

Standards of growth and obesity for Saudi children (Aged 3 – 18 years) living at high altitudes

*M. A. Al-Shehri¹, Ossama A. Mostafa², Khalid Al-Gezban², Anwar Hamdi³,

**Mansour Almbarki⁴, Hassan Altrabolsi⁴ and Nwoye Luke⁵

*Departments of Child Health¹, Family & Community Medicine², Clinical Pharmacology³,

School Health Unit⁴ and Physiology Department⁵,

College of Medicine, King Khalid University, Abha, Saudi Arabia.

E-mail: Fariss2000@yahoo.com

Summary

Aim of study: To standardize the growth parameters for Saudi children aged 3-18 years living at high altitude and to investigate the appropriateness of using the National Center for Health Statistics (NCHS) growth standards for the assessment of children's growth at this high altitude area.

Subjects and methods: The present study follows a cross-sectional study design. A total of 13,580 native Saudi children (7,193 boys and 6,387 girls) aged 3-18 years living in Abha City (Elevation: 3,100 meters above sea level) constituted the study's sample. All chronically and acutely ill children were excluded. The data regarding the children were obtained from the well-baby clinics at primary health care centers and nurseries, as well as primary, intermediate and secondary schools. The percentiles for the weight and height and the body mass index (BMI) were calculated separately for the boys and the girls using one-year intervals. BMI values above the 95th and below the 5th percentiles were considered as diagnostic for obesity and underweight, respectively.

Results: Median values of weight and height for Saudi's children (both boys and girls) were lower than their corresponding values for children in the USA. Median values of the BMI for the Saudi's boys were almost identical to those of the USA's NCHS median values through all ages that were studied. On the other hand, the median values for the BMI were almost identical for the Saudi's and USA's girls aged 3-9 years. However, after the age of 9 years the differences in the median values for the BMI were increased progressively due to the higher values for the Saudi's girls.

Conclusions: The use of the NCHS growth standards is not appropriate for the assessment of growth of children that live in the high altitude area of Abha and further studies are needed to determine the exact impact of high altitude on the growth patterns in children.

Key-words: Growth parameters, Saudi Children, High altitude, Body Mass Index.

Résumé

But et Etude: Pour normaliser les paramètres de croissance chez des enfants saoudiens dans la tranche d'âge de 3 – 18 ans qui habitent à une altitude élevée et d'étudier la

bienséance de l'utilisation de Centre National pour des Statistiques Sanitaires (CNSS) normes de la croissance pour l'évaluation de la croissance des enfants dans cette région d'altitude élevée.

Sujets et méthodes: Cette étude suit une étude de plan d'un groupe représentatif de la population. Un nombre total de 13,580 enfants originaire d'Arabie Saoudite (7,193 garçons et 6,387 filles) âgés de 3-18 ans qui habitent à la cité d'Abha (élévation: 3,100 mètres au-dessus du niveau de la mer) constitue l'échantillon de cette étude. Tous enfants qui sont gravement malade ne tiennent pas compte de cette étude. Les données sur les enfants ont été obtenues dans des cliniques des enfants en bonne santé dans des centres et chambre des enfants des soins sanitaire primaire de même que des écoles primaire, moyen et secondaire. Le centile pour le poids et la taille d'indice du masse du corps (IMC) ont été calculés séparément pour des garçons et des filles avec l'utilisation d'un intervalle d'une année. Les valeurs IMC au-dessus 95th et moins de 5th centile ont été notées comme diagnostique pour l'obésité et d'un poids insuffisant respectivement.

Résultats: Valeurs moyennes du poids et de la taille pour des enfants saoudiens (garçons et filles les deux) étaient moins que leur valeurs par rapport à des valeurs pour des enfants aux USA. Valeurs moyennes de IMC pour les garçons d'Arabie Saoudite étaient presque identiques par rapports aux ceux de l'USA, valeur moyennes de CNSS à travers tout âges qu'on avait étudié. D'autre part, les valeurs moyennes pour le IMC étaient presque semblable pour celui de Saoudienne et filles de l'USA âgée de 3-9 ans. Toutefois, après l'âge de 9 ans, les différences dans les valeurs moyennes pour le IMC ont été augmentées progressivement attribuable aux valeurs élevées pour des filles saoudiennes.

Conclusion: L'utilisation de CNSS normes de croissance n'est pas adéquate pour l'évaluation de la croissance des enfants qui habitent dans la région d'une altitude élevée d'Abha et des études supplémentaires sont exigées afin de décider l'impact exact de l'altitude élevée sur la tendance de la croissance des enfants.

Introduction

Physical growth of children provides an excellent measure of their health and nutrition and the percentile values of their heights and weights reflect the condition

*Correspondence

of the public health and the average nutritional status of their nation. Growth reference values are useful in research and in pediatric clinics, as well as in delivering a good healthcare. Growth assessment plays an invaluable role in the pediatric practice, not only for epidemiological purposes, but also, for the follow-up of childhood diseases.¹ In addition, the body mass index (BMI) is the simplest and the most widely used index in the evaluation of obesity clinically and epidemiologically.² However, the important question is related to what is considered the ideal reference population. It is obvious that the percentiles' values for weight and height from countries with high socioeconomic status, such as western Europe, cannot be used as references for estimating the physical growth in less developed countries such as those of Asia and Africa. Similarly, it is established whether BMI plots from the United States can be used for other national populations. The genetic background of different ethnic groups is also a significant, and perhaps more important in the distribution of BMI and its relation to body fatness.³

