recently suggested by the Committee on Nutrition of the European Society for Pediatric Gastroenterology, Hepatology and Nutrition [10], further studies are needed to determine whether the WHO growth charts are appropriate for monitoring growth, and whether they are more appropriate than national reference curves. In Russian Federation due to a diversity of climate and geographical areas, nationalities and ethnic groups and a difference of social and economic situation in the country regions there is no national growth reference [11]. Therefore, growth charts were developed for particular region and compared to WHO growth charts and there were some differences revealed [12].

In the USA, data sources, which were obtained before the prevalence of obesity increased, were used for the development of the growth charts to prevent weight-for-age and BMI-for-age percentiles from

shifting upward [8]. In the USA, several weight data sets were excluded from the development of the 2000 CDC Growth Charts, which were collected when the prevalence of obesity increased.

Analysis of height and weight in UB city schoolchildren between 1962-2010 showed both upward and downward changes. An upward change in height and weight were during period of, and then in 2010-2015 downward change was observed in most age groups [13]. Moreover, the fifth national survey on nutrition of Mongolian population showed the increasing number of overweight and obese children and adolescents [14].

All these factors influenced to develop the National growth references. Therefore, in the first instant we developed growth references for schoolchildren living in Ulaanbaatar city (UB city), where more than third of the country population resides. The purpose of the study was to compare the growth of UB school children with the WHO and CDC growth reference curves currently used.

SUBJECTS AND METHODS

The study is observational cross-sectional study, which was carried out in state-owned schools from Ulaanbaatar city, the capital of Mongolia, between September 2014 and May 2018. All state schools in six districts were mapped and 13 schools from each district were randomly selected. 8046 pupils aged from 6 to 17 years old were invited to participate in the study. The subjects were sampled 4044 boys and 4002 girls.

The informed consent was requested from the children parents or legal guardians who were informed about the objectives and methods prior to the study. Research protocols approval was obtained from the Ethics Committee of the Mongolian National University of Medical Sciences.

Height and weight were measured with Physician Beam Scale (Detecto 339 Balance Beam Scale with Height Rod). Height was measured to the nearest 0.5 cm as each subject stood erect, barefooted with the head held in Frankfort horizontal plane. Weight was measured to the nearest 0.1 kg with light clothing and barefooted.

Growth references were generated by the LMS method [15]. This method assumes that the data an be normalized by means of a power transformation, which expands one tail of the distribution and shrinks the other allowing to remove the skewness. The optimal power of a Box-Cox transformation to obtain approximate normality is calculated for each of a series of age groups and the trend summarized by a smooth (L) curve. Trends in the mean (M) and coefficient of variation (S) are similarly smoothed. The resulting L, M and S curves contain the information to draw any centile curve, and to convert measurements into exact SD scores. The first step of data processing was to remove outliers performing scatter and box plots. The resulting distributions included the mean ± 4 SD. After that, weight and height centiles were estimated on a sample of 4044 boys and 4002 girls. LmsChartMaker Light was used to develop the growth curves [16]. The centiles were compared to the WHO2007 and CDC2000 [2]. The 3rd, 50th and 97th centiles were plotted along with the corresponding values of WHO and CDC references. The extent of smoothing required was expressed in terms of smoothing parameters, which were selected taking into account the minimal penalized deviance, keeping the order M4S4L.

RESULTS

In total, 8046 pupils aged from 6 to 17 years old were invited to participate in the study. The subjects were sampled 4044 (50.3%) boys and 4002 (49.7%) girls and their mean age was 11.0±3.5 and 11.9±3.5 years respectively. Boys were significantly heavier than girls except from 6-11 years of age. They were also taller between 6-10 years old and from 12 onwards. At seven years old, differences between sexes averaged 7.3 kg and 12.9 cm.

The extent of smoothing required was expressed in terms of smoothing parameters or equivalent degrees of freedom edf, which were selected taking into account the minimal penalized deviance, keeping the order M<S<L.

In Tables 1, 2, and 3 are presented height, weight and BMI percentiles and LMS values for 6-17 year old school children of UB city.

Table 1.

