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SECULAR CHANGES IN HEIGHT AND LEG LENGTH AMONG TURKISH CHILDREN DURING THE LAST CENTURY

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Abstract

The secular change and socio-economic impact on it within developed countries have been well-documented in the past. The purpose of the study is to evaluate the brief analytic summary of the secular changes in growth pattern among Turkish children and adolescents during the last century. A cross-sectional survey was conducted on 1,427 (709 boys and 718 girls) healthy schoolchildren aged 6-17 years in Ankara, Turkey. Historical data sets were obtained from previous survey reports. According to the standard anthropometric protocols height and iliospinal height measured, socio-economic status of the sample recorded. Results showed significant sexual dimorphism for height and iliospinal height (ANOVA $p<0.001$). Coinciding with the first half of the last century, periods of sudden decreases and subsequent recoveries were found. However, in the last three decades secular change accelerated. This appears to be a logical outcome of the gradual changes in nutrition, health care, education and economic conditions. Therefore, it can be concluded that we might expect further positive changes for Turkish children.

Key words*: Secular change, anthropometry, height, leg length, children, adolescents, 20th century, Turkey.*

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Özet

Geçen Yüzyılda Türk Çocuk ve Adolesanlarında Boy ve Bacak Uzunluğunda Görülen Seküler Değişim

Seküler değişim ve sosyo-ekonomik koşullarla etkileşimi geçmişte pek çok gelişmiş ülkede tespit edilmiştir. Çalışmanın amacını geçen yüzyılda Türk çocuk ve adölesanlarında görülen seküler değişimin analizi oluşturmaktadır. Bu amaç doğrultusunda Ankara'da 1,427 (709 erkek ve 718 kız) sağlıklı okul çocuğu üzerinde kesitsel bir alan araştırması gerçekleştirilmiştir. Tarihsel veriler geçmiş araştırma raporlarından derlenmiştir. Standart antropometrik protokollere uygun olarak boy ve bacak uzunluğu ölçülmüş, sosyo-ekonomik düzeye ilişkin veri toplanmıştır. İstatistiki sonuçlar boy ve bacak uzunluğunun cinsiyetler arasında anlamlı farklılık gösterdiğini belirlemiştir (ANOVA $p<0.001$). Geçen yüzyılın ilk yarısı ile ilişkili olarak parametrelerde ani düşüş ve ardıl iyileşmeler gözlenmiştir. Ancak son 30 yıl sürecinde belirgin olan seküler değişimdeki hızlı ivme, bu değişimlerin beslenme, halk sağlığı, eğitim ve sosyo-ekonomik koşullardaki aşamalı iyileşmelere bağlı olduğunu düşündürmektedir. Bu veriler doğrultusunda Türk çocuklarındaki pozitif seküler değişimin ileride de devam edeceği tahmin edilmektedir.

Anahtar sözcükler: *Seküler değişim, antropometri, boy, bacak uzunluğu, çocuklar, adölesanlar, 20. Yüzyıl, Türkiye.*

1. Introduction

The term "secular change" refers the marked differences (increases or decreases) in body size and growth processes among groups within a population over time (Dittmar, 1998; Ulijaszek, 1998; Bogin, 1999; Roche and Sun, 2003). It is a good indicator of public health, determines environmental conditions act on human growth over long spans of time and clarifies physiological inter-generational relationships (Tanner, 1992; Bogin, 1999; Cole, 2003). Various researches showed that improved environmental conditions -increased availability of public health services, education, income, nutrition, sanitation and reduction in child labor- have been taking place with increase in the rate of growth and development (Ulijaszek, 1998; Bogin, 1999; Komlos, 1999).

Secular changes have been predominantly reported in industrialized countries during last two centuries around the globe (Eveleth and Tanner, 1990; Kouchi, 1996; Susanne and Bodzsar, 1998; Ulijaszek, 1998; Bogin, 1999; Komlos, 1999; Roche and Sun, 2003). Positive secular changes are particularly well documented for the Czech Republic, Japan, the Netherlands and the United States where sampling and anthropometric methods have remained fixed among repeated surveys (Roche and Towne, 2001). In children the growth-rate for height, weight and other body measurements

increased, while the mean age of onset of puberty decreased (Ulijaszek, 1998). In addition, change in body proportions is another major finding of these studies. Several studies mention that secular increase in mean height arises from the augmentation of leg length and not from that of sitting height (Kouchi, 1996; Susanne and Bodzsar, 1998). Remarkable secular change takes place in Japanese population associated with an increase in the relative length of the leg (Kouchi, 1996).

Negative secular change in population body-size is taken to be a response to environmental deterioration, and has been observed in historical sequences as well as in contemporary populations (Ulijaszek, 1998). During the World Wars, lack of secular trend and negative secular change had been observed in some countries. In Europe; France, Norway, Germany and Russia during World Wars I and II, experienced this situation, as did Japan during World War II (Malina, 1990; Susanne and Bodzsar, 1998). In India, South Africa, and Chile and in some of the Third World secular height decrease was documented in periods of socio-economic problems (Jurgens, 1990; Susanne and Bodzsar, 1998; Pheasant, 2002).

