

Growth Charts of Heights and Weights of Male Children and Adolescents of Isfahan, Iran

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ABSTRACT

Measurements of height and weight are important data source relating to growth and development, puberty, and nutritional status of children and adolescents. In clinical setting, the charts of the National Center for Health Statistics (NCHS), USA, are used in Iran. A survey identified significant differences in weight- and height-for-age across provinces, between urban and rural children. Although the percentiles derived from data of the national health survey, in 1990-1992, were substantially below the NCHS charts, the growth patterns were parallel to the NCHS percentiles. In 1997, an anthropometric assessment of male students aged 6-18 years was conducted in Isfahan, a centrally-located city in Iran. The goal of the study was to establish the normograms of heights and weights in Isfahan for use in clinical settings. By a random cluster sample survey, 4,364 of 200,000 male students aged 6-18 years were selected from all areas of the city. Trained health staff measured their heights (cm) and weights (kg), and all the percentiles were calculated. A comparison was made with weight and height data collected from other parts of the country on several occasions. Findings showed that the growth percentiles of 6-18-year male students of Isfahan in 1997 were comparable to the NCHS charts. These students were taller and heavier than their fellow-citizens 22 years earlier, their compatriots in rural areas of Isfahan (1997) and Rasht (1989). They were also taller than those who were living in Tehran (1994). A similar study was conducted at the same time on urban Isfahani female students aged 6-18 years. All the percentiles of their height and weight curves were comparable with those of the NCHS charts. Thus, it is appropriate to use the NCHS charts for school-age children and adolescents in Isfahan city. The cause of improvement in growth parameters in Isfahan should be evaluated in future studies.

Key words: Child growth; Anthropometry; Growth charts; Body-height; Body-weight; Adolescents; Iran

INTRODUCTION

Height and weight are important indicators of the health and nutritional status of children and adolescents. Also in adolescents, genetic, systemic, endocrine and external (socioeconomic, geographical) factors may affect growth (1). Cross-sectional studies have been conducted in Isfahan, a central city of Iran (1975), in rural areas in

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Isfahan province (1997), in Rasht—a city in the north of Iran (1989), in Shiraz city—in the south of Iran (1991), in Tehran (1990-1992), east of Tehran city (1983, 1994), and on female students of Isfahan city (1997) (2-8). They revealed significant differences between cities and between urban and rural children (2-7). All the percentiles of generated charts were substantially below those of the NCHS charts, but the percentile curves were parallel to the NCHS percentiles, but of urban Isfahani females, which were comparable to the NCHS charts (8).

In 1997, an anthropometric evaluation of 6-18-year old male students of Isfahani was designed by the Isfahan Endocrine Research Center. The goal of this study was to establish the normograms of heights and weights for

use in clinical settings. The NCHS growth charts are used in many parts of the world for this purpose (9). As the racial, genetic, geographic and environmental differences affect growth, it is logical to determine local charts in the evaluation of health and growth disorders. In addition, the results of the survey allow an assessment of rural-urban differences in Iran and secular trends.

MATERIALS AND METHODS

Isfahan province, located in the central part of Iran, had a total population of approximately 4,000,000, and its capital city had a total population of approximately 1,000,000 in 1997. Of a total of 200,000 male students aged 6-18 years, a sample of 4,364 students was selected by a random cluster method. The sample size was determined using the formula ($n=Z^2S^2/d^2$), in which, $Z=1.96$, $d=1$ cm, and S is standard deviation of heights of boys—similar to the method used in the survey conducted in east of Tehran city in 1994 (4). Age was copied from the identification cards of students which are reliable. Age was presented as completed years; for example, a student of 6 years 11 months and 29 days was reported as being 6 years. Heights (cm) and weights (kg) were measured with stadiometer and weighing-scale and rounded off to the nearest 1 cm and 1 kg respectively by trained health staff. For instance, if weight was 24.4 kg, it would be considered 24 kg, and if it was 24.8 kg, it would be considered 25 kg. Body mass index (BMI) was calculated as weight/height^2 (kg/m^2), and their percentiles were calculated by the SPSS software. To

compare the results with previous similar studies in Iran conducted in 1975, 1983, 1989, 1990-1992 (2-7,10), Student's *t*-test was used, and *p* value of less than 0.05 was considered statistically significant.