Body height (cm) percentiles and LMS values by sex and age in 6-17 year old schoolchildren of UB city

Age	L	M	S	P(1)	P(3)	P(5)	P(15)	P(25)	P(50)	P(75)	P(85)	P(95)	P(97)	P(99)
Boys														
6	1.272	116.088	0.048	104.5	106.6	107.7	110.6	112.5	116.1	120.0	122.2	126.2	127.8	131.0
7	0.968	121.275	0.049	108.8	111.0	112.2	115.4	117.4	121.3	125.4	127.8	131.9	133.6	136.9
8	0.693	126.613	0.050	113.2	115.5	116.8	120.3	122.4	126.6	131.0	133.5	137.9	139.6	143.0
9	0.447	131.875	0.051	117.5	120.0	121.4	125.2	127.4	131.9	136.5	139.1	143.7	145.5	149.0
10	0.163	136.862	0.051	121.5	124.3	125.8	129.7	132.2	136.9	141.7	144.4	149.1	151.0	154.6
11	0.204	142.091	0.052	125.6	128.7	130.3	134.6	137.2	142.1	147.2	150.0	154.7	156.6	160.2

12	0.659	147.849	0.052	130.2	133.5	135.3	139.9	142.6	147.8	153.1	156.0	160.8	162.7	166.3
13	1.182	153.940	0.052	135.0	138.7	140.6	145.6	148.5	153.9	159.3	162.2	167.1	168.9	172.4
14	1.776	159.790	0.051	139.8	143.8	145.9	151.1	154.2	159.8	165.2	168.1	172.8	174.6	178.0
15	2.449	164.865	0.049	144.0	148.3	150.5	156.1	159.2	164.9	170.2	173.0	177.6	179.3	182.5
16	3.189	168.897	0.047	147.4	152.1	154.4	160.1	163.3	168.9	174.1	176.8	181.1	182.7	185.7
17	3.961	172.451	0.045	150.6	155.5	157.9	163.8	166.9	172.5	177.5	180.0	184.1	185.5	188.3
Girls														
6	1.765	115.273	0.049	103.9	105.8	106.9	109.8	111.6	115.3	119.3	121.6	125.8	127.5	131.0
7	0.916	120.792	0.049	108.3	110.5	111.7	114.9	116.9	120.8	125.0	127.3	131.4	133.1	136.4
8	0.060	126.279	0.049	112.5	115.0	116.4	119.9	122.1	126.3	130.6	133.0	137.1	138.7	141.8
9	0.784	131.803	0.049	116.7	119.6	121.1	125.0	127.4	131.8	136.2	138.6	142.7	144.3	147.3
10	1.552	137.278	0.049	120.9	124.1	125.8	130.1	132.6	137.3	141.8	144.2	148.2	149.8	152.6
11	2.135	142.949	0.048	125.5	129.1	130.9	135.5	138.2	142.9	147.6	150.0	153.9	155.5	158.3
12	2.441	148.693	0.047	130.8	134.5	136.4	141.1	143.8	148.7	153.3	155.7	159.7	161.2	163.9
13	2.513	153.647	0.045	135.9	139.6	141.5	146.2	148.8	153.6	158.2	160.6	164.5	166.0	168.7
14	2.476	157.200	0.043	140.1	143.6	145.4	150.0	152.5	157.2	161.7	164.0	167.8	169.2	171.9
15	2.462	159.144	0.040	142.9	146.2	147.9	152.2	154.7	159.1	163.4	165.7	169.3	170.7	173.3
16	2.572	159.717	0.038	144.3	147.5	149.1	153.2	155.5	159.7	163.8	165.9	169.3	170.6	173.1
17	2.775	159.639	0.036	145.1	148.1	149.6	153.5	155.7	159.6	163.4	165.4	168.7	169.9	172.1

Table 2.