The changing growth pattern of Turkish children and adolescents are not well known due to lack of continuous growth-monitoring program that provides data. Prior to 1915 (the late period of Ottoman Empire), the Ottoman Ministry of Education made an attempt to take height and weight measurements from all schoolchildren. However, due to war conditions, this project was never initiated (Neyzi and Saka, 2002).

The first published study report contains height, weight and some other somatometric data on Turkish children and aims to describe racial/ethnic characteristics (Kansu, 1917; Kansu, 1939). In 1926-27, İrdelp studied more than 4,000 children between the ages of 9 and 18 of Turkish, Rum, Armenian, Jewish and Levantine origin (Nureddin et al., 1927). In 1938, two studies were conducted by Alantar (1938) and Tümay (1938). However, in these studies, there were some methodological limitations concerning data analyses and sample selection. In 1939, Kansu presented data regarding the anthropological investigation of the Turkish schoolchildren (Kansu, 1939). That study also includes other cross-sectional studies that were conducted within the same period of time by Gökçül (1939), Çınar (1939), and Kınay (1939). From the 1940s to the 1960s, a number of pioneering studies were carried out in order to determine the local norms for growth and development in various parts of the country (Yalım, 1940; Binbaşıoğlu, 1950; Bostancı, 1954; 1955; 1956; 1957). In the 1970s, the first growth standards were constructed on schoolchildren in Istanbul (Neyzi et al., 1973; 1976; 1978) and followed by a broader study in 1988 and 1992 (data from 7 geographical regions) (Saatçioğlu, 1988; Duyar, 1992). Consequent cross-

sectional studies in the last three decades conducted to determine growth status of children, as well (Baki and Teziç 1986; Kayış and Özok, 1986; Korkmaz, 1989; Duyar 1995; Akin 1995; Nebigil et al., 1997; Gültekin et al., 2002; 2003; 2005; 2006).

In 1927, Turkey's population was 13.6 million according to the census, which was conducted 4 years after the establishment of the Republic. According to 2000 census, the population increases to 67.8 million. Today, Turkey is among the 20 most populous countries of the world and has a young population structure as a result of high fertility and growth rates. 30% of the population is under 15 years of age and approximately 11% under 5 years of age (TURKSTAT, 2004; 2006; MoH, 2004; Hacettepe University Institute of Population Studies, 2004). From this starting point, understanding the secular change dynamics of Turkish children and adolescents takes an important part among auxology studies. In addition, the growth status of children and secular changes are useful determinants of the socio-economic aspect and health conditions of a population. In Turkey over the last eight decades significant improvements have been occurred in socio-economic determinants; education level, income per capita, urbanization, infant mortality rates and life span (TURKSTAT, 2004). Furthermore, the secular changes in anthropometric measurements have not been well documented. The purpose of the present study is to investigate the secular change dynamics for Turkish children and adolescents.

2. Material and methods

The present study based on a cross-sectional anthropometric survey and comparison with former data sets. Data were collected in November-December 2005 in Ankara, the capital city of Turkey. Ankara has a contradictory population structure. Beside its socio-cultural and economic mosaic structure, due to migration from almost all provinces of Turkey, it represents a good example for screening studies of the whole population. Survey conducted on primary and high school children, under the permission of the Turkish National Educational Ministry and local area boards of education and the Ankara University Foundation. The subjects were randomly selected, and schools represent different social strata; private schools, central public schools, and suburban public schools.

A total of 1,427 children, 709 boys and 718 girls aged between 6 and 17 years, were included. The date of birth was recorded (according to the day-month-year basis), and their ages were computed based upon the recorded date. Comparative data were obtained from former survey reports conducted on Turkish children and adolescents (Table 1).

Anthropometric measurements were performed as recommended by the International Biological Program (Weiner and Lourie, 1969). All

measurements were taken by examiner and recorded by another person. During the procedure, the participants were in light clothes and without shoes.

Body height (H, in cm) and iliospinal height or leg length (LL, in mm) measurements were recorded for each individual. Height was measured by Martin type anthropometer to the nearest mm. The subject stands erect looking directly forward while head oriented in the Frankfurt Plane maintained horizontally, aided by gentle traction by the measurer on the mastoid processes. Height of anterior superior iliac spine or iliospinal height was measured by a Martin type anthropometer to the nearest mm from the left side of the subject.

The parameters presented in mean and standard deviations. The Kolmogorov–Smirnov (K-S) test was applied to all the variables, though separately for each sex and age group, in order to establish the normality of the distribution.

Secular change was expressed as increase per decade obtained by multiplying the average annual increase by 10.

Student t test, analyses of variance (ANOVA) and Tukey tests were used to test sex differences for each age group and difference within age groups by using SPSS 13.0.

Table 1- Historical comparative data of children and adolescents

Survey Year	Age (years)	Sample (n)	Source of Data
1939	5-19	2,597 (1690 boys and 907 girls)	Kansu (1939)
1954	9-16	1,679 (832 boys and 847 girls)	Bostancı (1954; 1955)
1968	6-14	1,152 (592 boys and 560 girls)	Nashed and Bertan (1968)
1973	9-17	2,995 (1530 boys and 1465 girls)	Neyzi et al. (1973)
1978	0-18	3,606 (1851 boys and 1755 girls)	Neyzi et al. (1978)
1984	6-11	3,600 (1800 boys and 1800 girls)	Baki and Teziç (1986)
1988	7-11	1,000 (500 boys and 500 girls)	Saatcioglu (1988)
1992	12-17	1,200 (600 boys and 600 girls)	Duyar (1992)
1994	5-11	5,289 (2719 boys and 2570 girls)	Nebigil et al. (1997)
2006	6-17	1,427 (709 boys and 718 girls)	Present study

3. Results

Kolmogorov-Smirnov (K-S) test results confirmed the normality of the distribution for body height and iliospinal height (all K-S tests were non significant). Distribution of the sample by age and sexes and the mean and standard deviations of height and iliospinal height are presented in Table 2.

