

# Age at maximum growth spurt in body height for Saudi school children aged 9-18 years

Sulaiman Al-Emran, MSc, PhD, Huda M. Al-Kawari, BDS, MSc, Hoda M. Abdellatif, MPM, DrPH.

## ABSTRACT

**Objectives:** To provide growth reference values in body height, to determine the specific age at peak height velocity for Saudi male and female adolescences aged 9-18 years and to evaluate the appropriateness of using the Centers for Disease Control/National Center for Health Statistics (CDC/NCHS) growth standards in body height for the assessment of Saudi adolescents.

**Methods:** A cross-sectional anthropometric survey was conducted in 1053 Saudi male and female school children living in Riyadh city. The study sample was collected in the year 2000 and data were completed and refined in the year 2002. Standing height measurements were recorded for each subject using standard measuring techniques. The 10th, 25th, 50th, 75th, 90th percentiles for body height were calculated separately for boys and girls in one year intervals. The median reference values were compared with the corresponding values in the CDC/NHCS and with other similar studies on Saudi population.

**Results:** The results revealed that the age at peak height velocity for Saudi boys is 13-14 years and for Saudi girls is 10-11 years. The median value for body height at 18 years old for male and female was comparable with other studies reported in similar ethnic group.

**Conclusion:** The use of the CDC/NCHS growth standard for height does not appear appropriate for the assessment of growth of Saudi children aged 9-18 years.

*Saudi Med J 2007; Vol. 28 (11): 1718-1722*

*From the Department of Preventive Dental Sciences, College of Dentistry, King Saud University, Riyadh, Kingdom of Saudi Arabia.*

*Received 5th June 2007. Accepted for 11th June 2007.*

*Address correspondence and reprint request to: Dr. Sulaiman Al-Emran, Associate Professor, Department of Preventive Dental Sciences, College of Dentistry, King Saud University, PO Box 60169, Riyadh 11545, Kingdom of Saudi Arabia. E-mail: selemrans@yahoo.com*

The chronological age only provides a rough estimate of childrens' developmental age and often they do not coincide due to the great individual variations in growth. Thus, it is more suitable to use the developmental age to monitor a child growth. Growth reference values appear essential in orthodontic, pediatric dentistry and general dentistry clinics. These values are also useful information in research and in delivering quality healthcare. It has been reported previously that the growth of various facial dimension correlate well with the growth in body height.<sup>1</sup> According to Bjork and Helm,<sup>2</sup> a child's growth in body height was divided into 4 different stages namely the infantile, the juvenile, the puberty (early adolescence) and the late adolescence growth stages with the last stage getting completed at the age of 18-20 years. The adolescent growth spurt is one of the dramatic physical changes that accompany pubertal development. The rate of growth during the adolescent growth spurt is greater than at any other time of life after infancy.<sup>3</sup> The rate of growth varies throughout childhood and adolescence. It is highest immediately after birth, thereafter falling rapidly until about 5-6 years of age then leveling out until there is a further increase between the ages of 10 and 16 years associated with puberty. It has been reported that the orthodontic treatment including growth modification therapy is more effective during the period of increased growth,<sup>4</sup> and the orthognathic jaw corrective surgery treatment is best performed when most of the facial growth is completed.<sup>5</sup> The orthodontists therefore, are aware of the impact of maximum growth spurt on treatment outcome and the importance of monitoring patient growth during evaluation of the treatment progress. Differences in growth rates of children have been reported among various populations.<sup>6</sup> Moreover, populations of developing societies might show changes in body size over generations due to significant improvement in the nutritional health system in the 20th century.<sup>7</sup> It becomes essential therefore to establish growth standard values for every population, and to update these standard values at regular intervals in order to reflect the changes in children's growth and

development. Both longitudinal and cross-sectional studies have been used to provide growth standards for different populations.<sup>6,8,9</sup> Most of the previous studies, which were carried out on Saudi populations concentrated on monitoring growth pattern of infants and pre-school children.<sup>10,11</sup> Few studies had described growth pattern of Saudi adolescents, with no data regarding the age at peak height velocity for Saudis, or involvement of Saudi girls in the study samples.<sup>12,13</sup> There was one study which investigated growth pattern of Saudi boys and girls living at high altitudes.<sup>14</sup> The aims of this study were to provide growth reference values in body height, to determine the specific age at peak height velocity for Saudi male and female adolescences aged 9-16 years' and to evaluate the appropriateness of using the Centers for Disease Control/National Center for Health Statistics (CDC/NCHS) growth standards in body height<sup>15</sup> for the assessment of Saudi adolescents.