Body weight (kg) percentiles and LMS values by sex and age in 6-17 year old schoolchildren of UB city

Age	L	M	S	P(1)	P(3)	P(5)	P(15)	P(25)	P(50)	P(75)	P(85)	P(95)	P(97)	P(99)
Boys														
6	-1.298	22.091	0.148	16.6	17.4	17.9	19.2	20.1	22.1	24.6	26.2	29.6	31.2	34.8
7	-1.209	24.255	0.159	17.9	18.8	19.3	20.9	21.9	24.3	27.2	29.2	33.2	35.2	39.6
8	-1.128	26.745	0.170	19.3	20.3	21.0	22.8	24.0	26.7	30.2	32.6	37.4	39.8	45.2
9	-1.062	29.575	0.180	20.9	22.1	22.9	24.9	26.4	29.6	33.7	36.4	42.2	45.0	51.5
10	-0.990	32.411	0.188	22.5	23.9	24.8	27.1	28.8	32.4	37.1	40.2	46.9	50.1	57.5
11	-0.890	35.350	0.193	24.2	25.8	26.7	29.4	31.3	35.3	40.6	44.1	51.3	54.8	62.7
12	-0.760	38.855	0.195	26.3	28.1	29.2	32.2	34.3	38.9	44.6	48.4	56.1	59.7	67.8
13	-0.604	43.008	0.195	28.8	30.9	32.1	35.6	37.9	43.0	49.3	53.3	61.4	65.0	73.0
14	-0.428	47.587	0.192	31.6	34.0	35.4	39.3	41.9	47.6	54.4	58.6	66.9	70.5	78.2

15	-0.244	52.349	0.190	34.4	37.2	38.8	43.2	46.2	52.3	59.6	64.0	72.4	76.0	83.4
16	-0.050	57.189	0.186	37.2	40.4	42.2	47.2	50.5	57.2	64.9	69.4	77.9	81.5	88.7
17	0.150	62.214	0.184	40.0	43.6	45.7	51.3	54.9	62.2	70.3	75.1	83.6	87.1	94.1
Girls														
6	-1.083	21.221	0.143	16.0	16.8	18.5	19.4	21.2	23.5	24.9	26.0	27.9	29.2	32.1
7	-0.934	23.409	0.156	17.1	18.1	20.1	21.2	23.4	26.2	27.9	29.2	31.4	33.0	36.5
8	-0.786	25.853	0.169	18.4	19.5	21.9	23.2	25.9	29.1	31.2	32.8	35.4	37.2	41.3
9	-0.640	28.718	0.179	19.9	21.2	24.1	25.6	28.7	32.6	35.0	36.8	39.8	42.0	46.6
10	-0.482	31.925	0.186	21.5	23.1	26.5	28.3	31.9	36.3	39.1	41.1	44.5	46.8	51.9
11	-0.326	35.568	0.189	23.6	25.4	29.4	31.4	35.6	40.5	43.5	45.8	49.3	51.9	57.1
12	-0.207	39.851	0.187	26.3	28.4	33.0	35.2	39.9	45.3	48.5	50.9	54.7	57.4	62.8
13	-0.141	44.212	0.180	29.4	31.8	36.8	39.2	44.2	50.0	53.4	55.9	59.8	62.5	68.1
14	-0.134	48.099	0.171	32.7	35.1	40.4	42.9	48.1	54.0	57.5	60.1	64.0	66.8	72.3
15	-0.169	51.129	0.160	35.6	38.1	43.4	45.9	51.1	57.0	60.5	63.0	67.0	69.7	75.1
16	-0.221	53.228	0.1500	38.0	40.5	45.7	48.2	53.2	59.0	62.3	64.8	68.6	71.2	76.5
17	-0.270	54.874	0.1400	40.2	42.6	47.6	50.0	54.9	60.4	63.6	65.9	69.6	72.1	77.1

Table 3.

BMI (kg/m^2) percentiles and LMS values by sex and age in 6-17 year old schoolchildren of UB city

