

Secular Trends in Growth of the Contemporary Adolescents

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During the last decades most of the highly industrialised countries report slowing down of the secular trends in growth. AIM of the study is to investigate the trends in the growth and development among secondary school graduates from Varna. 2256 students, mean age 18.2 ± 1.3 years, with present weight and height measurements at birth and at final height were included. Additionally, 586 (285 girls) were interviewed. Analysis included inspection of individual growth curves, one-way ANOVA, etc. Overall 2159 (95.7%) students have finished growth, 6.3% of the boys and 2.6% of the girls are still growing. The mean age at peak height velocity is 11.6 ± 1.0 years for girls and 13.6 ± 1.1 years for boys. Growth stops at 14.8 ± 1.2 and 16.5 ± 1.2 years, respectively. The mean age at menarche for girls is 12.9 ± 1.1 years. Our results suggest slowing down of the acceleration of growth in our country and emerging of a trend towards "deceleration". This acquires closer surveillance in order to update growth references.

Key words: acceleration, growth velocity, menarche, adolescence.

Introduction

The secular trends of growth processes that began during the second half of the last century and were especially pronounced during the present century are well described and documented in most of the developed countries of the world. As it is well known, they have little influence upon the weight and length at birth [1] but strongly affect the tempo of growth and development, especially during puberty. As a result of the secular trends the final height has increased on average by as much as 1 cm/decade between 1880 and 1990 in most of the European countries and North America [2]. At the same time, the effects on rhythm of growth, earlier age at menarche and age at attaining final height are even more relevant [3, 4]. During the last few decades, however, most of the highly industrialised countries report slowing down of the acceleration of growth.

AIM of the present study is to investigate the trends of growth and development and the age at stopping growth among secondary school graduates from the city of Varna and to assess whether any slowing down of the secular trend is present.

Study Population and Methods

In 1999 the personal health files of students graduating from all secondary schools in the city of Varna were screened. Only those with recorded weight and height measurements at birth and at least three measurements during puberty were enrolled in the present study. Overall 2256 students, 1034 (45.8%) boys and 1222 (54.2%) girls born mainly in 1980-1982 (94.6%), mean age 18.2 ± 1.3 years, participated in the study. The majority (87.6%) had more than 15 height and weight measurements between 9 and 18 years of age. In the present work only heights were analysed. Linear growth was studied retrospectively from birth to final height in a longitudinal manner, i.e. by visual inspection of every individual growth curve [5]. Final height and, respectively, age at final height was defined as attaining growth velocity below 1 cm/year if peak pubertal height velocity for boys was registered at least 2 years earlier and for the girls — at least 2 years post menarche [6].

Structured interview was carried out additionally among 586 of these students (285, 48.6% girls) about the heights of parents and age at menarche for the girls.

The statistical analysis included descriptives, one-way ANOVA, etc. The SPSS statistical package was used. Statistical significance was assumed at the 5% level ($p < 0.05$).

Results and Discussion

From the studied 2256 students, 2159 (95.7%) have finished their linear growth and 97 (4.3%) are still growing — 65 (6.3%) boys and 32 (2.6%) girls. The final height of the boys is 177.2 ± 6.6 cm and of the girls — 163.8 ± 6.0 cm. Compared to the cross-sectional data of Varna students published by P. Minkov 25 years ago [7], this comprises final height with 4 cm higher for the boys and with 3 cm higher for the girls. This is consistent with the increase in the final height among most of the world's populations (about 1 cm/decade, [1]. Earlier studies [8] registered greater acceleration of growth — 3-4 cm/decade. Thus our findings are in concert with the opinion of most investigators nowadays that after the 80s the increase of the adult stature is decelerating.

The secular trends in growth can be further elucidated by investigating the tempo of growth and development. A very helpful parameter in this aspect is the age at peak height velocity that is in direct connection with the maximal growth potential of the individual, after which slowing down and ceasing of growth is imminent. Growth stops as a rule 2-4 years after reaching maximal growth velocity which is due to the maturing effect that sex steroids exert upon the growth plate [9]. Thus the age at peak height velocity is in direct relationship with the maximal pubertal steroid secretion and is a well-established diagnostic and prognostic tool. Estimates based on cross-sectional data are unbiased, but they are usually inaccurate [2]. The longitudinal character of our data although retrospective allows us to use them to calculate this very demonstrative parameter. The mean age at peak height velocity for boys is 13.56 ± 1.14 (95%CI $13.47 \div 13.63$) years and for girls — 11.62 ± 1.04 ($11.55 \div 11.67$) years. This is about 6 months earlier for both genders than the published age at pubertal acceleration of growth by Sul'tov [10]. Furthermore, the analysis of the histogram of the age at peak height velocity shows that the curve of the girls has a perfectly normal distribution while the curve of the boys is skewed a little to the right. This means that more boys than girls attain peak height velocity later than the mean age for sex, which is well explained by the fact that boys experience pubertal acceleration of growth later in puberty than girls [11].