ANOVA results revealed significant sexual dimorphism for height at ages 10 and 12 ($p<0.001$) where the maximum height increment observed (for boys at age 12 and for girls at age 10). In addition, at ages 8, 11 ($p<0.001$), 13 ($p<0.05$) and 14, 15, 16 and 17 ($p<0.001$) sexual dimorphism were significant. Height increment was pronounced at ages 8 (Tukey, $p= 0.017$), 9, 12, 13 and 14 (Tukey, $p=0.000$) for boys and at ages 10 and 11 for girls (Tukey, $p=0.000$). A gradual increase in height continues until the age of 14 years for girls and 16 years for boys. As a result of adolescent increase, after age 13 boys have greater height values for all ages ($p<0.001$). Mean height was found to be slightly higher at age 16 for boys and girls than at age 17 years. Although sample randomly selected, at this age group more children from better socio-economic background consisted, and also it might be linked with the secular trend concept.

Sex differences for leg length were negligible in early childhood, no significant differences were found before 10 years of age. After age 10, sexual differences were found to be more prominent for leg length. At ages 10, 11, 12, 14, 15, 16 and 17 ($p<0.001$) statistically significant differences observed between sexes. The increment at leg length were found to be significant with Tukey test at ages 12 and 13 for boys and 7, 9, 10, 11 and 12 ($p<0.001$) for girls.

Table 2- Mean and standard deviation values of height (cm) and leg length (mm) by sex and age groups

Age	Boys					Girls				
		Height		Leg Length			Height		Leg Length	
(years)	n	Mean	SD	Mean	SD	n	Mean	SD	Mean	SD
6	34	120.61	6.46	670.44	43.91	34	122.54	8.02	670.74	48.34
7	51	124.15	5.65	709.59	44.15	65	124.38	6.71	718.18†	48.06
8	68	129.20**†	7.03	741.62	48.80	48	127.33	5.55	732.71	40.22
9	77	134.56†	6.60	778.90	47.99	62	133.29	6.40	780.35†	50.06
10	77	138.58**	7.75	794.9**	60.75	85	141.36†	7.83	827.12†	55.56
11	50	140.05**	8.12	819.38**	62.20	70	148.19†	7.55	867.60†	66.78
12	43	149.92**†	7.43	883.63**†	70.07	50	152.72	5.83	911.60†	52.94
13	76	158.88*†	10.39	932.11†	83.13	72	157.04	6.18	940.51	55.58
14	66	166.94**†	7.42	953.48*	46.10	73	158.84	5.73	942.62	44.06
15	61	170.87**	8.12	976.08**	53.04	52	159.08	6.36	940.54	49.07
16	59	175.36**	7.12	996.19**	55.09	64	161.11	5.20	947.95	49.20
17	47	172.79**	5.77	973.89**	44.85	43	159.63	5.76	942.26	50.46

*$p<0.05$, **$p<0.001$ (ANOVA test between sexes); $^{\dagger}p<0.001$ (Tukey test between successive age groups)

Former studies provide data for investigation of the secular change in height and leg length during the last century. The secular increase of height for boys and girls over the past century are presented in Table 3 and Figures 1 and 2. The plots indicate that eight decades before both boys and girls were considerably shorter than today. The overall trend in height thus the largest gain in height have found around respective pubertal ages and after (Figures 1 and 2). Thus, it appears that the increase in body height between the survey years has been different during childhood and during adolescent. This indicates that secular increase at all ages is mainly due to growing height but also points out a change in the pace of growth. This reflects earlier puberty and thus shortening of the growth period. It is worth to mention that this gain alone does not contribute to the secular trend in adult height.

In 1954, a negative secular change is prominent for boys at all ages (9 to 16 years) (Bostancı, 1954) (Table 3). This negative secular change is marked between ages 9 to 12 years for girls. However, at ages 15 and 16 neither increase, nor decrease was observed for girls (Table 3). The results showed that largest increase took place starting from 1970s. The gradual increase in body height since 1973 survey report (Neyzi et al. 1973) is clearly visible. Significant further increases in mean height have occurred at almost all ages for both sexes.