Several studies have documented significant differences in growth rates of children from different populations due to differences in their health and nutritional status, environmental conditions¹ and genetic makeup.⁴ Moreover, in virtually all populations that were studied, and especially in developing societies, there has been a change in body size over generations. These secular trends in children's growth and development; i.e. the tendency towards improved growth and earlier maturity in later generations of the same population as the nutritional health systems improve have been greatest in the 20th Century.⁵ It becomes essential therefore, that growth reference values be established for every country since there has been much controversy regarding the validity of using growth standards based on well-nourished children, growing in a good environment in

developed countries-as references for the assessment of nutritional status in developing countries.⁶ In addition, it is necessary to update the growth reference values at regular intervals in order to reflect the changes in children's growth and development. Currently, there is no national standard for the Saudi children's growth, and the growth charts being used in the health centers suffer from two drawbacks due to its being based firstly on the results of the national center for health statistics (NCHS) in the USA, and the reference standards of one country not being applicable to another country⁽⁷⁾. Second, its results go back to 1984, and the need for an updating every one or two decades is obvious and critical for the adequacy and the accuracy.⁵

Despite the great advancement in the health-delivery system in the Kingdom of Saudi Arabia during the last two decades, there is still scanty data about the growth status of the Saudi children and the national standards for growth are not yet available. Available studies are inadequate and either not representative or are limited in the age-range.^{6-7, 9-13)}

The present study aims to standardize the growth parameters for Saudi children aged 3-18 years living at high altitude in the Aseer Region of K.S.A. (3,500 m) and to investigate the appropriateness of using the NCHS growth standards for the assessment of children's growth in our locality.

Subjects and methods

Abha City, the capital of Assir, lies in the southwestern part of Saudi Arabia, approximately 200 kilometers from the northern border of Yemen. It is about 3100 m above sea level. Its population is about 130,000. The climate is temperate, with daily temperatures ranging from 5 to 32 °C, and an annual rainfall of 450 millimeters⁽⁶⁾. The present study follows a cross-sectional design. A total of 13,580

Table 1 Weight-for-age percentiles for Saudi boys aged 3-18 years living in Abha

Percentiles/ Age	3 rd	5 th	10 th	25 th	50 th	75 th	90 th	95 th	97 th
3	9.0	9.5	10.0	11.8	13.1	14.8	15.8	16.1	16.4
4	10.5	11.3	12.0	13.2	14.9	16.9	18.1	18.6	19.0
5	11.5	12.3	13.0	14.1	16.2	19.0	21.0	22.5	24.0
6	12.3	13.7	15.0	16.5	20.2	23.0	27.0	28.5	30.0
7	15.0	16.0	17.0	20.0	22.5	26.4	32.0	35.0	38.0
8	17.0	18.0	19.0	21.5	25.0	30.0	39.2	42.6	46.0
9	19.5	20.8	22.0	24.0	28.0	34.0	45.0	49.0	53.0
10	22.0	24.0	26.0	28.0	31.0	39.0	51.0	55.2	59.3
11	24.0	25.5	27.0	30.0	35.0	44.0	56.4	60.7	65.0
12	26.0	27.5	29.0	33.5	39.0	49.0	60.0	66.3	72.5
13	28.0	30.5	33.0	37.0	43.0	55.0	66.0	72.0	78.0
14	30.0	32.0	34.0	39.0	47.0	60.0	71.0	78.0	85.0
15	32.0	35.0	38.0	44.0	51.0	64.0	77.0	85.5	94.0
16	36.0	38.5	41.0	47.0	55.0	69.0	83.0	91.2	99.3
17	39.0	42.0	45.0	50.0	58.0	74.0	88.0	96.2	104.4
18	41.0	43.5	46.0	51.3	60.0	75.0	92.6	99.8	107.0

Table 2 Weight-for-age percentiles for Saudi girls aged 3-18 years living in Abha

Percentiles/ Age	3 rd	5 th	10 th	25 th	50 th	75 th	90 th	95 th	97 th
3	9.0	9.5	10.0	11.0	12.5	14.4	15.6	15.9	16.2
4	10.0	10.5	11.0	12.5	14.5	16.4	17.5	18.2	18.8
5	11.0	11.5	12.0	13.9	16.0	18.0	19.8	21.4	23.0
6	12.0	12.5	13.0	16.0	18.0	21.0	24.0	26.8	29.5
7	14.0	15.5	17.0	19.0	21.0	24.0	28.0	31.5	35.0
8	17.0	18.0	19.0	21.0	24.0	29.0	35.0	39.0	43.0
9	19.0	20.0	21.0	23.0	28.0	33.0	40.0	45.0	50.0
10	21.0	22.0	23.0	27.0	32.0	38.0	46.0	51.0	56.0
11	24.0	25.5	27.0	30.0	37.0	45.5	54.8	58.9	63.0
12	26.0	27.5	29.0	34.0	41.0	50.0	59.0	63.5	68.0
13	28.0	30.5	33.0	38.0	44.0	53.3	62.0	66.5	71.0
14	31.0	33.5	36.0	40.5	46.5	55.0	64.0	69.0	74.0
15	33.0	35.5	38.0	42.0	48.5	58.0	66.0	70.9	75.8
16	35.3	37.7	40.0	44.0	50.0	59.0	67.6	72.8	78.0
17	36.0	38.5	41.0	46.0	51.0	60.0	70.0	75.0	80.0
18	37.0	39.5	42.0	47.0	52.5	61.0	72.4	77.7	83.0

