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ORIGINAL ARTICLE

Trends in body mass index, blood pressure and parental smoking habits in middle socio-economic level Turkish adolescents

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Patterns of cardiovascular risk factors in populations are not static over time. We examined trends in body mass index (BMI), parental smoking and blood pressure over a 15-year period in Turkish children aged 15–17 years. Two cross-sectional studies were performed in secondary schools in Turkey in 1989–1990 and 2004–2005. Study participants were 673 children in 1989–1990 and 640 adolescents in 2004–2005. Main outcome measures were weight, height, BMI, presence and amount of parental smoking, systolic and diastolic blood pressure. Age and sex matched comparisons were performed to assess temporal trends in these measures. Children in 2004–2005 had increased weight, height, BMI and decreased systolic and diastolic blood pressure in all age groups compared with children in 1989–1990. According to the international criteria, 3.4% of children were obese and 15.8% were overweight in 2005, compared to 0.7% obese and 4.2% overweight in 1990 ($P<0.001$). However, a decrease was noted in blood pressure; 16% were classified as hypertensive in 1989–1990 versus 8% in 2004–2005 ($P<0.001$). The prevalence and amount of parental smoking also decreased over the last 15 years. We observed significant changes in BMI and blood pressure in Turkish children over the last 15 years. Temporal trends in these parameters may indicate a change in the pattern of cardiovascular disease in this population.

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Introduction

Elevated blood pressure, smoking, overweight and obesity remain as major causes of morbidity and mortality throughout the world.[1,2] Patterns of cardiovascular risk factors in populations are not static over time and they are associated with changes in the pattern of cardiovascular disease.[3,4]

Overweight in adolescents has become a major public health concern in the United States and throughout the world.[5,6] Fewer data are available on blood pressure trends in youth. Findings from the United States have been inconsistent, whereas in United Kingdom and Northern Ireland, secular decreases in blood pressure have been noted in successive cohorts of university students and post-primary school students, respectively.[7–11] Blood pressure levels track well from youth to adulthood, making blood pressure in youth a useful predictor of essential hypertension in adulthood.[12] Indeed, the mean blood pressure of adults has decreased over the past two decades.[13]

Cigarette smoking is one of the most important avoidable causes of cardiovascular disease worldwide[1,2] and emerging data suggest that second hand smoke (smoking habits of family members such as parental smoking) is associated with adverse health affects.[14,15] Risk factors such as high blood pressure, parental smoking are common among Turkish children and adolescents[16] and cardiovascular risk profile in Turkish children appear to be unique compared to different populations.[17] In this study, we examined temporal trends in body mass index (BMI), parental smoking and blood pressure by comparing 15–17 years old children in 1989–1990 and in 2004–2005.

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Methods

Participants

The first children's cardiovascular risk factors study was carried out in 1989–1990 to evaluate the prevalence of cardiovascular risk factors, including blood pressure, weight, height and BMI among secondary school students. The study was performed at Hacettepe University Medical School (MA, GC). The secondary school was Kurtulus Lisesi in Ankara-Turkey, a state secondary school. We collected data from students aged 15–17 during 1989–1990. A total of 673 students were examined. Each student underwent complete medical history and physical examination. Students with acute or chronic medical problems and/or those who did not want to participate in the survey were excluded (less than 1%). Participating students were asked to complete a brief questionnaire that contained questions on second-hand smoke exposure, family history of coronary artery disease and dietary habits. Second-hand smoke exposure was assessed by asking students about the smoking habits of the family members, how many family members smoked, how many cigarettes family members smoked a day and whether these individuals smoked in the students' presence. Family history of coronary artery disease was defined as having a first degree relative with established coronary artery disease before age 50, or before menopause. Screening took place at schools during normal school hours. To ensure the accuracy of the questionnaire data, information was also confirmed with the parents.

A second cross-sectional study was carried out in 2004–2005 among 640 students attending another state secondary school. The study was performed at Marmara University Medical School (MA, BT, SA, EI, SO, BB). The school was Haydarpasa Lisesi in Istanbul, Turkey, another state secondary school. The methods of the second study were identical. Participants underwent blood pressure, weight and height measurements. They were also asked to complete the same questionnaire. Study was conducted according to the principles expressed in the Declaration of Helsinki. Subjects were given case numbers and identities were kept confidential, and the parents were informed. The study was approved by the local ethics committee.