Table 3– Secular change in mean height (cm) between 1939 and 2006 for Turkish boys and girls

Age	Boys									
(years)	1939[*]	1954[†]	1968[††]	1973[‡]	1978[‡‡]	1986[§]	1988[§§]	1992[≈]	1997[≈≈]	Present study
6					116.00	115.30			118.34	120.61
7	116.80				121.50	120.00	123.04		122.84	124.15
8	119.80		121.20		127.00	125.00	128.55		128.26	129.20
9	125.90	124.32	125.90	133.20	132.00	131.10	132.91		133.23	134.56
10	131.40	128.75	131.30	134.20	137.50	134.80	137.58		138.20	138.58
11	135.10	133.58	137.30	139.70	143.50	139.40	141.19		141.00	143.64
12	140.50	138.74	139.30	146.10	150.00			147.88		150.14
13	145.20	143.71	143.00	149.20	156.00			156.22		158.88
14	152.30	150.59	148.50	159.60	162.00			162.62		166.94
15	160.00	154.80		166.50	168.00			169.75		170.87
16	164.30	162.91		169.60	172.50			172.65		175.04
17	164.40			170.70	173.50			174.58		174.99
	Girls									
6					114.00	113.90			117.41	122.54
7	115.80				120.00	119.10	121.93		122.66	124.38

8	119.60		120.60		125.50	124.60	126.20		126.76	127.33
9	127.70	124.35	127.00	130.90	130.50	129.60	132.06		133.24	133.29
10	131.10	127.97	132.10	134.10	137.00	135.30	137.60		139.14	141.36
11	136.80	134.04	137.00	140.30	145.00	141.00	141.88		143.70	148.19
12	143.30	140.57	141.70	148.50	152.50			151.92		152.72
13	147.50	148.46	145.00	153.90	156.00			155.74		157.04
14	150.60	153.47	145.80	156.70	153.50			160.36		158.84
15	154.20	154.04		157.10	159.50			161.41		159.08
16	156.40	156.77		157.40	159.00			161.86		161.38
17	157.40			157.20	160.00			161.98		161.04

* Kansu, 1939; †Bostancı, 1954; ††Nashed and Bertan, 1968; ‡ Neyzi et al., 1973 (Middle SES); ‡‡ Neyzi et al., 1978 (median); §Baki and Teziç, 1986; §§Saatçioğlu, 1988; ~Duyar, 1992; ≈Nebigil et al., 1997

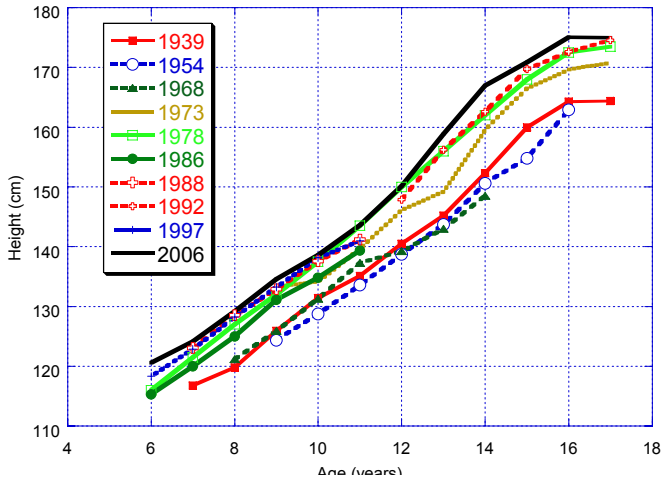

Figure 1- Secular change in height for Turkish boys between 1939 and 2006

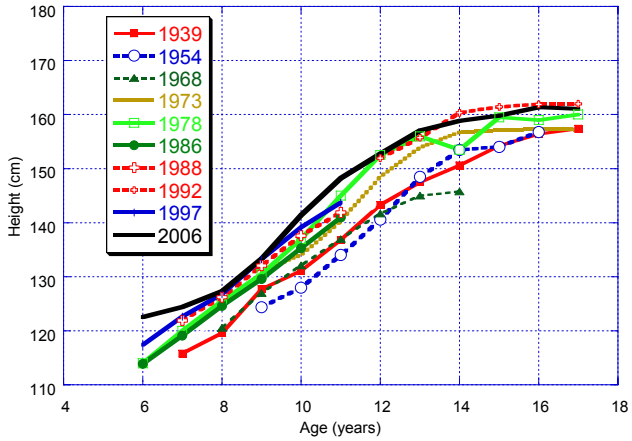

Figure 2- Secular change in height for Turkish girls between 1939 and 2006

The overall increase in height between 1939 and 2006 surveys is shown in Table 4. Secular growth rate for height was lowest for boys at ages 7 and 10 years by 1.10 cm/decade and 1.07 cm/decade. Where as, the highest secular growth rates for height was observed for boys at ages 13 and 14 years by 2.04 cm/decade and 2.19 cm/decade. This tendency is quite different for girls. The highest secular growth rates were observed at ages 10 and 11 years by 1.53 cm/decade and 1.70 cm/decade, where as the lowest rates were at ages 15, 16 and 17 years after the adolescent growth spurt ends. Findings point out the height increment difference between sexes during the last eight decades, mean height of 16 year old boys' height increased by 10.74cm, where as by 4.98 cm for their counterpart girls.

As it was stated before, a significant sexual dimorphism was prominent among the contemporary sample. In addition both increase and decrease in the mean height through time is more marked in boys than in girls (Table 3). The marked difference in increments between sexes through time might be explained by boys being able to respond more to the improvements of socio-economic conditions as mentioned by Susanne and Bodzsar (1998).