Age	L	M	S	P(1)	P(3)	P(5)	P(15)	P(25)	P(50)	P(75)	P(85)	P(95)	P(97)	P(99)
Boys														
6	-1.633	16.357	0.1244	12.9	13.4	13.7	14.6	15.1	16.4	17.9	18.9	21.0	22.0	24.2
7	-1.614	16.490	0.1309	12.9	13.4	13.7	14.6	15.2	16.5	18.1	19.2	21.5	22.6	25.1
8	-1.598	16.674	0.1372	12.9	13.4	13.8	14.7	15.3	16.7	18.4	19.6	22.1	23.3	26.1
9	-1.577	16.932	0.1425	13.0	13.5	13.9	14.8	15.5	16.9	18.8	20.0	22.7	24.0	27.1
10	-1.530	17.216	0.1458	13.1	13.7	14.0	15.0	15.7	17.2	19.2	20.4	23.2	24.6	27.8
11	-1.453	17.473	0.1467	13.2	13.9	14.2	15.2	15.9	17.5	19.4	20.7	23.5	24.9	28.0
12	-1.391	17.796	0.1453	13.5	14.1	14.5	15.5	16.2	17.8	19.8	21.1	23.8	25.1	28.1
13	-1.335	18.204	0.1426	13.8	14.5	14.8	15.9	16.6	18.2	20.2	21.5	24.1	25.4	28.2
14	-1.269	18.693	0.1398	14.2	14.9	15.3	16.4	17.1	18.7	20.7	21.9	24.5	25.7	28.4
15	-1.200	19.263	0.1374	14.7	15.4	15.8	16.9	17.6	19.3	21.3	22.5	25.1	26.3	28.8
16	-1.126	19.960	0.1358	15.2	15.9	16.4	17.5	18.3	20.0	22.0	23.3	25.8	27.0	29.5
17	-1.054	20.799	0.1349	15.9	16.6	17.0	18.3	19.1	20.8	22.9	24.2	26.8	27.9	30.4

Girls														
6	-1.239	15.908	0.1178	12.6	13.1	13.4	14.2	14.7	15.9	17.3	18.2	19.9	20.6	22.2
7	-1.103	16.028	0.1262	12.4	13.0	13.3	14.2	14.8	16.0	17.5	18.5	20.3	21.1	22.9
8	-0.974	16.242	0.1341	12.4	13.0	13.3	14.3	14.9	16.2	17.9	18.9	20.8	21.7	23.6
9	-0.853	16.581	0.1408	12.4	13.1	13.4	14.5	15.1	16.6	18.3	19.4	21.5	22.4	24.3
10	-0.726	17.016	0.1455	12.6	13.3	13.6	14.7	15.5	17.0	18.8	20.0	22.1	23.1	25.1
11	-0.595	17.493	0.1481	12.8	13.5	13.9	15.1	15.9	17.5	19.4	20.5	22.8	23.7	25.7
12	-0.485	18.102	0.1481	13.2	13.9	14.4	15.6	16.4	18.1	20.1	21.2	23.5	24.4	26.4
13	-0.432	18.806	0.1461	13.7	14.5	15.0	16.2	17.1	18.8	20.8	22.0	24.2	25.2	27.2
14	-0.473	19.556	0.1424	14.4	15.2	15.7	17.0	17.8	19.6	21.6	22.8	25.1	26.0	28.0
15	-0.601	20.270	0.1376	15.1	15.9	16.4	17.7	18.5	20.3	22.3	23.5	25.9	26.9	28.9
16	-0.779	20.861	0.1325	15.8	16.6	17.1	18.3	19.1	20.9	22.9	24.1	26.5	27.5	29.7
17	-0.967	21.399	0.1274	16.5	17.2	17.7	18.9	19.7	21.4	23.4	24.6	27.0	28.1	30.3

Figure 1, 2 and 3 shows the 3rd, 50th, and 97th centiles for height, body mass, BMI of Mongolian schoolchildren against WHO and US counterparts.

Height

In height the edf parameters were L01M06S04 in both sexes. Table 1 presents the LMS values and percentiles of height, respectively. Smoothed L values were 0.96 in boys and 0.54 in girls. In Mongolian children the overall height was below compared to both WHO and CDC growth references, with the highest differences at older age, 12-17 years, 14-17 years and 13-17 years of age at P3, P50 and P97 respectively.

Calculated height centiles in boys were lower than those of the WHO and CDC references at all ages on the 3rd and 50th but in 97th centiles the height lowering in Mongolian boys starts from the 13 years of age (Figure 1). In boys such differences were greater between 14–17 years old, reaching 6.2 cm and 6.8 cm on the 3rd centile, and 4.1 cm and 5.2 cm at P50 and 4.8 cm and 4.7 cm at 97 for the WHO and CDC references respectively. In girls the greatest differences were seen between 9–17 years old on the 3rd centile with highest difference of 3.9 cm and 4.6 cm for the WHO and CDC references respectively. On the 50th centile girls' height difference reached 3.3 cm (WHO) at 17 years and 3.7 cm (CDC) at 14 years old. On the 97th centile the highest difference was in 17 years old girls reaching 5.5 cm for WHO reference. On average, Mongolian boys and girls aged 17 measured 172.5 cm and 159.6 cm, respectively.

