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Research paper

Secular growth changes in the Hellenic population in the twentieth century

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ABSTRACT

Statural growth is dependent on hereditary and environmental factors, i.e disease, nutrition. The improvement of socioeconomic conditions that took place during the 20th century resulted in a secular trend towards greater height and earlier sexual maturation. Greek society has changed dramatically from a mainly agricultural society at the beginning of the 20th century to a mainly urban one in the second half of the century, and during this period Greece became a developed country. The various studies examining the height of children living in Athens during this period show a gradual increase in the height of children, the difference of the mean height between 2001 and 1928 being 11.8 cm and 7.3 cm for 17 year old boys and girls, respectively. The difference in mean height was present at all ages. The difference in final height was mainly due to prepubertal growth. Girls at the age of 10 and boys at 11 years were about 8 cm taller in 2001 than in 1928. A growth study carried out on conscripts in 1990 found no significant difference in the height of males coming from urban or rural areas of the country, whereas such a difference was detected in 1968, rural men being significantly shorter than urban ones in 1968. There are only a few studies on the sexual maturation of Greek children. The available data suggest a secular trend towards earlier puberty in females; however, this can not be substantiated for males. Menarcheal age in Greek girls showed a positive secular change that is in agreement with the observed trend for earlier pubertal maturation in girls. In conclusion, Greek children in the 20th century experienced a positive secular trend in stature which also includes final height. A secular trend for earlier sexual maturation can be shown only for girls.

Key words: Greek children, height, puberty, sexual maturation, secular trend.

INTRODUCTION

Human growth is dependent on genetic and environmental factors (disease, nutrition, psychosocial factors)[1]. It is well known that in the last hundred years, there has been an increase in stature as well as an earlier sexual maturation, at least in the industrialized countries. These somatic changes are attributed to the improvement of socioeconomic conditions[2]. Therefore, growth trends of a certain population are

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related to the socioeconomic situation of the population at that time.

In this paper, the authors outline current status of height and the evolution of body height and sexual maturation in the Hellenic population during the 20th century, in relation to recorded changes in socioeconomic conditons.

SUBJECTS AND METHODS

Current growth data of Greek school-age children living in the area of Athens is presented along with a critical review of all related studies carried out in Greece in the 20th century, in an attempt to show the secular trends of growth of the Hellenic population over the last century. Data on the population density and movement as well as of the social changes taking place in Greece during the 20th century were obtained from the "National Statistical Service of Greece" (Table 1).

The current standing height of school children, aged 6-18 years, was measured by a physician in the morning hours using the Harpenden stadiometer. The total number of children measured in this study was 7.385 (boys: 4.372, girls: 3.013) with approximately equal distribution at different ages. Besides school children the review also includes data on conscripts, which represent valid national data since army service is obligatory in Greece.

RESULTS

Statural Growth

The first available auxological studies on Greek children were carried out in 1920 by Lambadarios [3] and in 1928 by Exarchopoulos [4]. After the 1920s and up to the end of the 20th century, there has been a significant number of studies on the growth of Greek children [5-12]. All of these are cross-sectional and most of them refer to the growth of schoolchildren in a specific city, mainly in Athens, or a specific area of the country. The exception to this is the study of Mantzagriotis-Meimaridis et al[13], performed in 1981 and in which data on the growth of schoolchildren on a national level are recorded.

Hence adequate data on the somatic changes of Greek children in the 20th century are available only for Athenian school children. Analysis of the mean values of the various studies shows an initial positive secular change for stature, which was interrupted during the period of 2nd World War when a negative change was observed (Tables 2 and 3). The secular trend for greater size has been present in both sexes, at all ages and concerned final stature as well.

The height gain in Greek boys living in Athens from 1928 to 2001 was 11.8 cm (from 165 cm to 176.8 cm), and for girls 7.3 cm (from 155.7 cm to 163 cm) at 17 years of age, when growth is almost completed in boys and certainly completed in girls. From data analysis it is evident that the increase in final height was achieved, in both sexes, during infancy and childhood, the difference in height being 9 cm for boys at the age of 11 years and 7.8 cm for girls at 10 years, ages that correspond to the mean ages of entrance into puberty for Greek children.

Data on the growth of infants and preschool children in the Greek medical literature are very few. A

Table 1. Population of Greece by areas

	Censuses 1920-1991			
	Population (%)			
Census year	Total	Urban	Semi-urban	Rural
1920	5.016.889 (100%)	1.148.341 (22.9%)	760.500 (15.2%)	3.108.048 (61.9%)
1928	6.204.684 (100%)	1.931.937 (31.1%)	899.466 (14.5%)	3.373.281 (54.4%)
1940	7.344.860 (100%)	2.411.647 (32.8%)	1.086.079 (14.8%)	3.847.134 (52.4%)
1951	7.632.801 (100%)	2.879.994 (37.7%)	1.130.188 (14.8%)	3.622.619 (47.5%)
1961	8.388.553 (100%)	3.628.105 (43.3%)	1.085.856 (12.9%)	3.674.592 (43.8%)
1971	8.768.641 (100%)	4.667.489 (53.2%)	1.019.421 (11.6%)	3.081.731 (35.2%)
1981	9.740.417 (100%)	5.659.528 (58.1%)	1.125.547 (11.6%)	2.955.342 (30.3%)
1991	10.259.900 (100%)	6.036.667 (58.8%)	1.312.774 (12.8%)	2.910.446 (28.4%)