**Methods.** An epidemiological cross-sectional study on a sub-population of Riyadh city was carried out on Saudi male and female school children aged 9-18 years. The study sample was collected in the year 2000 and data were completed and refined in year 2002. A sample of 1053 subjects was selected from public schools. A list of all public schools in Riyadh city was provided by the Ministry of Education from which systematic random sampling was carried out to ensure unbiased representations of gender, geographic area, socioeconomic and class grades. Demographic data including gender and student's date of birth were obtained from student's school file. Standing height

was measured to the nearest tenth decimal centimeter (0.1 cm) using an anthropometric rod. All students were requested to remove their shoes and stand upright before measurements were taken. The measurements were recorded by trained personnel. To assess the intra-examiner reproducibility 3 subjects were re-measured during each day of data collection. No child with major illness or signs of physical deformity was included in the study and all participants were Saudi nationals. The protocol of the present study was revised and approved by the Ethical Committee of the Research Center of Dental College, King Saud University, Riyadh, Kingdom of Saudi Arabia.

Data analysis was carried out using the Statistical Package for Social Sciences (SPSS) software, version 10. The 10th, 25th, 50th, 75th, 90th percentiles for body height were calculated separately for boys and girls in one year intervals. The median of the observed values was compared with the median values in the CDC/NCHS<sup>15</sup> and with other similar studies on Saudis for the corresponding percentiles.

**Results.** Table 1 describes the age and gender of the 1053 subjects of the study. The 10th, 25th, 50th, 75th, 90th, percentiles of growth in body height and the peak height velocity of the studied subjects are presented in Tables 2-5 and Figures 1-4. The findings revealed a continuous increase in body height from age 9-16 years in male while in females, there was an increase in body height up to the age of 14 years after which the reference values for the subsequent age groups indicated slight fluctuations (Figures 1 & 2). The median values of

**Table 1** - Age and gender distribution of present sample.

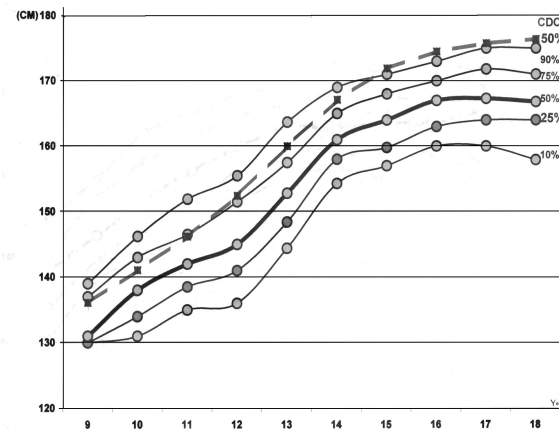
Age groups (years)	Male	Female	Total
9	7	54	61
10	15	96	111
11	53	81	134
12	51	69	120
13	26	59	85
14	56	61	117
15	78	51	129
16	87	60	147
17	57	28	85
18	56	8	64
<b>Total</b>	<b>486</b>	<b>567</b>	<b>1053</b>

**Table 2** - Growth in body height for different age groups of Saudi boys measured in centimeters (n=486).

Age Group	10% Percentile	25% Percentile	50% Percentile	75% Percentile	90% Percentile
9	130	130	131	137	139
10	131	134	138	143	146.2
11	135	138.5	142	146.5	151.9
12	136	141	145	151.5	155.5
13	144.4	148.4	152.8	157.5	163.7
14	154.3	158	161	165	169
15	157	159.8	164	168	171
16	160	163	167	170	173
17	160	164	167.3	171.8	175
18	157.9	164	166.8	171	175