Measurements

Height and weight measurements were used to calculate BMI, as a measure of overall adiposity. Several criteria have been used to define the overweight and obesity. Body proportions normally change during development and may vary among persons of different races and ethnic groups. The differences in waist-to-hip ratios are difficult to interpret in children. We therefore defined obesity on the basis of age- and sex-specific cutoff points of BMI (the weight in kilograms divided by the square of the height in meters) which were developed and published from the centile curves of an international reference population.[18,19] The criteria for overweight and obesity for adults are defined as having a BMI between 25–29.9 and $>30\,kg/m^2$ respectively.[20] To find the age-specific height percentile level for each case, we used the growth curves drawn for healthy Turkish children.[21] To define the overweight and obese children between 15 and 17 years of age in our study, we used the published age- and sex-specific cutoff points of BMI defined for 2–18 years old children, which corresponded to BMI of >25 and $>30\,kg/m^2$ in adult populations, respectively.[18]

Blood pressure was measured three times while the subjects were seated using a mercury sphygmomanometer (Erka, Germany). Medium-sized cuff was used for arm circumference of 22–32 cm. The last two measurements were averaged for the analysis. We used the age- and height-specific blood pressure percentile tables provided by Task Force Report on high blood pressure in children and adolescents.[22,23] Hypertension was defined as having a systolic or diastolic blood pressure $\geqslant$95th percentile.[22,23]

Statistical analyses

Continuous variables were presented as means $\pm$ s.d. and were compared by unpaired two-tailed Student's *t*-test between two groups and by analysis of variance between multiple groups. Comparisons between groups and semiquantitative scores were performed using Kruskal–Wallis and Mann–Whitney *U*-tests. Univariate and multiple linear regression analyses were used to examine variables associated with systolic and diastolic blood pressure. Time period, age, gender were always accounted for in the multivariate analyses. Other ancillary variables were included as possibly explanatory in the multivariable analyses, if the two-sided *P*-value was 0.05 or less. All tests of significance were two-tailed and a *P*-value of 0.05 or less is regarded as significant, and 95% confidence interval was derived.

Results

The response rate was above 99% for both surveys. Blood pressure readings, weight and height measurements showed good agreement between observers with no evidence of systematic variation. Tables 1 and 2 show findings from the two time periods, separately for male (Table 1) and female (Table 2) students. In all age groups, mean height, weight and BMI increased significantly in male students ($P<0.001$, Table 1). For female students, height remained similar, but there was a significant increase in weight and BMI (Table 2). As a result, there was a significant increase in the percentage of male students with overweight and obesity over the

Table 1 Characteristics of the male participants in 1989–1990 and 2004–2005

	15-year-old males			*16-year-old males*			*17-year-old males*		
Time period	*1989–1990*	*2004–2005*	P	*1989–1990*	*2004–2005*	P	*1989–1990*	*2004–2005*	P
Sample size	142	121		92	129		98	139	
Height (m)	166±9	170±7	<0.001	170±7	175±6	<0.001	172±8	177±7	<0.001
Weight (kg)	54±10	62±12	<0.001	57±8	68±12	<0.001	61±8	69±12	<0.001
Body mass index (kg/m^2)	19±2	21±3	<0.001	20±2	22±4	<0.001	20±2	22±3	<0.001
Overweight (%)	1.4	15.7	<0.001	2.2	22.5	<0.001	9.2	21	0.004
Obese (%)	0.7	4.1	<0.001	0	6.2	<0.001	0	3	0.004
Systolic blood pressure	117±11	113±13	0.007	119±15	117±11	0.26	118±14	117±11	0.7
Diastolic blood pressure	73±9	67±8	<0.001	74±10	69±9	<0.001	74±10	72±8	0.07
Hypertension (%)	18	8	0.02	22	10	0.02	13	7	0.12
Parental smoking (%)	70	54	0.008	70	57	0.06	72	56	0.01
No. of smokers in the family	1±0.9	0.7±0.8	0.005	1±0.9	0.8±0.8	0.02	0.9±0.7	0.8±0.9	0.36
No. of cigarettes parents smoke per day	10±12	6±10	0.006	10±14	8±12	0.2	9±11	11±17	0.17
Family history of coronary disease (%)	8.5	5.8	0.4	7.6	7	0.8	4	10	0.09
No. of eggs student consumes per week	7±8	3±2	<0.001	6±5	3±3	<0.001	6±5	4±5	0.001