Table 2. Mean height (cm) of Greek boys at various ages in the 20th century

	Labadarios	Exarchopoulos	Gedeon	Valaoras	Bezos	Batrinos	Meimaridis	Aivazis	Papadimitriou	Chiotis et al
Age	Athens	Athens	Athens	Attica & Corinth	Piraeus	Athens	National	Thessaloniki	Athens	Athens
(yrs)	1920	1928	1931	1942-3	1963	1968	1981	1988	1995	2000-1
6	105.0	111.7	111.9	*	118.8	*	117.0	118.0	118.0	117.5
7	111.0	117.1	116.9	115.4	122.7	*	122.6	122.0	123.9	124.3
8	115.0	121.3	121.2	118.8	127.2	129.4	128.1	126.5	130.0	129.5
9	120.0	127.1	126.8	124.2	132.9	133.9	133.2	131.5	135.0	135.1
10	126.0	130.8	130.9	129.7	140.6	139.1	138.3	136.5	140.2	141.1
11	131.0	136.0	136.2	135.5	141.7	144.0	143.3	142.0	144.0	145.0
12	138.0	141.0	141.0	140.1	148.4	149.4	148.7	148.8	150.5	151.9
13	148.0	148.0	148.2	144.5	153.1	155.6	155.5	154.5	157.1	160.1
14	155.0	156.2	156.5	151.0	161.0	162.4	163.0	161.8	165.9	167.5
15	161.0	163.3	163.2	158.6	166.9	167.8	169.8	167.5	169.9	172.0
16	164.0	166.2	166.0	164.4	170.0	171.5	173.1	171.8	175.5	173.6
17	169.0	165.0	166.9	168.1	171.6	172.7	174.2	*	176.7	176.8
18	*	167.8	167.5	170.4	171.7	171.9	175.0	*	*	177.4

*Data not available

study that covers this age group was performed in Thessaloniki in the 1980s [11]. In 1965, Economou et al [14] studied the growth of infants living in Athens during the first 12 months of life. Comparison of the mean values for body length shows that in the 1980s infants were taller than in the 1960s, the difference being 2 cm for boys and 3.4 cm for girls at 12 months.

The effect that the type of population (rural or urban) has on growth has not been studied systematically and is only recorded among conscripts. In 1990, Georgiadis et al [15] examined the height of conscripts and compared the results with those of a similar study

Table 3. Mean height (cm) of Greek girls at various ages in the 20th century

	Labadarios	Exarchopoulos	Gedeon	Valaoras	Bezos	Batrinos	Meimaridis	Aivazis	Papadimitriou	Chiotis et al
Age	Athens	Athens	Athens	Attica & Corinth	Piraeus	Athens	National	Thessaloniki	Athens	Athens
(yrs)	1920	1928	1931	1942-3	1963	1968	1981	1988	1995	2000-1
6	104.5	111.5	111.3	*	116.5	*	118.2	117.0	116.7	117.4
7	111.0	115.0	114.9	115.1	120.9	*	123.3	121.0	122.8	121.6
8	115.7	122.0	121.7	118.5	125.9	129.2	128.7	126.0	129.2	128.1
9	122.4	126.2	126.2	123.7	130.5	133.2	134.2	131.5	134.7	131.8
10	126.5	132.0	132.0	128.6	138.3	138.7	140.2	137.4	140.1	139.8
11	125.0	137.6	137.5	134.4	143.7	144.9	146.8	143.5	146.1	145.7
12	140.0	142.2	142.5	140.3	149.4	150.6	152.9	150.0	153.1	152.8
13	145.0	147.0	147.2	146.1	154.1	155.2	156.9	155.0	158.1	156.7
14	151.0	152.6	152.6	150.8	156.0	157.3	158.9	159.0	160.2	160.8
15	153.0	153.5	153.6	154.2	157.3	158.8	159.8	161.4	162.5	162.5
16	156.0	153.9	154.0	156.4	158.0	159.2	160.2	162.3	163.3	162.2
17	158.0	155.7	155.7	158.3	160.5	158.9	160.3	*	163.3	163.1
18	160.0	155.7	155.8	158.7	159.2	158.8	160.4	*	*	163.0

* Data not available

they performed in 1968. In their 1990 study, the authors could not find statistically significant differences in height between conscripts living in cities or rural areas (176.0 cm vs 175.3 cm, respectively), while, in the 1968 study, the conscripts in rural areas were significantly shorter than those who were from urban areas (167.4 cm vs 168.6 cm, respectively).

