İstanbul Med J 2022; 23(4): 237-40
DOI: 10.4274/imj.galenos.2022.78137

The Prevalence of Hypertension in Children and Adolescents and Affecting Factors

Cengizhan Kılıçaslan[1], Şükrü Arslan[2]

[1]Aksaray University Faculty of Medicine, Department of Pediatrics, Aksaray, Turkey
[2]Bakırçay University, Çiğli Training and Research Hospital, Clinic of Pediatric Rheumatology, İzmir, Turkey

ABSTRACT

Introduction: The incidence of hypertension (HT) has recently increased among children, and factors affecting the development of HT vary between regions; therefore, we determined the prevalence of high blood pressure (BP) and HT in children and adolescents in our region and risk factors affecting HT.

Methods: BP measurements were properly conducted in 3170 children and adolescents aged between seven and 17 years in our province. Children's BP measurements evaluated anthropometrically were also classified under the nomograms of the American Academy of Pediatrics-2017. Statistical analysis were evaluated regarding gender, age, and anthropometric values.

Results: HT was detected in 4.83% of 1592 children aged between seven and 12 years, and 7.6% of 1,578 children aged between 13 and 17 years, with a total rate of 6.21% (n=197). The risks of high BP and HT increased 1.231 times with a one-year increase in age ($p<0.001$). Likewise, the male gender also increases those risks 2,071 times, compared with the female gender ($p<0.001$). Compared to underweight participants, the risk of HT was observed to increase approximately six times among overweight individuals. Finally, obesity was also found to increase the risk of HT by approximately 26 times, compared with underweight individuals ($p<0.001$).

Conclusion: As a result, such effects as malnutrition, increase in age, and male gender were detected as the factors increasing the risk of HT development in children aged between seven and 17 years. The measurement of BP should be a part of routine physical examination in children and adolescents.

Keywords: Blood pressure, children, hypertension, obesity

Introduction

The fact that the prevalence of hypertension (HT) in childhood period is lower than that in adults may cause the physicians to pay less attention to childhood HT. It is now known precisely that HT detected in adulthood starts in childhood (1). Additionally, it has also been proven in many studies that having high blood pressure (BP) in childhood is a significant risk factor for developing chronic renal failure and cerebrovascular diseases, primarily atherosclerosis and cardiovascular diseases in adulthood (1).

In previous studies conducted to determine the prevalence of childhood HT, so different results have been obtained. The increase in BP is affected by various contributors, such as nutritional habits, socioeconomic status of families, and genetic and environmental factors (2). It is seen that there are differences between countries and even between regions of the same country, and so those differences in the prevalence of HT lead each region to determine its prevalence of childhood HT (3). However, different classification methods can be used in these studies. To prevent differences arising from the use of different classification criteria, current guidelines can be used to determine a common approach to the diagnosis and treatment of HT (1).

This study determined the prevalence of HT and the risk factors affecting BP in children and adolescents aged between seven and 17 years in our province, based on up-to-date guideline.

Methods

Study Population

After obtaining approval from the Konya University, Meram Faculty of Medicine Local Ethics Committee (approval number: 2012/29, date: 13.03.2012) and written informed parents' consent, 3,170 children between seven and 17 years of age were included in the study through the random sampling method from primary and high-school schools with similar socio-economic and cultural features. Both parents and the participants were informed about the voluntary participation and the design of the study. Those refusing to participate were excluded from the study.

Received: 21.04.2022
Accepted: 24.08.2022

Address for Correspondence: Cengizhan Kılıçaslan MD, Aksaray University Faculty of Medicine, Department of Pediatrics, Aksaray, Turkey
Phone: +90 505 271 94 17 **E-mail:** dr_cengizhan@hotmail.com **ORCID ID:** orcid.org/0000-0002-6093-7132

Cite this article as: Kılıçaslan C, Arslan Ş. The Prevalence of Hypertension in Children and Adolescents and Affecting Factors. İstanbul Med J 2022; 23(4): 237-40.

Assessments

The measurements of BP were performed at least thrice on the right arm of each child in the study in a calm and comfortable environment, and the average of three measurements was calculated for each child. In performing the measurements, the arm circumference of each child was measured from the middle of the arm, and the appropriate cuff was selected for the cuff length to be 80-100% of the arm circumference and for the cuff width to be 45-55% of the arm circumference. A benchtop mercury sphygmomanometer ERKA 3000 (ERKA, Kallmeyer Medizintechnik, Bad Tölz, Germany) was used to perform the measurements.