**Table 3** - Growth in body height for different age groups of Saudi girls measured in centimeters (n=567).

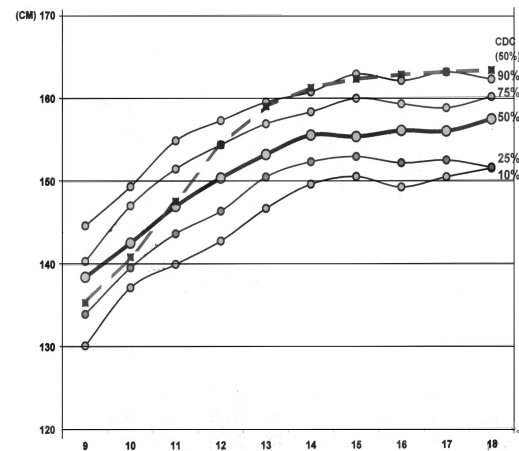
Age group	10% Percentile	25% Percentile	50% Percentile	75% Percentile	90% Percentile
9	130.2	134	138.5	140.4	144.7
10	137.2	139.6	142.6	147.1	149.4
11	140	143.7	147	151.5	154.9
12	142.8	146.4	150.4	154.4	157.3
13	146.7	150.5	153.2	156.9	159.5
14	149.6	152.3	155.5	158.3	160.7
15	150.5	152.9	155.3	159.9	162.8
16	149.2	152.1	156	159.2	162
17	150.4	152.4	155.9	158.7	163
18	151.4	151.5	157.3	160	162.1



**Figure 1** - Percentile curves for body height of Saudi boys (9-18 years).

**Table 4** - Growth height velocity per year for Saudi boys measured in cm. (n=486).

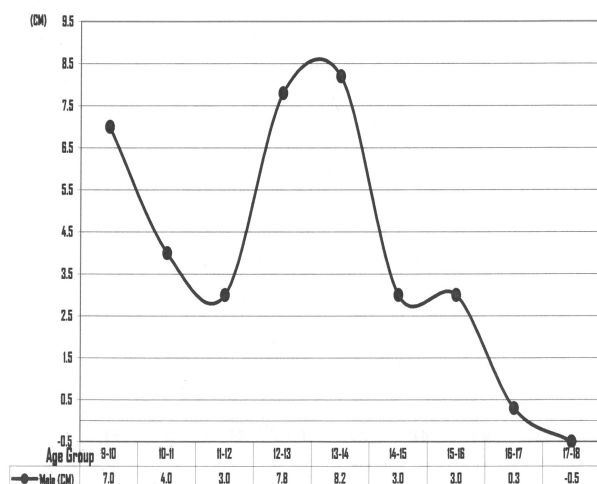
Age group years	10 <sup>th</sup> Percentile	25 <sup>th</sup> Percentile	50 <sup>th</sup> Percentile	75 <sup>th</sup> Percentile	90 <sup>th</sup> Percentile
9-10	1.0	4.0	7.0	6.0	7.2
10-11	4.0	4.5	4.0	3.5	5.7
11-12	1.0	2.5	3.0	5.0	3.6
12-13	8.4	7.4	7.8	6.0	8.2
13-14	10.0	9.6	8.2	7.5	5.3
14-15	2.7	1.8	3.0	3.0	2.0
15-16	3.0	3.2	3.0	2.0	2.0
16-17	0.0	1.0	0.3	1.8	2.0
17-18	-2.1	0.0	-0.5	-0.8	0.0



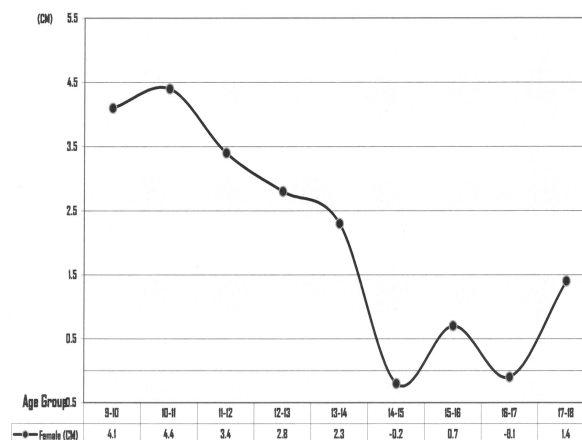
**Figure 2** - Percentile curves for body height of Saudi girls (9-18 years).