Table 2 Characteristics of the female participants in 1989–1990 and 2004–2005

	15-year-old females			*16-year-old females*			*17-year-old females*		
Time period	*1989–1990*	*2004–2005*	P	*1989–1990*	*2004–2005*	P	*1989–1990*	*2004–2005*	P
Sample size	146	79		122	98		73	74	
Height (m)	161±6	162±6	0.17	162±7	162±6	0.64	163±7	164±6	0.3
Weight (kg)	51±9	58±10	<0.001	52±7	55±7	0.001	53±6	56±8	0.02
Body mass index	20±3	22±3	<0.001	20±2	21±3	0.001	20±2	21±3	0.04
Overweight (%)	3.4	19	<0.001	7	6	0.8	2.7	4.1	0.7
Obese (%)	1.4	2.5	<0.001	1	2	0.8	1.4	1.4	0.7
Systolic blood pressure	113±12	110±10	0.06	115±11	108±10	<0.001	115±16	108±12	0.004
Diastolic blood pressure	72±9	68±8	<0.001	73±9	68±7	<0.001	73±11	68±8	0.002
Hypertension (%)	10	6	0.3	15	4	0.009	19.2	4.1	0.004
Parental smoking (%)	73	60	0.04	73	54	0.004	64	60	0.54
No. of smokers in the family	1.1±1	0.9±1	0.13	1.2±1	0.7±0.8	<0.001	1.2±1.3	0.9±0.9	0.26
No. of cigarettes parents smoke per day	11±14	8±10	0.04	12±22	8±14	0.08	13±14	12±15	0.79
Family history of coronary disease (%)	14	6	0.07	10	8	0.67	7	7	0.98
No. of eggs student consumes per week	5±6	2±2	<0.001	5±5	2±1	<0.001	5±5	2±2	<0.001

last 15 years (Table 1). A similar trend was observed for 15-year-old female students (Table 2). The percentage of 15-year-old females with overweight was 3.4% in 1990 and increased to 19% in 2005. No significant changes were observed for 16- and 17-year females (Table 2).

We found consistent differences in mean blood pressure between the two time periods. There was a significant decrease in diastolic blood pressure in both male and female students and across all age groups (Tables 1 and 2). Mean systolic blood pressure decreased on average 1–9 mm Hg and the decrease was more significant among females (Tables 1 and 2). Consequently, the prevalence of hypertension (systolic or diastolic blood pressure $\geqslant$95th age, sex and height specific percentile) decreased from the teens to less than 10% in all age groups (Tables 1 and 2). Parental smoking also decreased significantly over the last 15 years (Tables 1 and 2).

We found consistent differences in weight and height between male and female students at both time points. Males at ages 16 and 17 were significantly heavier and taller than females of the same age ($P<0.001$, specific values are listed in Tables 1 and 2). For 15-year-old students also, males were heavier and taller ($P<0.001$ for height and $P=0.038$ for weight in 1989–1990, and $P<0.001$ for height and $P=0.027$ for weight in 2004–2005). Male students had higher systolic blood pressure than female students at ages 15, 16 in 1989–1990 ($P=0.002$ and $P=0.03$ respectively) and at ages 16, 17 in 2004–2005 ($P<0.001$). Similarly, 17-year-old males had higher diastolic blood pressure than females of the same age in 2004–2005 ($P<0.001$).