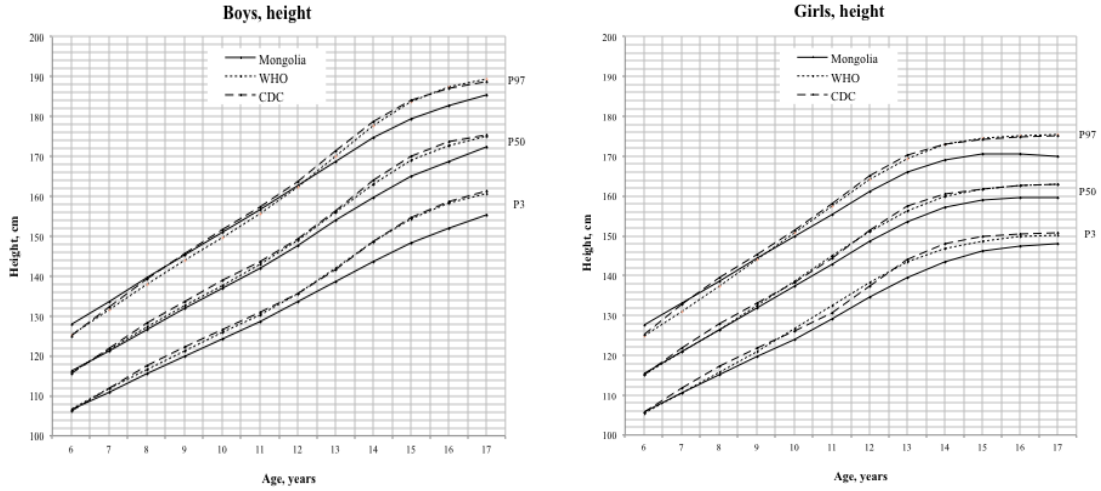

Figure 1. Comparison of the and sex-specific 3rd, 50th and 97th height centile curves for WHO, CDC and present study among boys (left) and girls (right) aged 6-17 years

Weight

The weight edf parameters were L03M06S04 and L03M05S04 in boys and girls, respectively. Smoothed L values for weight varied between -1.29 and -0.05 in boys and from -1.083 and -0.134 in girls (Table 2). Overall, body weight in girls of UB city was slightly heavier compared to the WHO and CDC counterparts on the 3rd and 50th centiles, but on the 97th centile the WHO and CDC counterparts became significantly heavier than Mongolian girls, especially at the 12-17 years of age (p=0.003, p=0.04). The highest differences on the 97th centile were 16 kg and 21.7 kg at the 17 years old for the WHO and CDC references respectively (Figure 2). Overall, body weight in boys of UB city was lighter than the WHO and CDC references at 12-17 years old age reaching the difference of 14.3 kg (WHO) and 7.5 kg (CDC) at the age of 16 years on the 97th centile (p=0.022, p=0.09). On the 3rd centile Mongolian boys lighter at 14-17 years of age compared to WHO reference reaching the lightest value of 1.4 kg and at the age of 10-17 years compared to the CDC counterparts with the lightest of 5.7 kg. The lightest differences on the 50th centile were 4.2 kg for both WHO and CDC counterparts at 12-17 years of age.

