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The relationship between BMI and blood pressure in school-age children in Izmir, Turkey

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Summary. *Objective:* Prevalence of hypertension and obesity are increasing in children. This study aimed to determine the relationship between hypertension and obesity among school-age children in Izmir (western part of Turkey), which is the third largest city in Turkey. *Design:* Cross-sectional descriptive study. *Participants:* The sample consisted of 1289 students aged between 6 and 10 attending two primary schools in Izmir, a province in Turkey. *Measurements:* The students' weights, heights and blood pressures were measured. *Data Analysis:* The independent sample t-test, anova test and multiple regression analysis were used for statistical analyses. *Results:* The prevalence of hypertension and obesity was 20.2% and 14.7% respectively. Gender was not associated with hypertension and obesity in children. The body mass index was statistically significant as an explanatory variable of hypertension for both genders. *Conclusion:* Overweight and obese children are at a significantly higher risk for hypertension than are normal weight children.

Key words: hypertension, obesity, school children, Turkish

Introduction

There is evidence that hypertension in adults' starts in childhood (1, 2). Children whose blood pressure and body weight are high for their age are more likely to develop hypertension in the future (3). In recent years, the prevalence of hypertension in children and adolescents is increasing. The increase in childhood hypertension leads not only to an increase in the prevalence of hypertension in adulthood but also to an increase in cardiovascular mortality and morbidity. Therefore, early diagnosis of childhood hypertension is an important public health strategy for the prevention and control of cardiovascular diseases (4).

Many chronic diseases such as diabetes, hypertension and cardiovascular diseases are known to be associated with obesity. Childhood obesity is also known to be associated with high blood pressure. Increase in the prevalence of hypertension in parallel with obesity epidemic in children has become a major problem (5). Studies conducted with large samples in several countries have demonstrated that high blood pressure is an important determinant for obesity in children (4, 6). However, in Turkey, data on the relationship between hypertension and obesity, and disease burden in children at the national level are limited. To overcome these diseases and to develop effective prevention strategies, knowing the prevalence of the disease is a priority. This present study was aimed to determine the prevalence and the relationship between obesity and hypertension in Turkish school-age children aged 6-10 years, living in the province of Izmir, Turkey. İzmir is the third largest city in Turkey, with a city population of more than four million.

Materials and methods

According to Turkey Population Statistics, 522.390 children, aged 5-14 years were living in Izmir in 2015. Using this information and the probable prevalence of overweight and obesity was accepted as 15 % with a margin of error of 0.05, and the minimum sample size was calculated 194 students for this study with a 95% confidence interval. Because of this study aims (statistical test selection, subgroup size, etc.) sample size was raised to 1000.

This cross-sectional and descriptive study was conducted among all grades (from grade 1 to grade 4) of two primary schools in Balçova district of Izmir city center, Turkey, between January 2014 and January 2015. Balçova was inhabited by people of different socio-economic levels and had a dynamic population structure. There were six primary schools and 3240 students were attending primary schools in the Balçova district. Two of these six primary schools were selected with a simple randomize method. For all of the schools, the classes were mixed sex and school attendance was imperative (primary school is enforced by the government in Turkey). All students enrolled in all grades in these two schools (n=1452) were asked to participate. The response rate was 88.7% (n=1289).

After data collection days were determined, data collectors were trained by researcher. The students were visited in schools and data collection was completed in classrooms. All students were invited for data collection but some students were excluded because they were absent on data collection days. The students' age and gender information was taken before height, weight and resting blood pressure (BP) measurements were obtained.

Weight and height measurements: Children's body weights were measured with a digital scale (Bosch) (±0.1 kg). While their weights were measured, the students took off their shoes and clothes except for school uniforms. For the height measurements, a digital tape measure (Bosch) (±0.1 cm) was used. Height measurements were made with shoes off, shoulders relaxed and arms at the sides. Body Mass Index (BMI) was calculated by dividing weight (kg) by the square of the body height (m^2), which is expressed in units of kg/m^2. After the children's BMIs were calculated, percentile values based on their age and gender were determined. Those in the less than the 5 th percentile were considered as underweight, from the 5 th percentile to less than the 85 th percentile as normal weight, from the 85 th to less than the 95 th percentile as overweight and equal to or greater than the 95 th percentile as obese (7).

Resting blood pressure: Resting blood pressure measurements were performed manually using a mercury sphygmomanometer (ERKA) with a cuff appropriate to their age. Measurements were performed in the sitting position after at least a 10-minute rest. The assessments were performed in accordance with the criteria defined in National High Blood Pressure Education Program Working Group on High Blood Pressure in Children and Adolescents (8). According to age and height, systolic or diastolic blood pressures in the ≥95 th percentile were considered as hypertension, between the ≥90 th percentile and the <95 th percentile as prehypertension, and lower than the 90 th percentile as normal.