RESULTS

Table 1 shows the distribution of heights at 6-18 years of age. The increase in median heights in 6-18-year old male students was 56 cm. The growth pattern showed an annual increase of 6-7 cm between age 6 and 8 years, hovered around 3-5 cm between age 8 and 12 years (pre-pubertal growth), with a pubertal peak of 14 cm between 13 and 14 years, and slowing down of linear growth between 15 and 17 years, at which adult height was reached.

The corresponding results for weights are shown in Table 2. The increase in median weights in 6-18-year old students was 41 kg. The annual median weight increments were more erratic than for height. The range was 0-4 kg between age 6 and 12 years, with a peak of 9 kg between 13 and 14 years, after which the annual weight increments reduced to 1-3 kg. Thus, the pubertal growth spurt in weight and height occurred at the same age.

The pattern in BMI showed that male students became fatter and/or more muscular with age, with a similar annual peak between age 13 and 14 years (Table 3).

DISCUSSION

The comparison of heights of male students of Isfahan aged 6-18 years in 1997 with those of male U.S. students

Table 1. Percentiles, mean, and standard deviation of heights of 4,364 male students of Isfahan in 1997

Age (years)	Frequency	SD	Mean	P ₅	P ₁₀	P ₂₅	P ₅₀	P ₇₅	P ₉₀	P ₉₅
6	214	5.4	118	110	112	114	117	121	125	127
7	178	7.4	126	114	117	121	124	130	136	140
8	242	6.5	129	118	120	125	130	133	137	139
9	233	6.6	134	125	126	129	134	138	143	146
10	191	6.7	139	128	131	134	139	144	148	150
11	370	6.8	143	132	134	138	142	147	152	154
12	321	8.3	147	135	136	141	147	153	158	161
13	395	9.9	155	141	143	148	154	161	169	172
14	554	9.1	164	148	152	158	168	171	175	179
15	437	8.4	170	157	160	165	170	175	179	183
16	553	7.6	172	160	163	168	172	177	181	184
17	530	6.3	174	164	166	170	173	177	182	184
18	146	7.1	173	163	166	169	173	176	183	185

SD=Standard deviation
P=Percentile
P₅₀=Median

of the same ages in 1979 (NCHS) (9) showed that heights of 11-year old students of Isfahan were either equal or even a little bit higher than U.S. students and, after that age, the U.S. adolescents were only 3 cm taller. Adolescents in both the populations got their mature height at 17 years of age (Fig. 1). The same applies to weight-for-age of students of Isfahan (Fig. 2). The curves of weights of students of Isfahan lay approximately on that of NCHS till 15 years of age but the U.S. boys were heavier than boys of Isfahan after 16 years of age.

In comparison with a similar study of 10-16-year-old boys in Isfahan city in 1975, a 9-16-cm increase in height was observed during 22 years (Fig. 3) (2). Similarly, a positive secular trend in weight can be observed for median weight-for-age in Isfahan. Their median weights increased as much as 4-12 kg from 1975 to 1997 (Fig. 4). The current Isfahan curves were also superior to those in other locations in Iran, as found in surveys done in 1983-1994 from points of view of height and weight (Figs. 3 and 4).