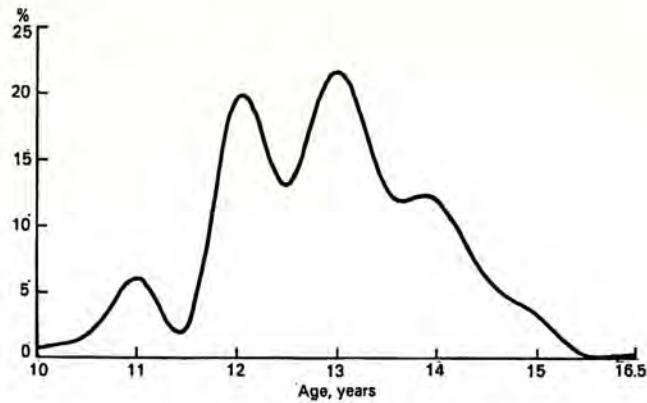


Fig. 1. Distribution (%) of the age at reaching menarche

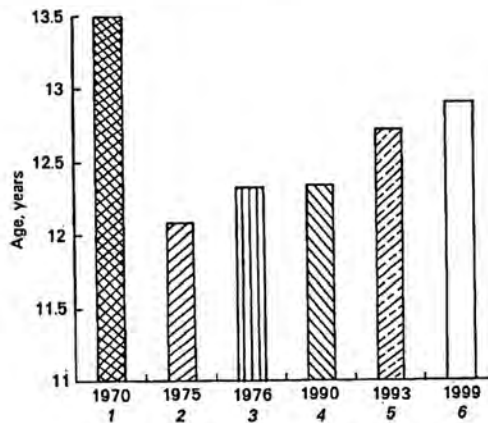


Fig. 2. Comparison of the age at menarche, registered by Bulgarian authors:
 1— Yordanov (Plovdiv); 2 — Bozhilov (Dobritsch);
 3 — Minkov (Varna); 4 — Petrova (Devnya);
 5 — Stanimirova (Pleven); 6 — Iotova (Varna)

Another very important parameter is the age at menarche in girls. It highly correlates with age at peak height velocity and thus findings concerning this parameter could be extrapolated to trends in tempo of growth [2]. Menarcheal age is well documented in most European countries as early as the last century and in this way can be used as an easy and exact measurement of maturation processes. The girls in our study reach menarche at 12.9 ± 1.1 years (12 years 10 months), median 13 years. The distribution curve is slightly positively skewed with the 3rd and 97th percentiles being 11 and 15 years, respectively. There are two well-defined peaks — 19% have menarche at 12 years of age and 22% at 13 years of age (Fig. 1). Comparing our data to previous Bulgarian studies, there is a clear trend of increasing the age at menarche [12, 13, 14]. During the last century other countries have reported deceleration of the age at menarche [1]. Some of the authors, especially those coming from the former Eastern

Table 1. Distribution of the age at ceasing growth (years) by sex (%)

Sex	Years							
	12	13	14	15	16	17	18	19
Boys	—	0.9	2.7	13.9	23.0	33.1	25.8	0.6
Girls	2.1	11.1	26.1	29.1	20.7	9.5	1.1	—

European countries — Croatia [15], Poland [16] suggest that this could be a reflection of the deterioration of the economic situation in those countries. Especially the studies from Poland compare age at menarche according to the area of residence and find that deceleration of the age at menarche is most pronounced among girls living in villages and small towns. However, this could hardly be the only reason since it is also seen in countries like Sweden [17]. Furthermore, the previous acceleration of menarcheal age was mainly due to the decrease in number of girls maturing very late (decrease of the 90th percentile), [18]. Eventual deterioration of the socioeconomic conditions would again first increase this upper limit and only afterwards the mean age at menarche.

The age at which linear growth comes to an end is another very sensitive indicator of the secular trends of growth. As a whole, age at stopping growth has decreased in parallel to the increasing final height and decreasing age at maturation during the previous decades [1]. In our study 83.9% of the boys cease to grow between 16 and 18 years, mean 16.54 ± 1.15 , the most at 17 years of age (33.1%), (Table. 1). Overall 76.4% of the girls reach final height between 14 and 16 years, 14.77 ± 1.23 years mean, with the maximum at 15 years of age (29.4%). Already in the early eighties Yordano v et al. [8] report that boys stop to grow at 17 years of age and girls — at 15-16 years. Still, about 5% of the adolescents in our study continue growth beyond that age — this was not characteristic for the previous couple of decades.

Conclusions

1. Up to the age of 18 the growth of 95.7% of adolescents has finished, 4.3% are still increasing their height
2. The age at peak height velocity is 11.6 years for girls and 2 years later (13.6 years) for boys
3. The girls who experience puberty during the last decade of the present century reach menarche at around 12 years 10 months, which represents considerable “deceleration” of the maturation processes
4. Linear growth comes to an end at 15 years of age in girls and at 17 years in boys on average

We suggest that at the end of the XX century the secular trends in growth in our country have slowed down and even a trend towards “deceleration” is emerging, especially in the maturation processes. These acquire closer surveillance during the forthcoming couple of decades in order to update growth reference data accordingly.

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