**Table 5** - Growth height velocity per year for Saudi girls measured in cm (n=567).

Age group years	10 <sup>th</sup> Percentile	25 <sup>th</sup> Percentile	50 <sup>th</sup> Percentile	75 <sup>th</sup> Percentile	90 <sup>th</sup> Percentile
9-10	7.0	5.6	4.1	6.7	4.7
10-11	2.8	4.1	4.4	4.5	5.5
11-12	2.8	2.7	3.4	2.9	2.4
12-13	3.9	4.1	2.8	2.5	2.2
13-14	2.9	1.8	2.3	1.4	1.2
14-15	0.9	0.6	-0.2	1.6	2.1
15-16	-1.3	-0.85	0.7	-0.7	-0.8
16-17	1.2	0.4	-0.1	-0.5	0.0
17-18	1.0	-0.8	1.4	1.3	-0.1



**Figure 3** - The median growth curve in body height per year for different age groups of Saudi boys.



**Figure 4** - The median growth curve in body height per year for different age groups of Saudi girls.

total body height at 18 years were 166.8 cm for males and 157.3 cm for females. The magnitude of increase in growth height per year varied among the different age groups, with maximum recorded velocity in height being at age 13-14 years for boys and at age 10-11 years for girls. The mean values of growth increment noted at peak height velocity were 8.2 cm in boys and 4.4 cm in girls (Figures 3 & 4).

**Discussion.** Riyadh city is the capital and the largest city in Saudi Arabia; it is considered the city which represents the best in the whole of Saudi Arabia due to the high migration rate from other cities and villages in the kingdom. Although a literature search revealed a number of studies which were carried out on Saudi populations, the majority investigated growth pattern in infant and pre-school age group, and none of these studies included female adolescents in their samples and neither did any report the age groups where the maximum growth in body height took place for each gender. Anthropometric measurements, such as body weight and height are the most widely accepted method for the evaluation of growth of children.<sup>7,16</sup> Data from cross-sectional as well as longitudinal studies samples to estimate the age at peak height velocity had been used in previous studies on children and adolescents.<sup>6,8,9</sup> Prediction of the pubertal growth spurt by measuring standing height was confirmed in the literature.<sup>4</sup> In addition, in orthodontic therapy it is important to evaluate the amount of remaining growth of a patient before setting up a treatment plan. This is due to the high impact of growth on treatment outcome of patients. This is manifestly relevant when using growth modifying appliances which are best used during the child pubertal

growth spurt. The utilization of this growth period can save the patient from undergoing jaw corrective surgery later in life. This study had provided the age-specific data for Saudi boys and girls where maximum increment in growth height occurred. During the preparation for this study it was decided to include female adolescents in the sample since no information was reported in the literature regarding their growth pattern and growth height velocity. Comparing the median values of the Saudi male and female children with the corresponding values for USA children (CDC/ NCHS) revealed that the Americans showed higher values for all ages except for age 9 years in boys and age 9 and 10 years respectively in females. The age at peak height growth velocity and the amount of growth increment during peak height velocity for Saudi boys were found in older age group and at a value greater than American boys; 8.2 cm at age 13-14 years for Saudis and 7.6 cm at age 12-13 years for Americans. The median value for body height at 18 years of age for American boys revealed bigger references at 176.4 cm for Americans and 166.8 cm for Saudi boys. Whereas comparing the present findings (166.8 cm) with what was previously reported by Al-Nuaim et al<sup>13</sup> and Al-Shehri et al<sup>14</sup> in similar ethnic group indicated almost similar reference values for the median of total body height at age 18 years being 167.1 cm and 168 cm. The Saudi girls indicated slightly younger age group for peak height velocity than Americans and lower growth values compared to American values being 4.4 cm at age 10-11 years in Saudis and, 6.8 cm at age 11-12 years in Americans. In addition, the median value of total body height at 18 years of age (157.3 cm) was less than for American girls (163.2 cm) and close to the reference value reported by Al-Shehri et al<sup>14</sup> for