It has been known that the increase in the mean height resulted from proportional increment in sitting height and leg length (Susanne and Bodzsar, 1998). However, several studies mentioned that increase in the mean height essentially arises from the augmentation of leg length and not from that of sitting height (Kouchi, 1996; Susanne and Bodzsar, 1998). Table 5 presents the secular change in the leg length during the last century

by age and sexes. Pioneering studies showed that there has been a decrease in the leg length coinciding the first half of the last century for both sexes. Data from 1988 and 1992 surveys (Saatçioğlu, 1988; Duyar, 1992) point out a peak during respective puberty period and a continuation gradual increase particularly in boys. Present study also confirms the continuation of positive secular increase in leg length during the last two decades for both sexes.

Table 4- Secular increase in height between 1939* and 2006† in Turkish boys and girls

	Boys		Girls	
Age (years)	Increase (cm)	Secular rate (cm/decade)	Increase (cm)	Secular rate (cm/decade)
7	7.35	1.10	8.58	1.28
8	9.40	1.40	7.73	1.15
9	8.66	1.29	5.59	0.83
10	7.18	1.07	10.26	1.53
11	8.54	1.27	11.39	1.70
12	9.64	1.44	9.42	1.41
13	13.68	2.04	9.54	1.42
14	14.64	2.19	8.24	1.23
15	10.87	1.62	4.88	0.73
16	10.74	1.60	4.98	0.74
17	10.59	1.58	3.64	0.54

* Kansu, 1939 †Present study

Table 5- Secular change in mean leg length (mm) between 1939 and 2006 in Turkish boys and girls

Age	Boys					Girls				
(years)**	1939*	1955†	1988§§	1992≈	2006	1939*	1955†	1988§§	1992≈	2006
7	538.0		678.3		709.6	525.0		676.1		718.2
8	570.0		716.0		741.6	551.0		706.3		732.7
9	580.0	559.7	748.8		778.9	585.0	563.2	748.8		780.4
10	606.0	585.5	780.3		794.9	607.0	584.0	782.1		827.1
11	641.0	617.3	810.5		819.4	655.0	618.7	805.9		867.6
12	689.0	646.5		841.6	883.6	682.0	652.1		858.3	911.6
13		675.0		893.3	932.1		688.9		881.1	940.5
14		716.5		930.5	953.5		712.1		905.4	942.6
15		731.9		972.0	976.1		707.6		907.1	940.5
16		769.0		980.7	996.2		720.4		908.6	948.0

* Gökçül, 1939 (boys n: 234, girls n: 188); †Bostancı, 1955; §§Saatçioğlu, 1988; ≈Duyar, 1992; **no comparative data for ages 6 and 17 for this parameter

4. Discussion

The interpretation of the results based on former somatometric data is complicated, especially in Turkish population where the data are relatively limited. Between the late 1930s and the 1950s, a limited number of studies have been done on Turkish children who were born between 1920 and 1943 (Kansu, 1939; Yalım, 1940; Binbaşıoğlu, 1950; Bostancı, 1954; 1955). Later, three major studies were carried out (Neyzi et al., 1978; Saatçioğlu, 1988; Duyar, 1992), and they provide more detailed information on growth status.

In 1939, mean body height was found to be at a range of 116.80 cm to 164.40 cm for boys and 115.80 cm to 157.40 cm for girls between the ages of 7 and 17 years. The present study demonstrates that there has been a significant increase in mean height in comparison with the 1939 study (Kansu, 1939), as recent generations are taller throughout all age groups. The secular change rate was found to have increased among 13 to 14-year-old boys by 2.04 cm/decade and 2.19 cm/decade, respectively. This peak has been observed earlier among girls, possibly due to earlier maturation. Among girls, the maximum increment was found to occur at age 11 years by 1.70 cm/decade. A comparison of available data showed that during the 1950s and 1960s (Bostancı, 1954; Nashed and Bertan, 1968), a distinct decrease occurred. This trend can be explained by the negative effect of deteriorating social and environmental conditions in the wake of WWI, the Independence War (1918-1923) and during WWII. This significant outcome, which points to a negative secular change, also has been interpreted by Neyzi et al. (1996). It has been reported that although Turkey did not take part in that war, its economic and living conditions were considerably affected by the situation (Neyzi et al., 1996). Thus, by the mid-1970s (Neyzi et al., 1973; 1978), the increase in body size was marked, and this trend continued into the late 1980s through early 1990s (Saatçioğlu, 1988; Duyar, 1992) until today. The secular increase was primarily observed during pubertal stages, but it was evident at the final height, as well.

Various studies have shown that the positive secular change in height is mainly due to an increase in leg length and does not derive from an increase in sitting height (Susanne and Bodzsar, 1998; Fredriks et al., 2004). It has been reported that the increase in the average height of the Japanese population is due solely to increases in leg length, rather than in sitting height (Kouchi, 1996). Bodzsar (1998) also reports that in the last decade there has been no change in the growth pattern of sitting height in both sexes for Hungarian population, but there has been an increase in leg length. Vercauteren et al. (1998) reported the secular increases in height and leg

length in Belgian boys between 1960 and 1980. This study also emphasizes that in the Belgian population between these years, the secular increase in height was almost entirely caused by an increase in leg length. Interpretation of the present study shows an increase in leg length among Turkish children and adolescents during the last century. Between the 1930s and today, there was first a tendency towards decrease, shown in 1955 study (negative secular change) (Bostancı, 1955), after which there began a stable continuous increase that has continued up to the present day. We might conclude that for Turkish children and adolescents, secular increases in height are mainly caused by increases in leg length.