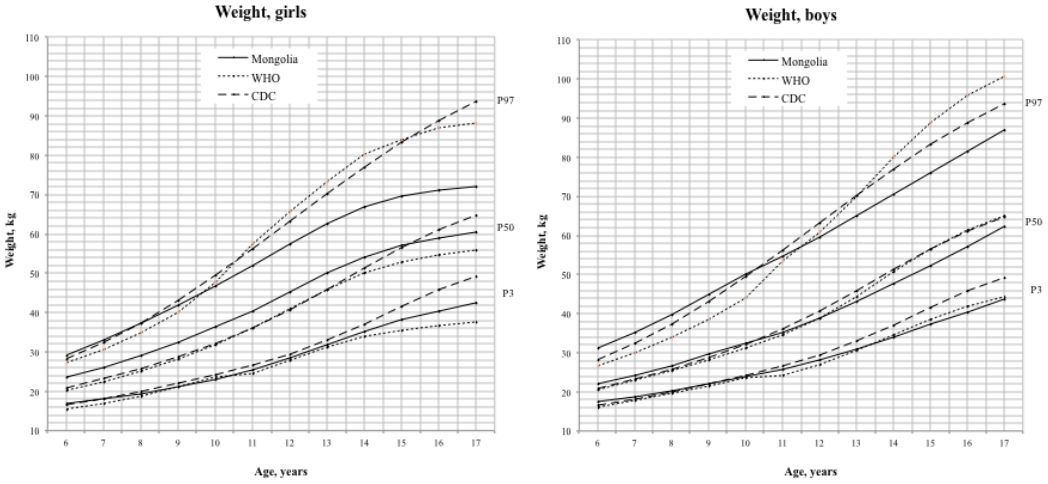

Figure 2. Comparison of the and sex-specific 3rd, 50th and 97th weight centile curves for WHO, CDC and present study among boys (left) and girls (right) aged 6-17 years

BMI

Smoothed L values for BMI varied between -1.63 and -1.05 in boys and from -1.24 and -0.43 in girls (Table 3). Overall, in Mongolian children BMI was greater on the 3rd centile, the greatest differences were 2.8 kg/m^2 and 2.1 kg/m^2 for girls and 2.1 kg/m^2 and 1.8 kg/m^2 for boys (WHO and CDC respectively). But on the 50th centile the BMI of Mongolian boys became smaller at 14-17 years old compared to WHO and CDC references (0.5 kg/m^2 and 0.7 kg/m^2 respectively) but for girls the BMI became smaller at 11-14 years of age (1.2 kg/m^2 and 0.9 kg/m^2) and becoming greater again at 15-17 years old (2.5 kg/m^2 and 2.3 kg/m^2). The striking differences were on the 97th centile. Mongolian boys' BMI were smaller at 12-17 years old and 7-17 years old against WHO and US counterparts respectively. Whereas Mongolian girls' BMI were smaller at 11-17 years old and 8-17 years old compared to their WHO and CDC references (Figure 3).

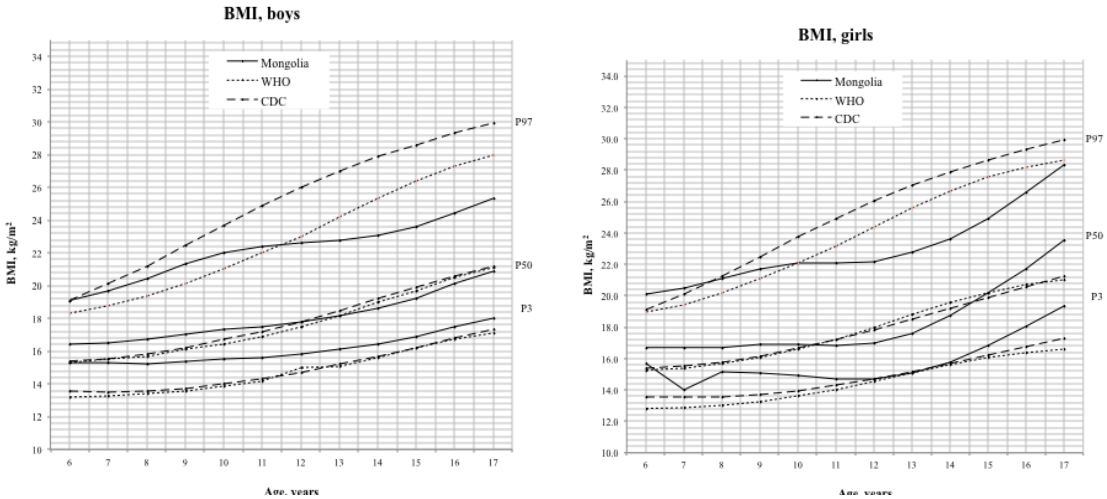

Figure 3. Comparison of the and sex-specific 3rd, 50th and 97th BMI centile curves for WHO, CDC and present study among boys (left) and girls (right) aged 6-17 years