Data on the children's age, gender, BMI and blood pressure were assessed with the descriptive statistics (numbers, percentages, means). While the comparison of the BMI and blood pressure values of boys and girls for age and gender were performed with the anova test, inter-gender comparisons were performed with the Independent Samples t test. To identify the variables affecting blood pressure in girls and boys, the multiple regression analysis was used. Data were analyzed using Statistical Package for the Social Sciences version 15.0 (SPSS Inc., Chicago, IL, USA) and the statistical significance was defined as $P<0$.

To carry out the study, the approval was obtained from the non-interventional clinical research ethics committee of Dokuz Eylul University.

Results

In this present study, data of 1289 students aged between 6 and 10 years were evaluated. Of the students, 51.4% (n=663) were male. The mean age of the girls and boys were 7.71±1.21 and 7.70±1.23, respectively. The students' mean BMI value was 17.93±3.51, mean systolic blood pressure value was 108.24±10.95 mmHg and mean diastolic blood pressure value was 66.62±8.28 mmHg. Of them, 61.8% (n=796) were normal weight, 12.7% (n=164) were overweight and 14.7% (n=190) were obese. The prevalence of hypertension and prehypertension was 20.2% (n=261) and

10.0% (n=129), respectively. Of the students, 4.8% (n=62) were both obese and hypertensive (Table 1).

According to age groups, the highest prevalence of obesity was in 8-year olds (21.5%), and the highest prevalence of hypertension was in the 7-year olds (26.1%) (Table 2). The distribution of BMI and blood pressure values of the participants for age and gender is shown in Table 3. An increase was determined in the BMI and diastolic blood pressure mean values with age in both genders ($p<0.000$). For the 6-year-old boy students, the BMI and diastolic blood pressure mean values were 17.02±3.01 kg/m^2 and 66.36 ± 9.17 mmHg respectively. These values increased to 19.68±4.68 kg/m^2 and 68.67±6.99 mmHg for the 10-year-old boy students. The values were 16.66±2.40 kg/m^2 and 65.02±7.12 mmHg for the 6-year-old girl students, and 18.98±3.34 kg/m^2 and 68.91±7.68 mmHg for the 10-year-old girl students. The comparison of girls' and boys' BMI (17.78±3.32 vs 18.07±3.67), systolic (107.94±11.19 vs 108.52±10.71) and diastolic blood pressure (66.52±7.86 vs 66.72±8.65) mean values revealed no significant difference ($p>0.05$).

Table 1. Obesity and hypertension prevalence (N=1289)

	n	(%)
Weight status		
Underweight	139	(10.8)
Normal weight	796	(61.8)
Overweight	164	(12.7)
Obese	190	(14.7)
Blood pressure status		
Normal	899	(69.8)
Prehypertension	129	(10.0)
Hypertension	261	(20.2)

Comparison of the blood pressure values of normal-weight students with those of the overweight and obese students revealed significant differences between the two groups in terms of both the systolic blood pressure values (106.71±10.34 and 112.12±11.42, respectively) and diastolic blood pressure values (65.69±8.01) and 68.50±8.28, respectively) ($p<0.000$). Blood pressure levels of the overweight and obese students were higher than were those of the normal weight students.

The results of regression analysis indicating the factors affecting the blood pressure values of the boys and girls are shown in Table 4. In the girls, BMI and age accounted for 10% and 9.5% of the variance for the systolic blood pressure and diastolic blood pressure respectively. These rates were 11.3% and 7.3% for the boys. BMI was identified as the variable directly affecting both the systolic blood pressure and the diastolic blood pressure for the two genders ($p<0.000$).

Discussion

In this current study, the prevalence of hypertension and obesity among school-age children (aged 6 to 10 years) in Balçova District of Izmir and the relationship between hypertension and obesity were assessed. The study findings showed that the prevalence of obesity and hypertension was high, and that diastolic blood pressure and BMI increased with age. Childhood obesity was determined to be associated with hypertension.

In this current study, anthropometric characteristics of the 1289 children were assessed and the prevalence of hypertension was found as 20.2%. In previous studies conducted in Turkey, the prevalence

Table 2. Hypertension and obesity prevalence according to age (N=1289)

Age	6		7		8		9		10		Total	
	n	%	n	%	n	%	n	%	n	%	n	%
Hypertension	70	(24.3)	74	(26.1)*	38	(13.2)	73	(19.6)	6	(10.5)	261	(20.2)
Pre-hypertension	32	(11.1)	41	(14.4)	26	(9.0)	27	(7.3)	3	(5.3)	129	(10.0)
Obesity	57	(19.8)	34	(12.0)	62	(21.5)*	30	(8.1)	7	(12.3)	190	(14.7)

** The highest prevalence in the age group*

Table 3. Body mass index (BMI (kg/m^2) and systolic and diastolic blood pressures according to age and gender