The results of the investigation of sexual dimorphism and the secular change rate differences between sexes constitute another important finding of the present study. The difference in increments between sexes through time might be explained as a result of boys' ability to respond more notably to improvements in socio-economic conditions. Previous studies have mentioned that growth in males is more eco-sensitive than in females. Responses to environmental improvements as well as to deterioration are therefore more marked in males than in females (Susanne and Bodzsar, 1998).

As has been stated above, improved environmental conditions such as increase in availability of public health services, education, income, nutrition, sanitation, and reduction in child labor stimulate increases in rates of growth and development (Ulijaszek, 1998; Bogin, 1999; Komlos, 1999). The present findings raise questions about the factors that might be responsible for the observed negative and positive secular changes in the Turkish population between the respective survey years. The influence of adequate nutrition on growth has been clearly demonstrated (Bogin, 1999). Nationwide nutritional survey findings indicate that the Turkish average diet has been adequate to meet recommended daily allowances. However intakes, of animal protein, calcium, vitamin A and riboflavin are lower than is recommended (Pekcan and Karaağaoğlu, 2000). Between 1965 and 1997, the average daily per capita dietary energy supplies (DES) for adults in Turkey increased from 2962 kcal to 3500 kcal. The percentage of protein, fat, and carbohydrates in DES within the given years also changed -0.9%, +3.2% and -2.2%, respectively (FAOSTAT, 2001). No significant change was observed in average food consumption within the last three decades. However, significant differences have been documented among families and sub-groups in terms of nutrition. Income level and education are the most important determinants of food consumption patterns, and maldistribution of

food among socio-economic, gender and age groups is still prominent (Pekcan and Karaağaoğlu, 2000; Pekcan, 2006).

On the other hand, the country has achieved important improvements in public health. Major infectious disease rates have declined between the late 1960s and the 1990s, and infant mortality has decreased as well. In 1980 the infant mortality rate was 120 per 1,000 live births, while in 1992 it was 55 per 1,000 live births and in 1995 it was 24 per 1,000 live births (TURKSTAT, 2004; 2005). Although Turkey has achieved success in improving of infant mortality rates, the rate still remains significantly above the European Union average (8 per 1,000 live births).

In addition, the illiteracy rate within the adult population was 81.3% in 1935, 61.9% in 1960, 34.4% in 1980 and 13.5 in 2000 (5.6% among males and 21.5% among females) (TURKSTAT, 2004). Better education, a better supply of food, clean water, safe sanitation, and decent housing are now more available for most of the Turkish population, although both regional and urban-rural disparities continue to exist across the country (TURKSTAT, 2004).

In conclusion, the present study provides up-to-date growth references for Turkish children and adolescents. The results demonstrate that prominent sexual differences can be linked with the sexes' different degrees of response to environmental improvements. Negative secular changes were previously found that may have been linked with the post-war depression of WWI and the Independence War (1918-1923), and the deteriorating conditions of WWII. Consequently, the positive secular changes that have been documented in the present study for height and leg length results during the last decades appear to be a logical outcome of gradual social changes. It must be noted that socio-economic conditions in Turkey still tend to be diverse within the population. Recent positive changes have been documented in the fields of health care, social welfare, nutrition, and education and general improvement in the living conditions in Turkey have been noted as well. In taking account of the potential for social improvement, we might predict a further positive secular trend in growth.

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References

AKIN Galip. (1995). "Van il merkezinde 8-12 yas grubu ilkokul çocuklarında fiziksel büyüme ve gelişmenin antropometrik yöntem ile incelenmesi (Investigation of physical growth and development of primary school children (8-12 age group) from Van province, Eastern Turkey, in terms of anthropometric methods)". *J Rheum Med Rehab.* 6(2), 104-110.

ALANTAR İhsan Hilmi. (1938). "Türk çocuklarında antropometrik ölçüler (Anthropometric measurements in Turkish Children), *Birinci Türk Çocuk Hekimliği Kongre Kitabı*, Ekspres Basımevi, 3-31, Ankara.

BAKİ Ali, Teziç Tahsin. (1986). Physical growth measurements of primary school children living in Trabzon, *The Turkish Journal of Pediatrics,* 28: 31-45

BİNBAŞIOĞLU Cavit Oral. (1950). *Ankara'da ilkokul çocuklarının beden gelişimi üzerinde bir inceleme (A research on body growth of primary school children in Ankara).* Sanat Basimevi, Ankara.

BODZSAR E. (1998). Secular Growth Changes in Hungary. In Bodzsar B.E. and Susanne C. (Eds.) *Secular Growth Changes in Europe*. Eotvos Univ. Press, Budapest.

BOSTANCI Enver Yaşar. (1954). "Ankara'da Türk okul çocuklarının boy büyümesi üzerinde bir araştırma (Growth research on height in Turkish school children in Ankara)". *Ankara Üniversitesi Dil ve Tarih-Coğrafya Fakültesi Dergisi.* 12 (1-2), 41-75.

BOSTANCI Enver Yaşar. (1955). "Türk okul çocuklarında büst ve alt taraf kısımlarının büyümesi üzerinde bir araştırma (Growth research on trunk and legs in Turkish school children in Ankara)". *Ankara Üniversitesi Dil ve Tarih-Coğrafya Fakültesi Dergisi.* 13 (1-2), 70-136.