DISCUSSION

The aim of the present study was to develop age and sex-specific anthropometric indices of normative values for schoolchildren aged 6-17 years living in the capital city of Mongolia and to compare specific centile values from two widely applied estimation methods. This study provides current information on normative values of somatic growth for schoolchildren in UB city. These values could be used as approximate indicative values to compare anthropometric indices scores of children from rural area of Mongolia, especially nearing regions to the capital city. These data can also be used as benchmark values for health screening and surveillance of children and adolescents 6-18 years old in Mongolia, especially after the new WHO Child Growth Standard, growth assessment necessarily became a subject of debate, particularly because of the variability in growth patterns across populations and the lack of local standards in many countries [17].

In our study height values were below against WHO and CDC values, especially starting from the age of 12 years in both sexes. It could be due to heritage issues. Study on role of genetic factors in the determination of height showed that it is one of the most heritable human quantitative phenotypes [18]. Interest in the genetic influences on height was renewed when genetic linkage studies enabled research into genetic effects over the whole genome studies allowed identification of loci consistently associated with height in populations of different ancestry [19-22]. Greater mean height has been consistently observed in Western populations as compared with East-Asian populations [23]. But beside the genetic factors, a multitude of environmental factors can affect height. They can operate during the whole growth period, but infancy is probably the most sensitive phase regarding external influences [24, 25]. In the presence of adverse environmental conditions, the physical growth of children can decline and even adult height be affected [23]. The main negatively influencing environmental factor for growth in UB city is air, water and soul pollution, which has been since early 2000. In UB city, study showed that the height and weight levelling-off effect was obvious in boys and girls between 2010-2015 in most age groups [13].

In our study body weight in girls of UB city was heavier compared to the WHO and CDC counterparts on the 3rd and 50th centiles, but on the 97th centile the WHO and CDC counterparts became significantly heavier than Mongolian girls, especially at the 12-17 years of age. The highest differences on the 97th centile were 16 kg and 21.7 kg at the 17 years old for the WHO and CDC references respectively. Therefore, further use of WHO and CDC references for monitoring the weight of girls aged 12-17 years old could lead to increase of number of overweight and obese women in Mongolia. Moreover, the fifth national survey on nutrition of Mongolian population showed the increasing number of overweight and obese children and adolescents [14]. In this survey, the prevalence of overweight and obesity in school children aged 6-11years sharply increased from 2010 survey level and reached 22.2% and 6.4%, respectively; prevalence of overweight and obesity in women and men aged 15 and upwards was 46.2% and 27.1% respectively. Whereas, percentage of stunted and wasted children, aged 6-11 years, in Mongolia are 7.3% and 2.8%, respectively, which was reduction compared to 2010 survey level. Regarding the boys weight, in our study their weight values were lighter compared to WHO and CDC references at all studied centiles, especially at the age of 12-17 years.

CONCLUSION

The height, weight and BMI values of developed growth curves for Mongolian school children differ compared to the WHO and CDC growth references, especially for schoolchildren aged 12 years and upwards. Therefore, despite the recommendations of the Ministry of Health of Mongolia to use WHO and CDC growth curves recommends use of WHO and CDC growth references for monitoring children growth in Mongolia it has become obvious that these significant differences in school children growth pattern could lead to incorrect interpretation of children growth.

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DECLARATION

The Ethics Committee of the Mongolian National University of Medical Sciences approved the study in June 2015.

REFERENCES

1.Cole TJ. The development of growth references and growth charts. Ann Hum Biol. 2012;39(5):382-94

2.Freeman JV, Cole TJ, Chinn S, Jones PR, White EM, Preece MA. Cross sectional stature and weight reference curves for The UK-1990. Arch Dis Child. 1995;73:17-24.

3.Hamill PVV, Drizd TA, Johnson CL, Reed RB, Roche AF, Moore WM. Physical growth: National Center for Health Statistics percentiles. The Am J of Clin Nutr. 1979;32:607-629.