After choosing the appropriate cuff, the stethoscope was placed on the brachial artery as proximal and medial to the cubital fossa and at the lower end of the cuff while the child was in the sitting position. Attention was paid to ensure that the cubital fossa was at the level of the heart. The cuff was inflated to approximately 20 mmHg above the point of loss of pulse and deflated at a rate of 2-3 mmHg per second. During the measurements, the first stage of Korotkoff sounds (K1) heard as the cuff pressure was released was accepted as systolic BP. The point (K5) at which Korotkoff sounds disappeared and when the cuff pressure was sufficiently released to allow normal blood flow was accepted as diastolic BP.

The findings after the measurements were analyzed under the staging criteria standards released by the American Academy of Pediatrics in 2017 (AAP-2017) (4). Percentile curves were evaluated in terms of age and gender differences. While those in the 90-95th percentile or those having a value of BP above 120-80 mmHg despite <90th percentile were assessed to have high BP, that <95th percentile was accepted to be hypertensive. Additionally, those having a value of ≥95 P +12 mmHg or ≥140/90 mmHg were considered stage-2 HT. For the children evaluated to have HT and high BP, the measurements of BP were carried out three times more (six times), and the average measurements were recalculated. Those having the value of 90th percentile for both systolic and diastolic BP readings were considered normotensive.

The body mass index (BMI) values of the children who appropriately underwent the anthropometric evaluation concerning the height and weight measurements were calculated by the formula defined as a child's weight in kilograms divided by the square of the child's height in meters (kg/m^2). Based on the charts constituted for Turkish children by the age and gender differences, while the children below the 5th percentile and those between the 5th and 85th percentiles were defined as underweight and normal weight recently, those between the 85th and 95th percentiles and above the 95th percentile were evaluated as overweight and obese, respectively (4).

Statistical Analysis

Based on the statistics of the census database, it has been accepted that there are approximately 450,000 individuals between the seven and 17 age group, meeting the study inclusion criteria throughout the province of Konya. The information related to the prevalence of HT based on the literature was taken as approximately 6%, and the sample size to be reached such a rate with a 2% difference and 95% confidence interval (CI) was calculated as at least 2808 for the bilateral hypothesis at 0.80 power and 0.05 error level.

In evaluating the data obtained in the study, the Statistical Package for Social Sciences (SPSS) for Windows 21.0 software package was used to perform the statistical analyses (SPSS Inc., Chicago, IL, USA) (5). The calculation of the sample size, however, was performed using GPower (3.1.9.6, Franz Faul, Universintäl Kiel, Germany). In our study planned as a prevalence study, the descriptive statistics were summarized as the frequency distributions and percentages for categorical variables, and the mean ± standard deviation and the median (minimum-maximum) for continuous quantitative variables. The variables questioned and found significant as the risk factors affecting HT in our study were analyzed by the multiple logistic regression analysis, and the findings were stated with the odds ratios of 95% CI and the relevant p-values. The type-1 error rate was accepted as 0.05 for all statistical analyses.

Results

The demographic data and study findings of 3,170 children included in the study are presented in Table 1.

The mean age of 3,170 children was found as 12.68±3.26, and HT was detected in 77 (4.83%) of 1,592 children aged between seven and 12 years included in the study. Even so, in those aged between 13 and 17 years, HT was determined in 120 (7.6%) of 1,578 children.

In this study, the normotensive children and those diagnosed with high BP and HT were evaluated in terms of gender and weight status, and the statistical differences evaluated in the study are presented in Table 2.

High BP and risk factors affecting the status of HT were examined by the multiple logistic regression analysis, and the findings are shown in Table 3. Accordingly, when the age included in the model increases by one

Table 1. Data from the study

		n	%
Gender	Male	1624	51.23
	Female	1546	48.77
Percentile of BMI	Obese	339	10.69
	Overweight	370	11.67
	Normal weight	2255	71.14
	Underweight	206	6.50
Systolic HT	HT	190	5.99
	High BP	136	4.29
	Normal	2844	89.72
Diastolic HT	HT	65	2.05
	High BP	147	4.64
	Normal	2958	93.31
AAP 2017	HT	**197**	**6.21**
	Stage 1 HT	94	2.97
	Stage 2 HT	103	3.25
	High BP	141	4.45
	Normotensive	2832	89.34

AAP: American Academy of Pediatrics, BP: Blood pressure, BMI: Body mass index, HT: Hypertension unit, the risks of high BP and contracting HT also increase 1,231 times, and the finding is statistically significant (p<0.001).

Similarly, when compared to the female gender, the male gender was seen to increase the risks of high BP and HT 2,071 times (p<0.001). It was also observed that compared to underweight status, overweight status was detected to increase the risk of HT approximately six times (p<0.001). Finally, obesity was determined as a factor increasing the risk of HT approximately 26 times, compared to the underweight (p<0.001).