In univariate linear regression analyses examining the association of each characteristic with systolic and blood pressure, time period (1990 versus 2005), age, male gender, height and BMI were significantly associated with systolic and diastolic blood pressure at the 0.05 level. Number of eggs consumed per week was marginally significant at the 0.051 level. Family history of coronary artery disease and

Table 3 Adjusted and unadjusted decreases in blood pressure between 1989–1990 and 2004–2005

	Systolic blood pressure (mm Hg)		*Diastolic blood pressure (mm Hg)*	
Age and sex	*Unadjusted decrease*	*Adjusted decrease*[a]	*Unadjusted decrease*	*Adjusted decrease*[a]
15 years				
Males	2.68 (−0.37, 5.74)	4.31 (1.13, 7.49)	3.89 (1.51, 6.27)	5.62 (3.19, 8.05)
Females	3.96 (0.97, 6.94)	6.73 (3.72, 9.75)	5.99 (3.86, 8.13)	6.82 (4.57, 9.07)
16 years				
Males	6.70 (3.80, 9.60)	8.15 (5.29, 11.02)	5.11 (2.93, 7.29)	5.45 (3.21, 7.69)
Females	1.70 (−1.66, 5.07)	5.88 (2.33, 9.43)	4.54 (2.03, 7.05)	7.59 (4.92, 10.25)
17 years				
Males	6.77 (2.19, 11.35)	7.86 (3.27, 12.45)	4.63 (1.61, 7.65)	5.25 (2.27, 8.24)
Females	0.37 (−2.81, 3.55)	2.97 (−0.37, 6.31)	1.98 (−0.37, 4.33)	3.36 (0.85, 5.87)
Overall				
Males	5.27 (3.32, 7.23)	6.74 (4.77, 8.71)	4.54 (3.12, 5.96)	5.43 (3.99, 6.88)
Females	2.02 (0.19, 3.84)	5.24 (3.36, 7.13)	4.24 (2.90, 5.58)	5.81 (4.39, 7.23)

[a]Estimates and 95% confidence intervals derived from a regression model, adjusted for body mass index and height. For 'Overall' estimates, adjustment was also made for age.

current smoking history of family members were not significantly associated with systolic or diastolic blood pressure.

Table 3 shows the mean difference in systolic and diastolic blood pressure between the two time periods, both unadjusted and adjusted for age, gender, BMI and height. Substantial decreases between the time periods were found consistently in all ages and additional adjustments for age, gender, BMI and height yielded slightly greater decreases in blood pressures. Overall, mean decrease in systolic blood pressure was 6.74 mm Hg in males and 5.24 mm Hg in females, after adjusting for age, BMI and height. Similarly, mean decrease between the time periods in diastolic blood pressure was 5.43 mm Hg in males and 5.81 mm Hg in females, after adjusting for age, BMI and height (Table 3).

Discussion

Cardiovascular morbidity and mortality are high in the adult Turkish population.[24] Trends in obesity and blood pressure in adolescent children are markers of the future population burden of cardiovascular disease. Changes in the prevalence of these risk factors in adolescents may be important determinants of the future cardiovascular mortality and morbidity trends. Our findings from two cross-sectional studies demonstrate that the prevalence of overweight and obesity has increased in Turkish adolescents over the last 15 years. This trend is similar to the trends observed in other populations.[5,6] In contrast, we observed that increase in overweight and obesity in Turkish adolescents was not accompanied by increases in blood pressure.

Our findings are similar to previous observations from Ireland. Watkins *et al*.[10] reported large decreases in blood pressure among adolescents aged 12 and 15 years from Northern Ireland over a decade between 1990 and 2000. The magnitude of the trends could not be accounted for by several important mediating or confounding factors.

Secular trends in blood pressure among children and adolescents have been a subject of interest in several studies from developed countries. Decreases in blood pressure have been reported in young adults from Europe and the United States over the 50 years from 1948.[25] National Health (and Nutrition) Examination Surveys and the Bogalusa Heart Study indicated that variable decreases occurred in blood pressure of 6–17 year old American children and adolescents from the 1960s to the early 1990s.[7,26]

There are limited data from adolescents living in developing countries. Rapid epidemiological transition and urbanization result in large shifts in physical activity, dietary habits and lifestyle.[27] In Pakistani children living at different levels of urbanization, prevalence of cardiovascular risk factors increased with the level of urbanization.[28] Similarly, studies from Iran revealed an increasing trend in the prevalence of cardiovascular risk factors including obesity and dyslipidemia.[29]