Table 3 Height-for-age percentiles for Saudi boys aged 3-18 years living in Abha

Percentiles/ Age	3 rd	5 th	10 th	25 th	50 th	75 th	90 th	95 th	97 th
3	83.0	85.0	86.0	87.5	92.0	94.8	97.0	98.0	99.0
4	90.0	91.0	92.0	95.2	98.0	102.5	105.0	106.5	108.0
5	96.0	98.0	99.0	105	102.0	109.5	112.5	115.3	118.0
6	101.0	104.0	107.0	111.0	114.0	120.0	124.0	126.5	129.0
7	107.0	110.0	113.0	117.0	120.0	126.4	131.0	133.5	136.0
8	112.0	115.0	117.0	121.0	126.0	131.0	137.0	139.3	141.5
9	116.0	120.0	123.0	126.5	131.0	136.0	141.0	143.5	146.0
10	120.0	124.0	128.0	132.0	136.0	141.0	145.0	148.0	151.0
11	125.0	128.0	131.5	136.0	141.0	146.0	151.0	153.5	156.0
12	128.0	132.0	136.0	141.0	146.0	152.0	156.0	158.5	161.0
13	132.5	136.0	140.0	145.0	151.0	156.0	161.0	164.0	167.0
14	135.0	139.0	143.0	148.0	154.8	161.0	167.0	169.9	172.7
15	138.0	142.0	146.0	152.0	160.0	166.5	171.0	174.0	177.0
16	141.7	146.0	150.0	157.3	164.0	169.5	174.0	176.9	179.7
17	144.0	148.0	152.0	160.0	167.0	173.0	177.0	179.5	182.0
18	145.0	149.0	153.0	161.0	168.0	173.8	178.0	180.5	183.0

native Saudi children (7193 boys and 6387 girls) aged 3-18 years living in Abha City constituted the study sample. The data pertaining to these children were obtained from the well-baby clinics at the primary health care centers and nurseries, as well as the primary-, the middle- and the secondary-schools. All chronically and acutely ill children were excluded from the study.

Anthropometric measurements: Trained research assistants measured the body weight and the height for every child included in the study. Weight (in kilograms) was measured after breakfast (light clothing and no shoes) with a portable scale (SECA 762; Vogel and Halke, Hamburg, Germany). Children were asked to void before they were weighed. Children were weighed barefoot and in their underclothes to the nearest 100 grams. Height (in

centimeters) was measured in the standing position, with a portable stadiometer (SECA 208; Vogel and Halke). The portable scale and stadiometer were calibrated daily at the beginning of each working day. Height was measured to the nearest 0.50 centimeter using a fixed wall ruler with a sliding headpiece. The child stood with his or her heels, buttocks, shoulders and occiput touching the wall. The head was held erect with external auditory meatus and the lower border of the orbit in one horizontal plane. The headpiece was then lowered until it made light contact with the hair, and the reading was taken.

BMI was calculated according to the formula:

$$BMI = \frac{Wt (kg)}{h^2 (m^2)}$$

[BMI = Body Mass Index; Wt = weight (Kg); h = Height (m)].

Statistical analysis

Data analysis was done using the Statistical Package for Social Sciences (SPSS) software, version 10. Percentiles were calculated for the body weight and height and the BMI, separately for boys and girls in one-year intervals. The calculated percentiles were the 3rd, 5th, 10th, 25th, 50th, 75th, 90th, 95th and 97th. BMI values for the underweight and the overweight children are indicated by those below the 5th and above the 95th percentiles, respectively.¹⁴ The observed values were smoothed prior

to plotting and their median was compared with the median values in the NCHS¹⁵ for the corresponding percentiles.

Results

Tables 1-4 represent the weight-for-age and the height-for-age percentiles for Saudi children aged 3-18 who live in Abha. Tables (5, 6) show the BMI percentiles for these children. BMI values for the underweight and the obese children are indicated by those below the 5th and above the 95th percentiles, respectively.

Figures 1-4 show the weight-for-age and the height-for-age growth charts for Saudi boys 3-18 years old, living in Abha.

Table 4 Height-for-age percentiles for Saudi girls aged 3-18 years living in Abha

Percentiles/ Age	3 rd	5 th	10 th	25 th	50 th	75 th	90 th	95 th	97 th
3	82.2	83.0	83.2	86.5	89.5	93.0	95.0	95.9	96.8
4	88.0	89.0	90.0	93.0	96.5	100.0	103.2	104.4	105.5
5	94.0	95.0	96.2	100.0	101.0	108.0	111.1	113.1	115.0
6	101.0	103.0	105.0	108.0	107.5	116.0	120.0	122.0	124.0
7	108.0	110.0	111.2	114.5	116.0	123.0	127.0	129.0	131.0
8	112.6	114.0	116.0	120.0	123.5	128.0	132.0	134.5	137.0
9	117.0	120.0	122.0	126.0	130.0	135.0	138.0	140.0	142.0
10	122.0	124.0	126.0	130.0	134.5	139.0	143.5	145.8	148.0
11	128.0	130.0	132.0	135.5	142.0	144.5	149.0	150.5	152.0
12	133.0	135.0	137.0	141.0	147.0	150.0	154.0	155.5	157.0
13	137.0	140.0	142.5	146.8	150.0	154.0	157.0	159.0	161.0
14	141.0	144.0	146.0	149.0	152.0	156.0	159.5	161.3	163.0
15	143.0	145.0	147.5	151.0	153.5	157.1	161.0	162.5	164.0
16	144.5	146.0	148.0	151.0	154.0	158.0	161.7	163.6	165.5
17	145.0	147.0	148.7	151.5	154.5	158.3	161.8	163.9	166.0
18	145.5	147.0	149.0	151.5	155.0	158.5	162.5	164.8	167.0