Discussion

In this study, the rates of HT were detected as 4.83% in children aged between seven and 12 years, 7.6% in those aged 13 and 17 years, and 6.21% in those aged between seven and 17 years. In previous studies conducted in different countries and centers worldwide, the prevalence of HT varied between 1 and 11%. In a study by Kamath et al. (6) on 2,067 school children in South India in 2010, the prevalence of HT was emphasized to be 2.2%. Again, in another study conducted by Vivek and Singh (7) in the province of Gujarati in India in 2012, the prevalence of HT was found to be 9.2% in 1087 school children between five and 18 years of age. Under the report of AAP-2017, the prevalence of HT was announced as 9.4% (11.1% for boys and 7.5% for girls) (1). Many epidemiological studies have so far been conducted to determine the prevalence of HT in the different provinces of Turkey over the years. Although the prevalence of HT in children and adolescents varies between 0.6 and 14.4% in the studies conducted in Turkey, the study by Duzova et al. (8) found the frequency of HT as 6.1% in children aged between five and 18 years. However compatible our study results are with the findings detected both in Turkey and in the world, differences can be observed among the findings of those studies, and such differences can be attributed to the diversity of ethnic and genetic structures, the changes in socioeconomic status, the evaluation of different age groups, the changes seen in BP rates of age groups, and the different techniques used to measure BP (9).

In the study conducted in Western India by Buch et al. (10), it was reported that the prevalence of HT increases with age. In the same study, although the prevalence of BP was observed to increase after 10 years of age in girls (0.62% for <10 years, 8.67% for 10-13 years, and 8.48% for >13 years), BP prevalence elevated in boys following 13 years of age (5.88% for <10 years, 6.04% for 10-13 years, and 9.19% for >13 years). In our study, there was also a significant difference between the values of BP among the different age groups, and as the age increases by one unit, the risks of high BP and HT increase 1,231 times; in other words, the prevalence of HT was determined to increase with age.

Unfortunately, different studies investigating the association between BP and gender have found and reported different findings. While some studies found the mean BP values to be different, others detected BP values to be higher in boys or *vice versa*. However, the prominent view reported in previous studies is that the male gender has a higher rate of BP (1-11). In the study by Kamath et al. (6) with 2,067 school children in South India, the prevalence of HT was determined to be 2.1% in boys and 2.4% in girls, and no significant difference was reported between the genders. In a study conducted in Russia, however, it was found that the prevalence of HT was higher in children living in cold regions (12.7%), than those in the general population (12.7%), and it was also revealed that the rate of HT was higher in boys than that in girls (12). Based on the AAP-2017 criteria, statistically significant differences were

Table 2. The presentation of the data obtained from the study

n		HT		High BP		Normal		p
		%	n	%	n	%		
Gender	Male	116	58.88	91	64.54	1417	50.04	**<0.001**
	Female	81	41.12	50	35.46	1415	49,96	
Percentile of BMI	Obesity	102	51.78	34	24.11	203	7.17	**<0.001**
	Overweight	35	17.77	27	19.15	308	10.88	
	Normal weight	58	29.44	73	51.77	2124	75.00	
	Underweight	2	1.02	7	4.96	197	6.96	

BP: Blood pressure, BMI: Body mass index, HT: Hypertension

Table 3. The results were obtained through the multiple logistic regression analysis

	B	S.E.	Six.	Exp (B)	95% CI for exp (B)	
					Lower	Upper
Constant	-6.671	0.505	-	-	-	-
Age (years)	0.207	0.022	**<0.001**	1.231	1.178	1.285
Male	0.728	0.133	**<0.001**	2.071	1.597	2.685
Underweight	-	-	-	-	-	-
Obesity	3.260	0.370	**<0.001**	26.062	12.626	53.795
Overweight	1.912	0.376	**<0.001**	6.767	3.241	14.129
Normal weight	0.648	0.357	**<0.001**	1.911	0.949	3.849

CI: Confidence interval

found in high BP in terms of gender differences (11.8% for boys and 5.8% for girls) (1). In studies conducted at various centers, different findings were obtained about the effects of male and female genders on BP in children. In our study, the male gender has increased the risk of HT 2,071 times, compared with the female gender.