Saudi girls living in high altitudes 155 cm. Although peak height velocity for Saudi boys and girls was noted at age 13-14 years and 10-11 years, the acceleration in growth height started one year earlier for both gender. This suggested that orthodontic treatment utilizing the impact of growth might start one year before the maximum growth spurt bearing in mind that patients should be followed until the maximum growth velocity subsided. The reference value for body height at 18 years of age for Saudi school children was comparable to other studies reported in similar ethnic groups. The age at peak height velocity for Saudi boys was 13-14 years and for Saudi girls it was 10-11 years. The use of the CDC/NCHS standard for growth in height does not appear appropriate for the assessment of growth of Saudi children aged 9-18 years.

## References

1. Bjork A. The use of metallic implants in the study of facial growth in children: method and application. *Am J Phys Anthropol* 1968; 29: 243-254.
2. Cara JF. Growth hormone in adolescence. Normal and abnormal. *Endocrinol Metab Clin North Am* 1993; 22: 533-552.
3. Cara J. Growth hormone in adolescence. Normal and abnormal. *Endocrinol Metab Clin North Am* 1993; 22: 533-552.
4. Sullivan PG. Prediction of the pubertal growth spurt by measurement of standing height. *Eur J Orthod* 1983; 5: 189-197.
5. Proffit W, White J, Sarver D. Contemporary Treatment of Dentofacial Deformity. St Louis (MO): Mosby, Inc; 2003.
6. de Onis M, Dasgupta P, Saha S, Sengupta D, Blossner M. The National Center for Health Statistics reference and the growth of Indian adolescent boys. *Am J Clin Nutr* 2001; 74: 248-253.
7. Vaughan VC 3rd. On the utility of growth curves. *JAMA* 1992; 267: 975-976. Erratum: *JAMA* 1992; 267: 1780.
8. Lee TS, Chao T, Tang RB, Hsieh CC, Chen SJ, Ho LT. A longitudinal study of growth patterns in school children in Taipei area I: growth curve and height velocity curve. *J Chin Med Assoc* 2004; 67: 67-72.
9. Buckler JM, Wild J. Longitudinal study of height and weight at adolescence. *Arch Dis Child* 1987; 62: 1224-1232.
10. Al-Frayh A, Bamgboye E.: The growth pattern of Saudi Arabian pre-school children in Riyadh compared to NCHS/CDC reference population. *J R Soc Health* 1993; 113: 234-239.
11. Mosavi Jazayeri SM. Clinical growth charts for pre-school children. *Saudi Med J* 2005; 26: 896.
12. al-Hazzaa HM. Anthropometric measurements of Saudi boys aged 6-14 years. *Ann Hum Biol* 1990; 17: 33-40.
13. al-Nuaim AR, Bamgboye EA, al-Herbish A. The pattern of growth and obesity in Saudi Arabian male school children. *Int J Obes Relat Metab Disord* 1996; 20: 1000-1005.
14. Al-Shehri MA, Mostafa OA, Al-Gelban K, Hamdi A, Almbarki M, Altrabolsi H. Standards of growth and obesity for Saudi children (aged 3 -18 years) living at high altitudes. *West Afr J Med* 2006; 25: 42-51.
15. National Health Nutrition Examination Survey, CDC Growth chart Unitedstate 2002. Available from URL: [www.cdc.gov/nchs/about/major/nhanes/growthchart/datafiles.htm](http://www.cdc.gov/nchs/about/major/nhanes/growthchart/datafiles.htm)
16. Shetty PS. Food and nutrition. In: Detels R, McEwen J, Beaglehole R, editors. Oxford Textbook of public Health. 4th ed. Oxford: University Press; 2004. p. 149-170.

## Do you have any comments or questions? Agree or disagree with published articles?

The correspondence section within the journal is a forum to comments on any of the articles published in the journal. Correspondence will not be sent for peer review, and will only be edited for the use of appropriate language. All correspondence should be submitted and published within 6 months from the date of the original publication.

Please submit your correspondence through the journal website ([www.smj.org.sa](http://www.smj.org.sa)), and don't forget to clearly state the title of the original publication, and your contact details.