Table 5 BMI* percentiles for Saudi boys aged 3-18 years living in Abha

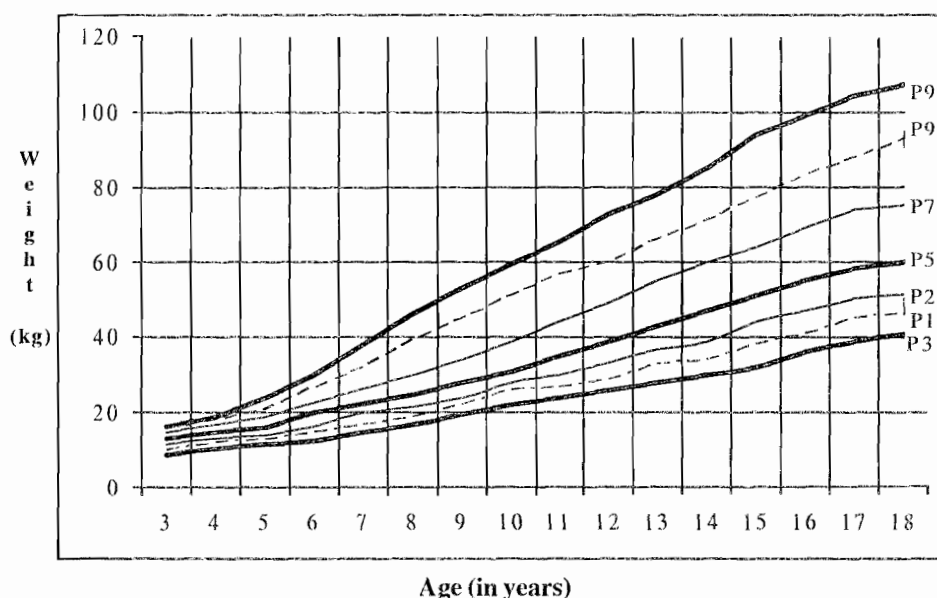
Percentiles/ Age	3 rd	5 th	10 th	25 th	50 th	75 th	90 th	95 th	97 th
3	13.06	13.15	13.52	15.41	15.48	16.47	16.79	16.76	16.73
4	12.96	13.65	14.18	14.56	15.53	16.09	16.42	16.40	16.29
5	12.48	12.81	13.26	13.77	15.51	15.85	16.59	16.92	17.24
6	12.06	12.67	13.10	13.39	15.56	15.97	17.56	17.81	18.03
7	13.10	13.22	13.31	14.61	15.68	16.52	18.65	19.64	20.54
8	13.55	13.61	13.88	14.68	15.75	17.48	20.89	21.95	22.97
9	14.49	14.44	14.54	15.00	16.32	18.38	22.63	23.80	24.86
10	15.28	15.61	15.87	16.07	16.76	19.62	24.26	25.20	26.01
11	15.36	15.56	15.61	16.22	17.60	20.64	24.74	25.76	26.71
12	15.87	15.78	15.68	16.85	18.30	21.21	24.65	26.39	27.97
13	15.95	16.49	16.84	17.60	18.86	22.60	25.46	26.77	27.97
14	16.46	16.56	16.63	17.80	19.61	23.15	25.46	27.02	28.50
15	16.80	17.36	17.83	19.04	19.92	23.09	26.33	28.24	30.00
16	17.94	18.06	18.22	19.00	20.45	24.02	27.41	29.14	30.75
17	18.81	19.17	19.48	19.53	20.8	24.73	28.09	29.86	31.52
18	19.50	19.59	19.65	19.79	21.26	24.83	29.23	30.63	31.95

* BMI = Body Mass Index

Table 6 BMI^{*} percentiles for Saudi girls aged 3-18 years living in Abha

Percentiles/ Age	3 rd	5 th	10 th	25 th	50 th	75 th	90 th	95 th	97 th *
3	13.32	13.79	14.45	14.7	15.61	16.65	17.29	17.29	17.29
4	12.91	13.26	13.58	14.45	15.57	16.40	16.43	16.70	16.89
5	12.45	12.74	12.97	13.9	15.68	15.43	16.04	16.73	17.39
6	11.76	11.78	11.79	13.72	15.58	15.61	16.67	18.01	19.19
7	12.00	12.81	13.75	14.49	15.61	15.86	17.36	18.93	20.40
8	13.41	13.85	14.12	14.58	15.74	17.70	20.09	21.56	22.91
9	13.88	13.89	14.11	14.49	16.57	18.11	21.00	22.96	24.80
10	14.11	14.31	14.49	15.98	17.69	19.67	22.34	23.99	25.57
11	14.65	15.09	15.50	16.34	18.35	21.79	24.68	26.00	27.27
12	14.70	15.09	15.45	17.10	18.97	22.22	24.88	26.26	27.59
13	14.92	15.56	16.25	17.63	19.56	22.47	25.15	26.30	27.39
14	15.59	16.16	16.89	18.24	20.13	22.60	25.16	26.52	27.85
15	16.14	16.88	17.47	18.42	20.58	23.50	25.46	26.85	28.18
16	16.91	17.69	18.26	19.30	21.08	23.63	25.85	27.20	28.48
17	17.12	17.82	18.54	20.04	21.37	23.94	26.74	27.92	29.03
18	17.48	18.28	18.92	20.48	21.85	24.28	27.42	28.61	29.76

* BMI = Body Mass Index

**Fig. 1** Percentile curves for weight of Saudi boys (3-18 years) living in Abha

Figures 5-8 show the median values pertaining to weight-for-age and height-for-age of Saudi's children aged 3-18 years living in Abha compared with the corresponding values of USA's children.

Saudi's boys aged 3-12 years had median values for weight and height almost identical to their corresponding USA counterparts. Beyond 12 years of age, the differences between both standards increase progressively, the values for USA boys being higher.