BOSTANCI Enver Yaşar. (1956). "Türk erkek ve kız çocuklarında kol, üst kol, on kol ve el büyümesi ile bedenin diğer kısımları arasındaki korelasyonlar üzerinde bir araştırma (Growth research on arm, upper arm and forearm length and hand length and width and the correlations in Turkish boys and girls)", *Ankara Üniversitesi Dil ve Tarih-Coğrafya Fakültesi Dergisi.* 14 (1-2), 103-203.

BOSTANCI Enver Yaşar. (1957). "Türk erkek ve kız çocuklarında bedenin genişlemesine büyümesi ile proposyonların değişmesi üzerinde bir araştırma (A research on the growth and changing proportions in body

width in Turkish boys and girls)", *Ankara Üniversitesi Dil ve Tarih-Coğrafya Fakültesi Dergisi.* 15 (1-3): 1-47.

BOGIN B. (1999). *Patterns of human growth*. Cambridge University Press, Cambridge.

ÇINAR Naciye. (1939). "Ankara, Devrim ilkokul talebelerinden 433 kız ve erkek çocuk üzerinde antropometrik bir tetkik ve neticeleri (Recherches anthropometrique sur 242 garçons et 201 filles eleves d'une ecole primaire d'Ankara)", *Türk Antropoloji Mecmuası*. 15(19-22), 67-79 and 247-271.

COLE Tim. (2003). "The secular trend in human physical growth: a biological view". *Economics and Human Biology.* 1, 161-168.

DITTMAR Manuela. (1998). "Secular growth changes in the stature and weight of Amerindian schoolchildren and adults in the Chilean Andes, 1972-1987". *American Journal of Human Biology*. 10(5), 607-617.

DUYAR İzzet. (1992). *Growth standards in 12-17 years aged Turkish children*. Hacettepe University, Graduate School of Social Sciences (Unpublished PhD Thesis).

DUYAR İzzet. (1995). "Ankara'da yasayan çocukların bazı antropometrik ölçülerinde 1950-1986 yılları arasında gözlenen değişimler". *Hacettepe Üniversitesi Edebiyat Fakültesi Dergisi.* 12(1-2), 1-13.

EVELETH PB., JM. Tanner. (1990). *World Variation in Human Growth* (2nd ed.). Cambridge University Press, Cambridge.

FOOD AND AGRICULTURE ORGANIZATION (FAO) (2001). *Nutrition Country Profiles-Turkey.* Rome.

FREDRIKS AM, S. van Bruuen, WJM. van Heel, RHM. Dijkman-Neerincx, SP. Verloove-Vanhorick, JM. Wit. (2004). Nation-wide references for sitting height, leg length, and sitting height/height ratio, and their diagnostic values for disproportionate growth disorders. In: Fredriks AM. (Eds) *Growth diagrams 1997, Fourth Dutch Nation-wide Survey; 2004*.

GÖKÇÜL Nebile. (1939). "Ankara İsmetpaşa ilkokul talebelerinden 422 kız ve erkek Türk çocuğu üzerinde antropometrik araştırmalar ve neticeleri (Anthropometric research on 422 female and male primary school students in Ankara Ismetpasa Primary school) (Recherches anthropometriques sur les eleves d'une ecole primaire d'Ankara)". *Türk Antropoloji Mecmuası.* 15(19-22),176-186.

GÜLTEKİN Timur, Hauspie Roland, Susanne Charles, Güleç Erksin. (2006) "Growth of children living in the outskirts of Ankara: Impact of low socio-economic status". *Annals of Human Biology.* 33(1), 43-54.

GÜLTEKİN Timur, Akın Galip, Koca Özer Başak. (2002). "Obesity in 12-17 aged low socioeconomic level children". *Antropoloji.* 14, 31-42.

GÜLTEKİN Timur, Koca Özer Başak, Akın Galip. (2003). "Height and knee height values of 6 – 11 years old group school children: establishment of their percentiles by means of LMS method". *Antropoloji.* 16, 53-69.

GÜLTEKİN Timur, Akın G., Koca Özer Başak. (2005). "Gender Differences in fat patterning in children living in Ankara". *Antropologischer Anzeiger.* 63(4), 1-11.

HACETTEPE UNIVERSITY INSTITUTE OF POPULATION STUDIES (HUIPS), Ministry of Health, State Planning Organization, and European Union. (2004) *2003 Turkey Demographic and Health Survey*. HUIPS; Ankara.

KANSU Nafi Atuf. (1917). "Şakirtlerimizin nümayu bedenisi. Bursa mekteplerinde 125 kız ile 156 erkek çocuk neşvünemasını tetkik". *Muallim Mecmuası.* 11: 348-351.

KANSU Şevket Aziz. (1939). "Kız ve erkek Türk çocukları üzerinde antropometrik araştırmalar (Anthropometric research on Turkish girls and boys)". *Belleten.* 9, 69-79.

KAYIŞ B., Ozok A.F. (1986). *İlkokul öğrencilerinin boyutsal ölçümlerinin saptanması*. TUBITAK no: 128.

KINAY Melih. (1939). "Ankara Gedikli ortaokulu talebelerinden 200 erkek çocuk üzerinde antropometrik bir tetkik ve neticeleri (La croissance chez les eleves de sexe masculin d'une ecole secondaire)", *Türk Antropoloji Mecmuası*. 19-22,176-188.