Table 2. Percentiles, mean, and standard deviation of weights of 4,364 male students of Isfahan in 1997

Age (years)	Frequency	SD	Mean	P ₅	P ₁₀	P ₂₅	P ₅₀	P ₇₅	P ₉₀	P ₉₅
6	214	3.2	21	17	18	19	21	22	25	27
7	178	4.9	25	20	21	23	25	26	31	35
8	242	4.3	26	19	20	24	25	28	31	33
9	233	6	29	22	23	25	28	31	36	39
10	191	6.5	24	31	24	27	30	34	39	45
11	370	8.2	35	26	27	30	33	38	45	52
12	321	8.6	39	28	30	33	37	44	51	55
13	395	10.7	45	30	33	37	43	51	59	66
14	554	10.4	53	36	40	46	52	58	66	73
15	437	10.9	57	42	46	50	56	63	71	78
16	553	10.3	60	45	49	54	58	66	74	78
17	530	10.9	64	50	52	56	61	69	78	84
18	146	11.2	64	50	52	57	62	69	81	90

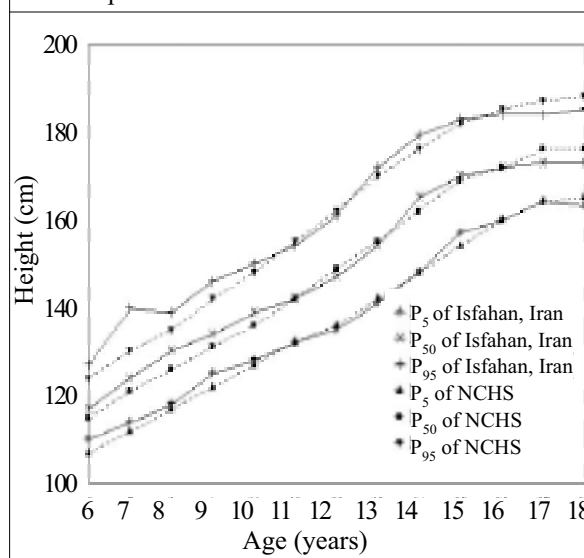
SD=Standard deviation
P=Percentile
P₅₀=Median

Table 3. Mean±SD of BMI in 4,364 male Isfahani students in 1997

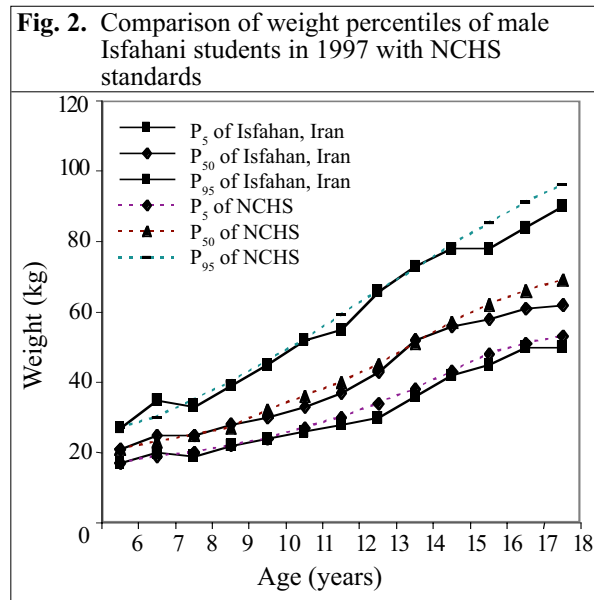
Age (years)	Frequency	Mean±SD
6	214	15.2±1.58
7	178	16±1.7
8	242	15.4±1.82
9	233	16.1±2.32
10	191	16.1±2.61
11	370	16.9±2.86
12	321	17.7±2.85
13	395	18.2±2.65
14	554	19.3±2.8
15	437	19.7±3.07
16	553	20.3±2.9
17	530	21.2±3.47
18	146	21.5±3.34

BMI=Body mass index
SD=Standard deviation

Fig. 1. Comparison of male Isfahani students' height percentiles in 1997 with NCHS standards



However, the differences in weights compared to those in other locations were not as large as for height, which may be a positive indication that male students in Isfahan did not become overweight (Figs. 3 and 4).