Saudi's girls aged 3-9 years had median values of weight and height parallel to their USA counterparts. From 10-12 years, the growth lines approximate, then, the differences between both standards increase progressively, the values for USA girls being higher.

Results for the median values for BMI among Saudi's boys (Fig. 9) were almost identical with the USA's NCHS values through all ages (3-18 years). On the other hand, Figure (10) shows that. The median values for BMI for girls aged 3-9 years were almost identical for both standards. Beyond the age of 9 years, the differences between both standards increase progressively, the values for Abha girls being higher.

Discussion

Anthropometric measurements, such as body weight and height, are the simplest, easiest to obtain, cheapest, and noninvasive and the most widely accepted methods for the evaluation of growth and body composition of

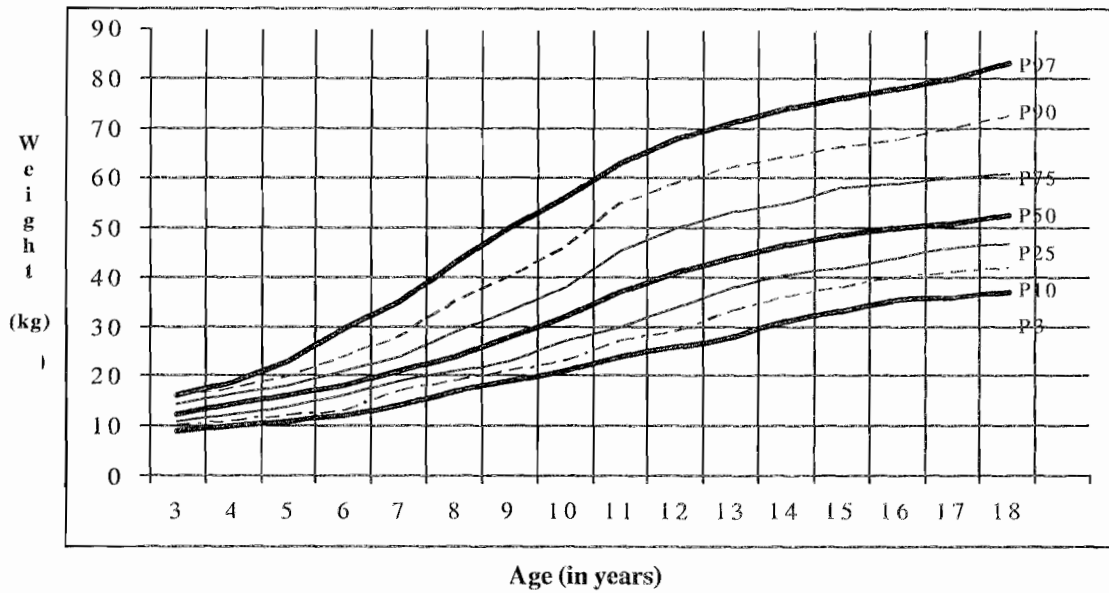


Fig. 2 Percentile curves for weight of Saudi girls (3-18 years) living in Abha

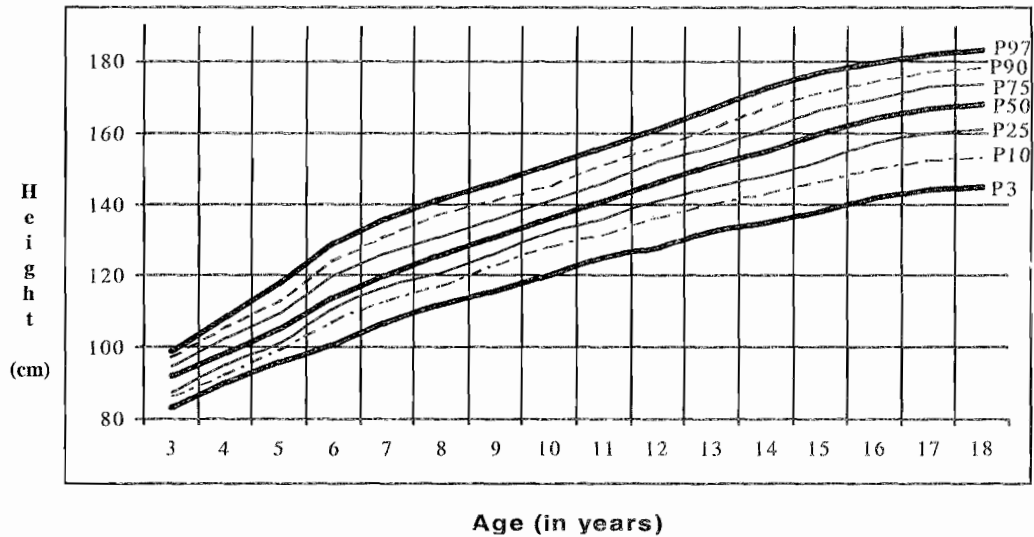


Fig. 3 Percentile curves for height of Saudi boys (3-18 years) living in Abha

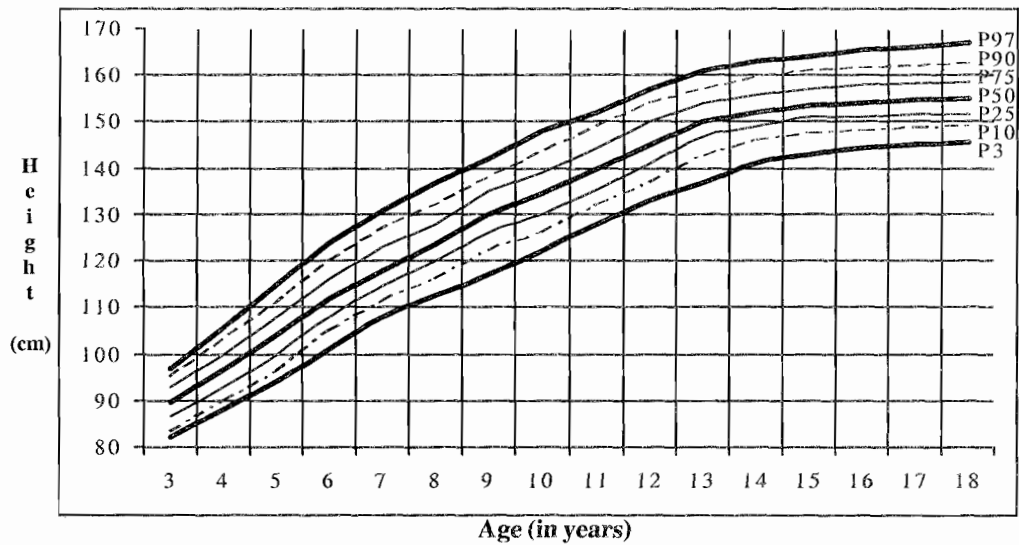


Fig. 4 Percentile curves for height of Saudi girls (3-18 years) living in Abha



Fig. 5 Median weight-for-age of Saudi boys living in Abha compared with the USA NCHS (2002) standard

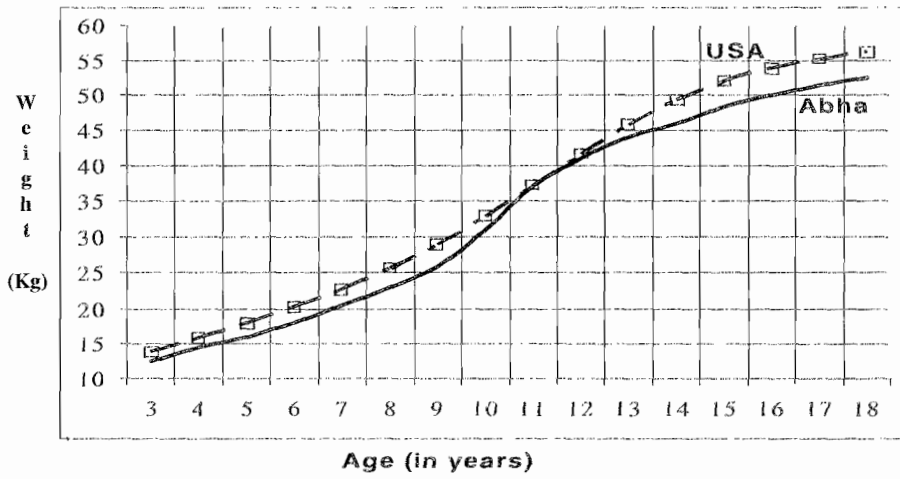


Fig. 6 Median weight-for-age of Saudi girls living in Abha compared with the USA NCHS (2002) standard

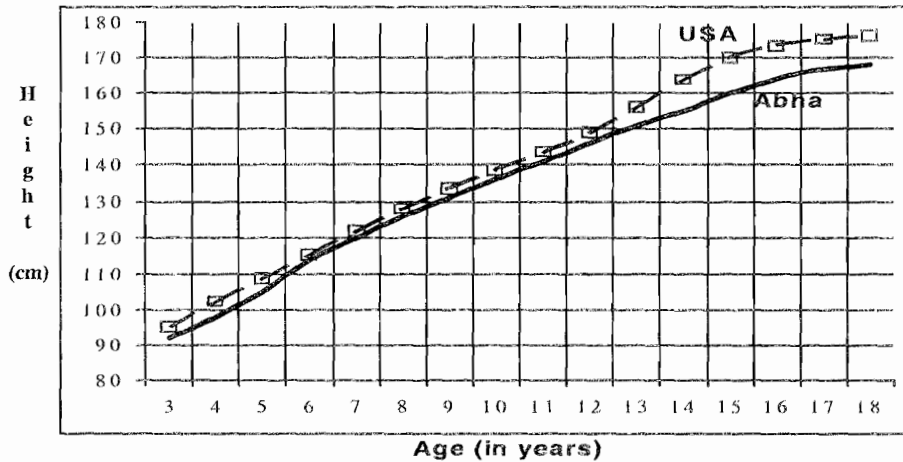


Fig. 7 Median height-for-age of Saudi boys living in Abha compared with the USA NCHS (2002) standard

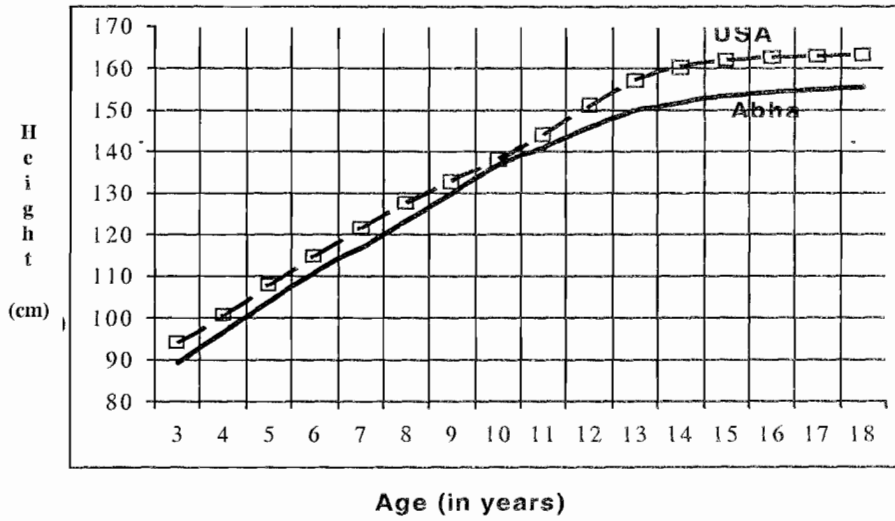


Fig. 8 Median height-for-age of Saudi girls living in Abha compared with the USA NCHS (2002) standard