Sexual maturation

There are not many studies on sexual development of Greek children. These studies examined pubertal maturation of school children in the greater Athens area.

Boys: As far as we know, there are three studies[16-18] examining the pubertal maturation of Greek boys, one performed in the year 1968 and the other two in the years 1979 and 1996. In the study performed in 1968, testicular enlargement was reported to begin at the 10th and 11th year of age and pubic hair was reported to develop at the 11th year of age. In the study performed in 1979, testicular enlargement (Prader 4 ml) began at a mean age of 10.5 years and pubic hair Tanner II stage was observed at a mean age of 11.8 years. In 1996, genital stage 2 (G2) according to Tanner classification, i.e enlargement of scrotum and testes but no penile growth, was reported to occur at a mean age of 11.0 years of age and pubic hair stage 2 (PH2) at a mean age of 11.5 years. Statistical analysis of the three studies was not appropriate because of the different methodologies in pubertal rating. However, interpretation of the data suggests that there has been no significant change in pubertal maturation of Greek boys during this period.

Girls: In girls the secular changes in pubertal maturation are examined by the recordings of physical changes (breast and pubic hair development) and the timing of menarche.

There have been few studies examining the physical changes of pubertal maturation in girls. In a study performed in 1979, breast development (Tanner stage 2), the sign that indicates the start of puberty, was at a mean age of 10.6 years[19] and in a study performed in 1995, the start of puberty was at a mean age of 10 years[12], showing a significant secular change towards earlier maturation.

Menarche is a landmark in female sexual maturation and is considered to be a marker of the inception of the reproductive period of the girl. In the industrialized countries, the age at menarche has been falling over the last hundred years by about 3-4 months per decade[20]. In Greece, menarcheal age was examined by various investigators during the 20th century. In the year 1935, Malaspina in her study of girls from all over the country found menarche to have occurred in 37.1% of girls during the year following their 13th birthday and in 26.5% after the 14th year, whereas only 18.6% had their menarche after the 12th year[21]. In 1979, Dacou-Voutetakis et al found the mean age at menarche to be 12.5 years in girls living in Athens[19] and at around the same time, Mantzagriotis-Meimaridis, in a nationwide study, found median menarcheal age to be 12.59 years[13]. In 1996, Papadimitriou et al found the mean age at menarche in schoolgirls living in Athens to be 12.27 years and the median 12.1 years[22]. These studies suggest that in the 20th century there was a continuing positive secular trend towards earlier menarche in Greek girls.

DISCUSSION

According to Tanner, growth is a mirror of the social conditions prevailing in a given society[23]. The growth and development of children are considered reliable markers of the health and nutrition of their society and their changes reflect the changes in the socioeconomic status of the particular population group. If a population stops showing positive changes in these parameters, two interpretations may be offered; either there is no further improvement in the environmental conditions or the population reached the full expression of its genetic growth potential.

According to the National Statistical Service of Greece, in 1930, 73% of the working families' income was lower than the poverty line. 57.5% of income expenditure was on food, bread representing 40% of the family expenditure. In 1937, the average working Greek man had to pay half his daily wage for 1 kg of meat and one fifth of his daily wage for 1 kg of milk, whereas at the same time the average working Englishman had to pay one tenth and one twentieth of his daily wage, respectively[24]. In 1938, only 17% of families had an income equal to or greater than the poverty line.

Greece entered the 20th century as an underdeveloped country, spent most of the middle part of the

century as a developing one and succeeded in becoming a developed country in the 1970s. Economic development resulted in urbanization of the population[25]. While in 1920 only 22.9% of the population lived in cities with more than 10000 inhabitants, in 1991 urban population was 58.8% of the total. The shift from rural to urban areas was more intense in the 1960s.

During the second half of the 20th century, the improvement of the economic conditions of the population resulted in a change in dietary habits. In 1970, the expenditure on bread and cereals was only 9.6% and dropped even further to 6.4% in 1990, and food expenditure on meat was 22% and 26.5% in 1970 and 1990, respectively[25].

These changes in the socioeconomic conditions that took place in the second part of the 20th century in Greece had a dramatic impact on the growth of Greek children. The change in dietary habits, as described above, mainly concerned an increase in protein consumption, especially meat. The increase in height observed in both boys and girls, was noted before the ages at which children are entering puberty. This indicates that most of the height gain took place in prepuberty and should be attributed to better nutrition as well as improvement of the hygienic conditions of Greek children during this period.

The observation that in 1990 conscripts from urban areas were not taller than those from rural areas, contrary to what was observed in 1968, most likely signifies that in recent years nutrition and other socioeconomic factors related to growth have been more uniform in urban and rural areas.

In conclusion, Greek children showed positive secular growth changes during the 20th century. These changes showed a tendency to level off over the last decade and therefore the Greek population might have reached its full genetic growth potential, at least in the greater Athens area.

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