substantially below those of the NCHS charts, although the spread was similar (10). Results of studies on heights and weights of male students done in east of Tehran city in 1983, 1990-1992, and 1994 (4,5,10) and Rasht city (3)

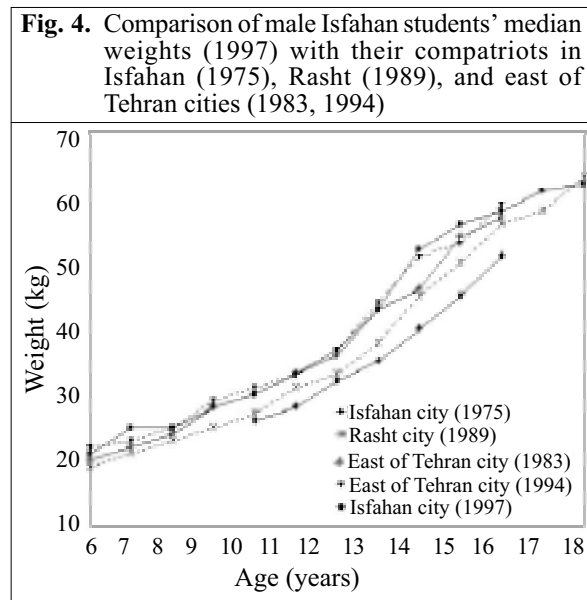


Fig. 3. Comparison of median heights of male students in Isfahan city (1997) with their compatriots in Isfahan (1975), Rasht (1989), and east of Tehran cities (1983, 1994)

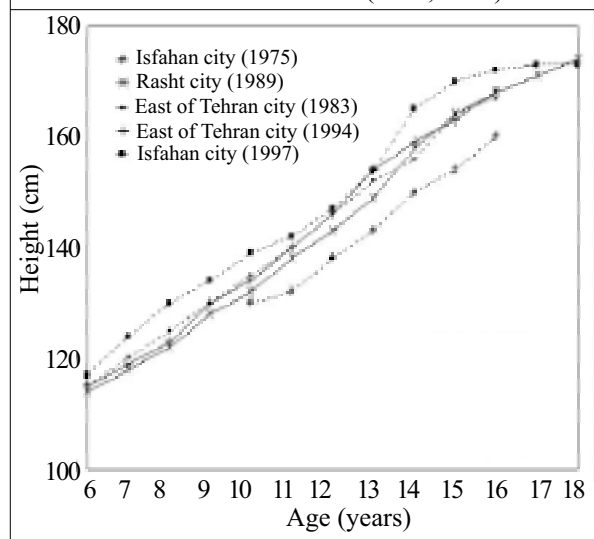
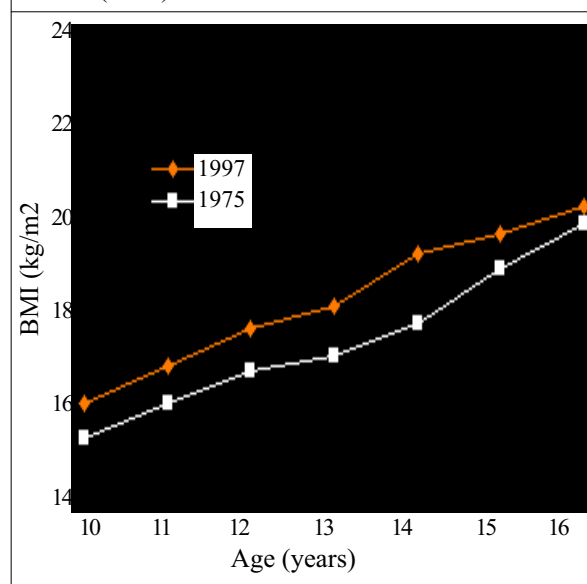


Fig. 5. Median BMI of male students in Isfahan city (1995) with their fellow-citizens in 1975