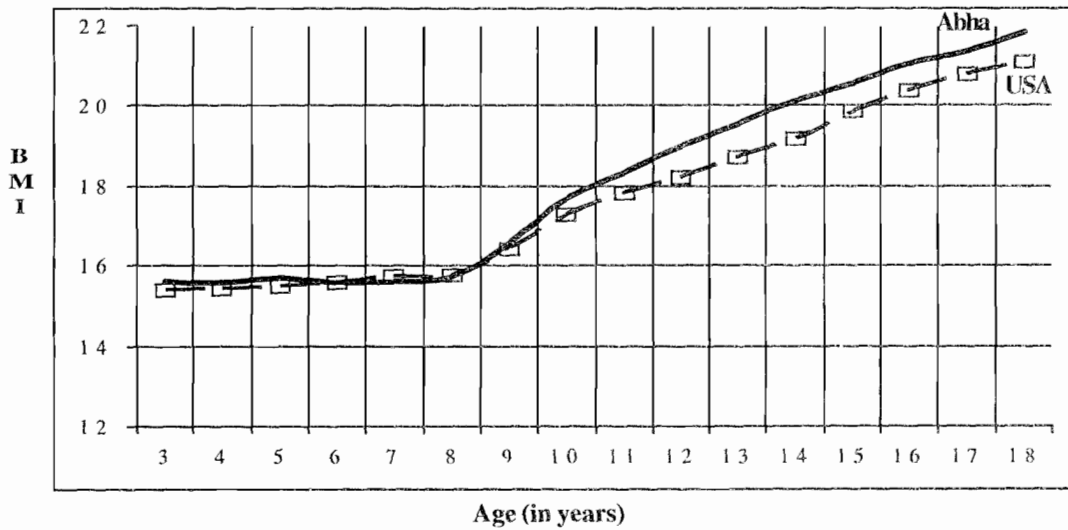


Fig. 9 BMI-for-age of Saudi boys living in Abha compared with the USA NCHS (2002) standard

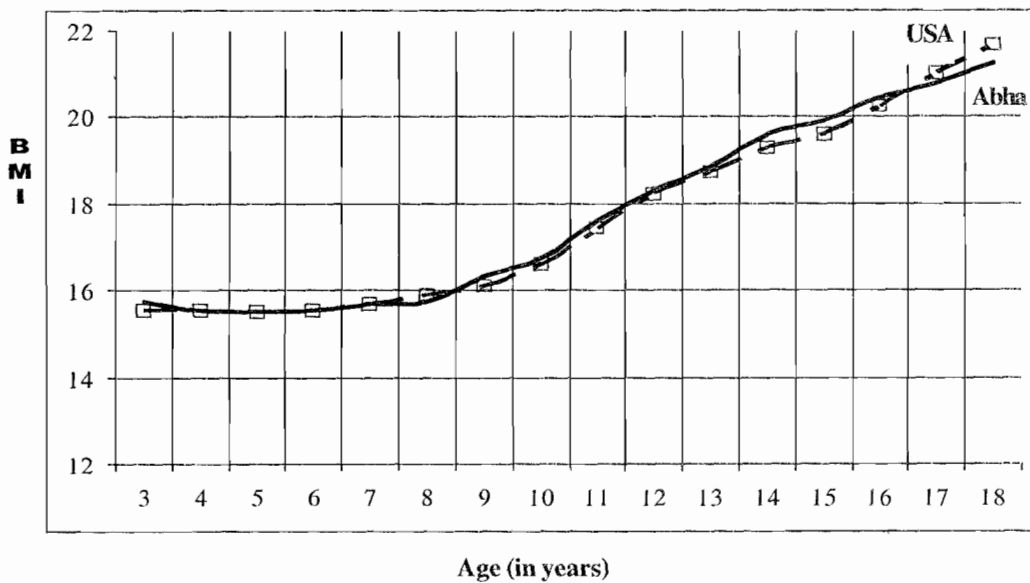


Fig. 10 BMI-for-age of Saudi girls living in Abha compared with the USA NCHS (2002) standard

children.^{1,4,5} These measurements also reflect the nutritional status of children, and are, therefore, useful in the evaluation of children's health. In the clinical setting, the anthropometric measurements are plotted against the percentile plots from a "reference" population that poses acceptable limits of these parameters.¹⁶

The median values of weight and height of the Saudi's children (both boys and girls) were lower than the corresponding values for USA's children, especially after the age of 12 years. These findings are in agreement with those reported by other studies both in Saudi Arabia^{6, 17, 18} and in other Arab countries such as Libya. Al-Sharbati et al.¹⁹ reported that the growth pattern (height/age and weight/age) of the public primary schoolchildren aged six to twelve years in Benghazi in the year 1993 was similar to the international standards at early school years for both sexes but it dropped down with increase in age. This divergence of the median values of weight and height from the reference population evident in our study may reflect both nutritional and ethnic variations in Saudi between children and the NCHS data representing American children. Moreover, differences in weight-for-age and height-for-age between children in our present study who live at high-altitude compared with those of the reference population could also be attributed to the growth-retarding effects of high-altitude hypoxia.⁶ These growth-retarding effects of high-altitude hypoxia have been well documented by several studies reporting that healthy, well-nourished high-altitude children are usually shorter and lighter than their age-matched low-altitude counterparts.^{13,20} These effects have been attributed to the negative energy balance and the interference with protein metabolism leading to a significant weight loss in children living in such high-altitude areas.^{6,20}

The present study showed that the BMI for boys in Abha is almost identical to that of boys in USA, while the BMI for girls in Abha is higher than that for USA girls after the age of 9 years. This finding is similar to that of Al-Sekait et al.¹⁷ and Magbool,¹⁸ who explained their findings by over nutrition, which was more evident among adolescent girls over the age of 12 years, for whom overweight is likely to be a common problem.