4.Zong XN, Li H. Construction of a new growth references for China based on urban Chinese children: comparison with the WHO growth standards. PLoS ONE. 2013;8:e59569.

5.Centers for Disease Control and Prevention for the Academy of Pediatrics. 2007 Children and adolescents standard growth charts (South Korea). Seoul, 2007. https://www.e-cep.org/journal/view.php?number=20125550718

6.WHO Multicentre Growth Reference Study Group. WHO Child Growth Standards based on length/height, weight and age. Acta Paediatr Suppl. 2006;450: 76–85.

7.de Onis M, Onyango AW, Borghi E, Siyam A, Nishida C, Siekmann J. Development of a WHO growth reference for school-aged children and adolescents. Bull World Health Organ. 2007;85: 660–667.

8.Kuczmarski RJ, Ogden CL, Guo SS, Grummer-Strawn LM, Flegal KM, Mei Z, et al. 2000 CDC Growth Charts for the United States: methods and development. Vital Health Stat. 11 2002;(246): 1–190.

9.Rolland-Cachera MF, Péneau S. Assessment of growth: variations according to references and growth parameters used. Am J Clin Nutr. 2011;94: 1794S–1798S.

10.Turck D, Michaelsen KF, Shamir R, Braegger C, Campoy C, Colomb V, et al. World health organization 2006 child growth standards and 2007 growth reference charts: a discussion paper by the committee on nutrition of the European society for pediatric gastroenterology, hepatology, and nutrition. J Pediatr Gastroenterol Nutr. 2013;57: 258–264.

11.Ямпольская ЮА. Региональное разнообразие и стандартизованная оценка физического развития детей и подростков. Pediatria. 2005;6:73–6.

12.Nazarova E and Kuzmichev Yu. The height-, weight- and BMI-for-age of preschool children from Nizhny Novgorod city, Russia, relative to the international growth references. BMC Pub Health. 2016 16:274 DOI 10.1186/s12889-016-2946-8

13.Munkhzaya M, Undram L, Ser-Od K, Khuderchuluun N, Chimedsuren O, Tsolmon Ch. The Secular Growth Changes in Height and Weight of Mongolian Children over the Past 50 Years. Int J Mar Biol Res. Open access. 2018, January, 1-7

14.Ministry of Health of Mongolia, National Centre for Public health, UNISEF. Nutrition status of the population of Mongolia. The fifth national nutrition survey report. Ulaanbaatar, Mongolia. 2017

15.Cole TJ, Green PJ. Smoothing reference centile curves: the LMS method and penalized likelihood. Statist Med. 1992. 11:1305–1319.

16.Pan H, Cole TJ. 2010. LMSchartmaker, a program to construct growth references using the LMS method. Version 2.43. Available online at: http://www.healthforallchildren.co.uk (accessed March 15, 2013).

17.Butte NF, Garza C, de Onis M. 2007. Evaluation of the feasibility of international growth standards for school-aged children and adolescents. J Nutr.137:153–157.

18.Silventoinen, K. Determinants of variation in adult body height. J Biosoc Sci. 2003. 35, 263–285.

19.Cho, Y. S. et al. A large-scale genome-wide association study of Asian populations uncovers genetic factors influencing eight quantitative traits. Nat Genet. 2009. 41, 527–534.

20.Lango Allen, H. et al. Hundreds of variants clustered in genomic loci and biological pathways affect human height. Nature. 2010. 467, 832–838

21.N'Diaye, A. et al. Identification, replication, and fine-mapping of Loci associated with adult height in individuals of african ancestry. PLoS Genet. 2011. 7, e1002298.

22.Wood, A. R. et al. Defining the role of common variation in the genomic and biological architecture of adult human height. Nat Genet. 2014. 46, 1173–1186.

23.Eveleth, P. B. & Tanner, J. M. Worldwide variation in human growth. Cambridge University Press, Cambridge, 1990.

24.Bozzoli, C., Deaton, A. & Quintana-Domeque, C. Adult height and childhood disease. Demography. 2009. 46, 647–669.

25.Steckel, R. H. Heights and human welfare: Recent developments and new directions. Explor Econ Hist. 2009. 46, 1–23