Several factors may account for the secular decreases in blood pressure. The downward trend seems to be occurring despite positive associations between blood pressure in children and height and BMI. Similar findings have been observed in the adolescents from Northern Ireland, when increases in BMI were accompanied by decreases in blood pressure.[10]

One possible explanation may involve birth weight, which has shown a consistent inverse association with subsequent blood pressure. Low birth weight, in general, is thought to place the infant at greater risk of later adult chronic medical

conditions, such as diabetes, hypertension and heart disease.[30] Differences exist in birth weight of Turkish children compared to other populations.[31,32] Low birth weight at term is common in the developing countries.[33] Parental smoking and maternal dietary imbalances at critical periods of fetal development may affect metabolism and predispose the individual for future cardiovascular risk. Similarly, elevated blood pressure in youth may be a response to fetal under nutrition, causing long-term changes in arterial structure in the child.[34,35] In our study, we observed a high prevalence of parental smoking. Maternal smoking is a major risk factor for low birth weight; furthermore paternal smoking also carries risk for the fetus.[36] A trend for decreasing parental smoking and decreasing prevalence of low birth weight may explain the secular decreases in blood pressure in Turkish adolescents.

Another plausible explanation is alterations in diet and salt intake over time.[37] In our study, we performed a limited dietary questionnaire to understand participant's dietary habits. Recent observations indicate that Turkish adolescents have a high fibre, total fat, saturated fatty acid, cholesterol and sodium intake compared to AHA recommendations.[38] Changing dietary habits in Turkish adolescents may explain increased BMI in our second cross-sectional study. Further research is needed to investigate these hypotheses.

We also observed that parental smoking is highly prevalent among Turkish school children. Even though there was a decrease in the prevalence and amount of parental smoking over the last 15 years, our data indicate that parental smoking presents a major threat to Turkish children. Smoking parents are more likely to have smoking children, and parental smoking particularly maternal, results in an increase in low birth weight and a decrease in the physical and mental development of the child.[39]

We report an observational study that has several limitations. We compared height, weight, BMI and blood pressure at two different time points and at different locations. Comparison of blood pressure levels at different time points is important but also difficult. Many factors can contribute to the observed differences such as study design, differences in examination, methodological differences. The two surveys were conducted at different schools, at different time points by different observers. Therefore, measurements may not be comparable. One can question whether comparison of the two cohorts is valid from a methodological point of view since the cohorts are small in size and from different areas. This is a potential source of bias. Yet given the resources of the study, it was not feasible to increase sample size or recruit the later cohort at the same location.

We selected two state secondary schools and the socioeconomic status of the students was similar. On the other hand, the diagnosis of hypertension was based on a single blood pressure value, which may overestimate the true prevalence of hypertension.

Our study participants attended a public school; therefore most students were from middle socioeconomical level. Socio-economical status is far more complex than diet alone, and it is likely that many factors interact to produce the difference in BMI and blood pressure that we have observed. We did not account for other risk factors, such as insulin sensitivity, salt intake and physical activity levels that may mediate the association between blood pressure and BMI.

Future studies should elucidate the psychosocial, environmental, educational, physical activity and metabolic determinants of the trends in BMI and blood pressure.

What is known about this topic

- Elevated blood pressure, smoking, overweight and obesity remain as major causes of morbidity and mortality throughout the world.[1,2]
- Patterns of cardiovascular risk factors in populations are not static over time and they are associated with changes in the pattern of cardiovascular disease.[3,4]
- Overweight in adolescents has become a major public health concern in the United States and throughout the world.[5,6]

What this study adds

- We observed significant changes in body mass index and blood pressure in Turkish children over the last 15 years.
- Children in 2005 had increased weight, height, body mass index and decreased systolic and diastolic blood pressure in all age groups compared with children in 1990.
- According to the international criteria, 3.4% of children were obese and 15.8% were overweight in 2005, compared to 0.7% obese and 4.2% overweight in 1990 ($P<0.001$).

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