Magbool¹⁸ noted that the BMI among American and Saudi girls aged 6-16 years could be attributed to genetic factors. Sorensen et al.²¹ emphasized that the role of genetic factors is considerably more important than the environmental ones. However, this finding needs further investigation with focus on dieting customs, exercise and sedentary lifestyle of female adolescents in the conservative community of Abha.

Conclusions

The use of the NCHS growth standards is not appropriate for the assessment of growth of children aged 3-18 years in the high altitude area of Abha. There is still a need for further studies to determine the exact impact of high altitude on the growth patterns of children. However, whether or not altitude, climate, or

socioeconomic status- or combinations of them may be responsible for such patterns, new national standards for growth of school children are needed. Such standards should represent the optimum achievable growth in all geographical areas of the country.

Acknowledgments

The authors acknowledge with gratitude, the assistance of Directors, Doctors and Nursing staff of the School Health Unit, and primary care centers who participated in this study. Our special gratitude goes to Dr. Yusif Al-Najjar, the Medical Director of the School Health Unit for help with anthropometric measurements

References

1. Shetty PS (2004): Food and nutrition. In: Oxford Textbook of Public Health. Detels R, McEwen J, Beaglehole R (Eds). 4th ed. Oxford University Press. pp. 149-170.
2. Dietz WH, Bellizzi MC (1999): Introduction: the use of body mass index to assess obesity in children. *Am J Clin Nutr* 70(suppl),123S-1235.
3. Savva SC, Kourides Y, Tornaritis M, Epiphaniou-Savva M, Tafouna P, Kafatos A (2001): Reference Growth Curves for Cypriot Children 6 to 17 Years of Age. *Obesity Research*, 9:754-762.
4. Abbassi V (1998): Growth and normal puberty. *Pediatrics*, 102:507-511.
5. Vaughan VC (1992): On the utility of growth curves. *JAMA*, 267:975-976.
6. Abolfotouh MA, Badawi IA (1995): Growth pattern of Saudi schoolboys in a high-altitude area of Saudi Arabia. *Eastern Mediterranean Health Journal*, 1(2):205-209.
7. Al-Amoud M, Al-Mazrou Y, Khoja T, Al-Turki K, Tantawi NE (2001): National study of growth monitoring for 0-5 years Saudi children.
8. WHO (1995): WHO physical status: the use and interpretation of anthropometry. Report of a WHO Expert Committee. WHO Technical Report Series No. 953. Geneva.
9. Sebai ZA (1983): The health of the family in a changing Arabia. 3rd ed. Jeddah, Tihama Publications.
10. Al-Frayh AR, Jabbar FA, Al-Haque K, Al-Omair A, Al-Bawardy M, Adam KAR (1989): Survey of auxological variance and growth standards in the Saudi newborn at various gestational ages and the preschool children in the Kingdom of Saudi Arabia. King Abdul Aziz City for Science and Technology, Riyadh.
11. Attallah NL, Jibrel SO, Campbell JJ (1990): Patterns of growth of Saudi boys and girls aged 0-24 months, Asir region, with a role on their rates of growth: a 1988 review. *Saudi Medical Journal*, 11: 466-472.

12. Attallah NL (1994): Patterns of growth of Saudi boys and girls from birth up to maturity in the Asir region: before the turn of the twentieth century. *Saudi Medical Journal*, 15: 414-423.
13. Al-Shehri MA, Abolfotouh MA, Dalak MA, Nwoye LO (2005): Birth anthropometric parameters in high and low altitude areas of Southwest Saudi Arabia. *Saudi Med J*, 26: 560-565.
14. Flegal KM, Ogden CL, Wei R, Kuczmarski RL, Johnson CL (2001): Prevalence of overweight in US children: comparison of US growth charts from the Centers for Disease Control and Prevention with other reference values for body mass index. *American Journal of Clinical Nutrition*, 73: 1086-1093.
15. Kuczmarski RJ, Ogden CL, Guo SS (2002): CDC growth charts for the United States: Methods and Development. *Vital Health Stat 11(246)* National Center for Health Statistics.
16. de Onis M, Habicht JP (1996): Anthropometric reference data for international use: recommendations from a World Health Organization Expert Committee. *Am J Clin Nutr* 64:650-658.
17. Al-Sekait MA, Al-Nasser AN, Bamgboye EA (1992): The growth pattern of schoolchildren in Saudi Arabia. *Saudi Med J*, 13:141-46.
18. Magbool G. (1993): Weight and height of Saudi children, 6 to 16 years from the Eastern Province. *Ann Saudi Med*, 13:344-49.
19. Al-Sharbati MM, Younan AA, Sudani OH (2001): Growth pattern of primary schoolchildren in Benghazi, Libya. *SQU Journal for Scientific Research: Medical Sciences*, 1:45-49.
20. Giussani DA, Phillips PS, Anstee S, Barker DJP (2001): Effects of altitude versus economic status on birth weight and body shape at birth. *Pediatric Research*, 49: 490-494.
21. Sorensen TI, Holst C, Stunkard AJ (1992): Childhood body mass index - genetic and familial environmental influences assessed in a longitudinal adoption study. *Int J Obes*;16:705-14.