	Age	n	BMI (kg/m^2)		Systolic BP (mmHg)		Diastolic BP (mmHg)	
			Mean	SD	Mean	SD	Mean	SD
Boys	6	148	17.02	3.01	108.18	11.56	66.36	9.17
	7	150	17.01	2.76	107.70	11.10	64.32	8.66
	8	148	17.76	2.92	108.54	8.83	66.52	8.09
	9	183	19.74	4.41	109.39	11.09	68.77	8.46
	10	34	19.68	4.68	108.82	10.73	68.67	6.99
Total		663	18.07	3.67	108.52	10.71	66.72	8.65
			F=19.392 p<0.001		F=0.569 p=0.686		F=6.131 p<0.001	
Girls	6	140	16.66	2.40	106.36	10.47	65.02	7.12
	7	134	16.61	2.34	107.53	11.61	65.07	8.04
	8	140	18.17	3.53	107.30	10.01	66.00	7.70
	9	189	18.98	3.79	109.49	12.14	68.75	7.91
	10	23	18.98	3.34	111.08	10.43	68.91	7.68
Total		626	17.78	3.32	107.94	11.19	66.52	7.86
			F=17.109 p<0.001		F=2.234 p=0.064		F=7.160 p<0.001	

Table 4. Multiple regression analysis of blood pressure results

Dependent variable			R^2	β	t	p value
Systolic BP	Girls	BMI	-	0.311	7.811	<0.001
		Age	-	0.017	0.440	0.660
		BMI and Age	0.100	-	28.073	<0.001
	Boys	BMI	-	0.348	9.062	<0.001
		Age	-	-0.056	-1.471	0.142
		BMI and Age	0.113	-	33.681	<0.001
Diastolic BP	Girls	BMI	-	0.252	6.320	<0.001
		Age	-	0.116	2.916	0.004
		BMI and Age	0.095	-	22.647	<0.001
	Boys	BMI	-	0.244	6.208	<0.001
		Age	-	0.066	1.681	0.093
		BMI and Age	0.073	-	22.896	<0.001

of hypertension in school-age children ranged between 7.9 and 15.1% (9-11). In studies conducted in various countries, the prevalence of hypertension was 6.2% in Italy (12), 5.9% in India (13) and 20.6% in the United States (14). In this present study, the obesity prevalence in school-age children was determined as 14.7%. In a study conducted in Bursa, a province in Turkey, the prevalence of obesity in school-age children was reported as 11.2% (9). In another large-scale study conducted with students from fifty-three provinces in Turkey, the prevalence of obesity in school-age children was 10% and 6.6% for boy and girl students respectively (15). In two studies conducted in Greece and China, the prevalence of obesity in school-age children was similar to the prevalence of obesity determined in this present study 13.1% (16) and 15.7% (17). It is difficult to determine the exact prevalence of hypertension in children, because results vary from one study to another due to the differences in participants' age groups, populations of the studies (schoolchildren or general population), blood pressure measurement methods, the number of blood pressure measurements, the place of residence and ethnicity. Another reason may be due to the differences between the prevalence of obesity (10).

The results showed that BMI and diastolic blood pressure increased with age in both genders. Polat et al. carried out a study with schoolchildren in Ankara, the capital of Turkey and found similar results indicating that BMI, and systolic and diastolic blood pressure increased with age in both gender (11). The results showed that blood pressure and BMI did not differ by gender. The relationship between gender, and blood pressure and BMI is controversial. Previous studies showed that in Iranian and Turkish children, BMI and blood pressure values of boys were higher than were those of girls (11, 18). On the other hand, Gündogdu reported that girl students' BMI was higher than that of boy students, but that blood pressure values did not vary for gender (19). Although it is not clear, the possible causes of the gender-related differences are considered to be associated with the effects of sex hormones in the control of blood pressure (18).

The results of the regression analysis showed that high BMI is an important predictor for the risk of hypertension in children. In both sexes, both diastolic and systolic blood pressure increased as BMI increased. A study conducted in Turkey indicated that obese children had higher systolic and diastolic blood pressure values (20). Similarly, a study of Chinese schoolchildren showed that obesity was a risk factor for hypertension (4). In another study conducted in the United States, the risk of hypertension in overweight and obese schoolchildren was found to be 3 times more than that in other children (15).

The results obtained from this present study are applicable only to the students surveyed and thus they cannot be generalized to other schoolchildren in Turkey.

Conclusion

The results of the present study confirm that the prevalence of hypertension and obesity in school-age children is increasing, and that childhood obesity is a significant risk factor for hypertension. To protect children against cardiovascular disease risks in adulthood, it is important to diagnose their problems at an early stage and to implement preventive interventions. Conducting yearly body weight and blood pressure measurements in children is the first step in protecting them against hypertension and obesity. Routine follow-ups and screenings carried out in schools, and primary and secondary healthcare facilities offer significant opportunities for health professionals to diagnose childhood hypertension and obesity. In order to reduce cardiovascular morbidity and mortality, it is recommended that regular screening programs should be conducted in schools, children at risk should be followed, appropriate treatment programs should be organized, education programs on the prevention of obesity and hypertension should be prepared for children, families and teachers, and environmental and political measures to promote a healthy lifestyle should be taken.

Ethics statement

This study was reviewed and approved by the Dokuz Eylül University Ethical Committee.

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