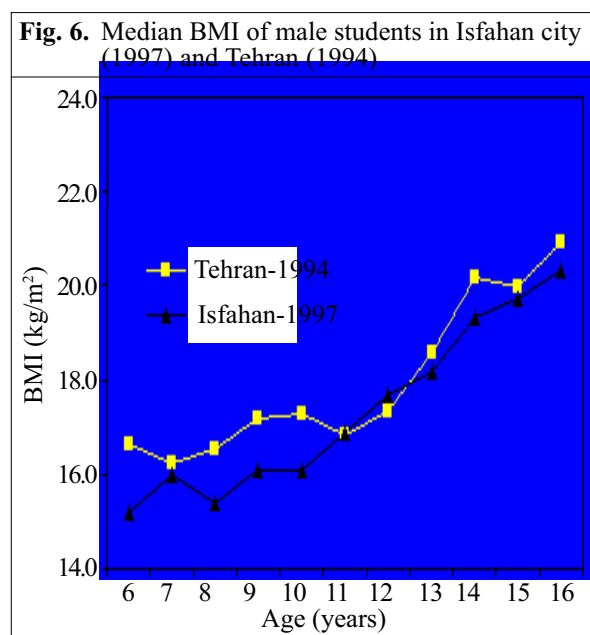


The changes in BMI over time are comparable with those in height- and weight-for-age (Fig. 5).

In comparison with other surveys, a study performed in Tehran city in 1990-1992 reported that all the growth charts of Tehrani children aged 2-18 years were

in 1989 showed that the percentiles were lower than those of NCHS but parallel to the NCHS growth curves. In 1997, heights of male Isfahani students aged 6-18 years were higher than those of their Rashti compatriots (1989) (Fig. 3). Except in the 18-year age group which was

almost equal, they were 2-8 cm taller than male Rashti students ($p < 0.02$). They were also 2-7 cm taller ($p < 0.04$) compared to Tehrani students (1983, 1994) (Fig. 3). The growth percentiles of Tehrani students did not increase from 1983 to 1994 ($p = \text{NS}$) (Fig. 3). Students of Isfahan were 1-7 kg heavier than children of Rasht until 16 years of age ($p < 0.04$) (Fig. 4). No difference was observed between weights and BMIs of students of Isfahan and Tehran ($p = \text{NS}$) (Figs. 4 and 6). The median heights and weights of children in Shiraz a decade ago lay approximately on the 25th percentile of U.S. children, but were above most groups of children from the developing world (7).



This study has shown that the NCHS charts can be applied in evaluating male children and adolescents of Isfahan. As geographic and genetic conditions have not been changed, it seems that probable improvement in nutritional status and hygiene may be the causes of secular improvement trend in the growth of male Isfahan students.

This assumption is supported by the growth charts of 6-9-year old primary school children residing in rural areas of Isfahan, surveyed in 1997, layed on 25th percentiles of NCHS charts (6).

The differences between urban and rural children appear to persist across all provinces (10) and even between urban children in different cities (2-5,10), although they have the same genetic endowment (all of them are Arians).

In another survey, an anthropometric evaluation of 4,638 female students aged 6-18 years, carried out at the same time (1997) in Isfahan city, showed an increase of 6-12 cm in height and of 1-4 kg in weight compared to their fellow-citizens in 1975. The height curves were approximately superposed on those of the NCHS growth charts, but U.S. girls were heavier than Isfahan girls after the age of 14 years. The growth parameters among female students of Isfahan have improved compared to those of their compatriots and also their fellow-citizens 22 years earlier (8). Therefore, improvements in growth patterns of both male and female students have been similar in secular trend during 22 years and indicate common underlying factors.

Based on the results of this study, it can be concluded that the growth patterns of boys and girls of Isfahan in 1997 are comparable to the NCHS reference curves. So, these normograms can be used in Isfahan. The main determinant factors in growth charts in various parts of Iran may be the result of socioeconomic differences.

ACKNOWLEDGEMENTS

We thank the Isfahan Province Health Center, Education and Development Administration, for their help in performing this study.

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