KOUCHI Makiko. (1996) "Secular change and socioeconomic difference in height in Japan". *Anthropological Science.* 104(4), 325-340.

KOMLOS John. (1999). "On the biological standard living in Russia and the Soviet Union". *Slavic Reviev.* 58(1), 71-79.

KORKMAZ Tuncer. (1989). "Çocuklarda boy büyümesi (The growth of stature in children)". *Selçuk Üniversitesi Eğitim Fakültesi Dergisi.* 3, 269-275.

MALINA Robert M. (1990). "Research on secular trend on auxology". *Antropologischer Anzeiger.* 48(3), 209-218.

MINISTRY OF HEALTH OF TURKEY (MoH). (2004). *Turkey Health Report*. Ankara.

NASHED Salwa, Bertan Münevver. (1968). "Growth and physical development of primary school children in Etimesgut", Turkey, *Turkish Journal of Pediatrics* 10(4), 101-105.

NEBİGİL I., Hızel S., Tanyer G., Dallar Y., Coşkun T. (1997). "Heights and weights of primary school children of different social background in Ankara, Turkey". *Journal of Tropical Pediatrics.* 43, 297-300.

NEYZİ Olcay, Yalçındağ Ayfer, Alp Hülya. (1973). "Heights and weights of Turkish children". *Journal of Tropical Pediatrics Environmental Child Health.* 19(1), 5-13.

NEYZİ Olcay, G. Saner, H. Alp. (1976). Relationship between body-weight in infancy and weight in later childhood and adolescence. In Laron Z. (Eds) *Pediatric and Adolescent Endocrinology*. Vol. 1. Basel: Karger.

NEYZİ Olcay, Binyıldız Pervin, Alp Hülya. (1978). "Türk çocuklarında büyüme-gelişme normları I. tartı ve boy değerleri (Reference norms for Turkish children I. Height and weight measurements)". *İstanbul Tip Fakültesi Mecmuası.* 41(Supplementum 74), 3-22.

NEYZİ O, R. Bundak, H. Günöz, F. Darendeliler, N. Saka. (1996) Social class differences and secular trend in height in Turkish schoolchildren. In Bodzar BE, Susanne C. (Eds) *Studies in Human Biology*, Eotvos Univ. Press: Budapest.

NEYZİ Olcay, Saka Nurçin. (2002). "Anthropometric studies in Turkish children", *Antropoloji* 14: 81-113.

NUREDDİN, Neşet Ömer, Moucht, Süreyya, İsmail Hakkı (1926-1927). "İstanbul'daki Türk, Rum, Ermeni ve Musevi ocuklarının neşvünemaları üzerinde tetkikler". *Türk Antropoloji Mecmuası.* 2-3-4.

PEKCAN Gulden. (2006). "Food and nutrition policies: what's being done in Turkey". *Public Health Nutrition.* 9(1), 158-162.

PEKCAN Gülden, Karaağaoğlu N. (2000). "State of nutrition in Turkey". *Nutritional Health.* 14(1), 41-52.

PHEASANT S. (2002) *Bodyspace Anthropometry, ergonomics and the design of work.* Taylor and Francis, London.

ROCHE A, S. Sun. (2003). *Human Growth: Assessment and Interpretation*. Cambridge University Press, Cambridge.

SAATÇİOĞLU A. (1988). *Growth standards for 7 to 11-year-old Turkish children*. Publications of the University of Kuopio: Kuopio.

SUSANNE C., E. Bodzar. (1998). Patterns of secular change of growth and development. In Bodzar BE, Susanne C. (Eds) *Secular Growth Changes In Europe.* Eotvos Univ. Press, Budapest.

TANNER JM. (1992). "Growth as a measure of nutritional and hygienic status of a population". *Hormone Research.* 38 (Suppl. 1),106-115.

TURKISH STATISTICAL INSTITUTE (TURKSTAT). (2004) *Statistical Indicators 1923-2004*. Publication no: 535, Ankara.

TURKISH STATISTICAL INSTITUTE (TURKSTAT). (2006). *Statistical Year Book of Turkey 2005*. Publication no: 3009, Ankara.

TÜMAY Sezai Bedrettin. (1938). "*Çocuklarda büyüme nispetleri (Growth ratios in children)*". Birinci Türk Çocuk Hekimliği Kongre Kitabı, Ekspres Basımevi, Ankara.

ULIJASZEK SJ. (1998). The secular trend. In: Ulijaszek SJ., FE. Johnston, MA. Preece (Eds.) *Cambridge Encyclopedia of Human Growth and Development*, Cambridge University Press, Cambridge.

WEINER JES., JA. Lourie. (1969). *Human Biology: A Guide to Field Methods*. IBP Handbook, No: 9, Oxford, Blackwell.

VERCAUTEREN M., RC. Hauspie, C. Susanne (1998). Biometry of Belgian boys and girls: change since Quetelet. In Bodzsar B.E. and Susanne C. (Eds.) *Secular Growth Changes in Europe.* Eotvos Univ. Press, Budapest.

YALIM Z. (1940). "Türkiye'de mektep çocuklarının boy ve ağırlıkları (Height and weights of Turkish schoolchildren)". *Tıp Fakültesi Mecmuası.* 3(12), 1546-1558.