Although the underlying etiology is complex, obesity-related HT is a serious problem during the childhood period (13). Obesity and high sodium intake have been strongly reported to affect the prevalence of HT (14). The prevalence of obesity-associated HT in childhood is increasing rapidly worldwide as a crucial health problem (15). The frequency of HT increases 2.5-3.7 times among the children with BMI ≥90th percentile (16). Additionally, studies have shown that the rates of both systolic BP and diastolic BP are higher in obese children with insulin resistance (17). In our study, it was also observed that obese individuals face approximately 26 times higher risk of HT, compared to underweight individuals, and the overweight status increases the risk of HT approximately six times, compared to underweight individuals.

Study Limitations

Although the prevalence of HT was found to be 6.21% in our study, several studies have revealed that the frequency of HT decreases in repeated measurements performed due to the high measurements of BP, and therefore, the true prevalence is considered lower (18). To evaluate BP more appropriately, Ambulatory blood pressure monitoring is gaining vital importance in the diagnosis, treatment, and management of HT in childhood and adolescence (19). We consider that long-term studies are needed to elucidate the prevalence of HT and related factors.

Conclusion

In conclusion, while each one-year increase in age causes the risk of HT to increase approximately 1.2 times in children aged between seven and 17 years, such factors as male gender, being overweight, and obesity also elevate the risk of HT twice, six times and 26 times increases, respectively. As in adults, the measurement of BP should also be a part of routine physical examination in children.

Ethics Committee Approval: The study was approved by the Ethics Committee of Konya University, Meram Faculty of Medicine Clinical Research Ethics Committee (approval number: 2012/29, date: 13.03.2012).

Informed Consent: It was obtained.

Peer-review: Externally and internally peer-reviewed.

Authorship Contributions: Concept - C.K., Ş.A.; Design - C.K., Ş.A.; Data Collection or Processing - C.K.; Analysis or Interpretation - C.K., Ş.A.; Literature Search - C.K., Ş.A.; Writing - C.K.

Conflict of Interest: No conflict of interest was declared by the authors.

Financial Disclosure: The authors declared that this study received no financial support.

References

1. Flynn JT, Kaelber DC, Baker-Smith CM, Blowey D, Carroll AE, Daniels SR, et al. Clinical practice guideline for screening and management of high blood pressure in children and adolescents. Pediatrics 2017; 140: e20171904.
2. Falkner B. Hypertension in children and adolescents: Epidemiology and natural history. Pediatr Nephrol 2010; 25: 1219-24.
3. Sorof JM, Lai D, Turner J, Poffenbarger T, Portman RJ. Overweight, ethnicity, and the prevalence of hypertension in school-aged children. Pediatrics 2004; 113: 475-82.
4. Neyzi O, Furman A, Bundak R, Gunoz H, Darendeliler F, Bas F. Growth references for Turkish children aged 6 to 18 years. Acta Paediatr 2006; 95: 1635-41.
5. IBM SPSS Statistics for Windows, Version 21.0. Armonk, NY: IBM Corp; 2012.
6. Kamath GV, Pathage PM, Pattanshetty S, Kamath A, Balakrishnan A, Sinha N, et al. Prevalence of hypertension in the pediatric population in coastal South India. Australasian Medical Journal 2010; 3: 695-8.
7. Vivek V, Singh SK. Prevalence of hypertension in Gujarati school-going children and adolescents in ANAND district. National Journal of Community Medicine 2012; 3: 452-7.
8. Duzova A, Yalçinkaya F, Baskin E, Bakkaloglu A, Soylemezoglu O. Prevalence of hypertension and decreased glomerular filtration rate in obese children: results of a population-based field study. Nephrol Dial Transplant 2013; 28(Suppl4): iv166-71.
9. National High Blood Pressure Education Program Working Group on High Blood Pressure in Children and Adolescents. The fourth report on the diagnosis, evaluation, and treatment of high blood pressure in children and adolescents. Pediatrics 2004; 114: 555-76.
10. Buch N, Goyal JP, Kumar N, Parmar I, Shah VB, Charan J. Prevalence of hypertension in school going children of Suratcity, Western India. J Cardiovasc Dis Res 2011; 2: 228-32.
11. Ewald DR, Haldeman PhD LA. Risk factors in adolescent hypertension. Glob Pediatr Health 2016 3: 2333794X15625159.
12. Gakova EI, Aseeva SI. Arterial pressure mean values and distribution, and relation to duration of residence in the North in school children living in the north of Tumen region. Ter Arkh 2001; 73: 21-4.
13. Becton LJ, Shatat IF, Flynn JT. Hypertension and obesity: epidemiology, mechanisms and clinical approach. Indian J Pediatr 2012; 79: 1056-61.
14. Calcaterra V, Larizza D, De Silvestri A, Albertini R, Vinci F, Regalbuto C, et al. Gender-based differences in the clustering of metabolic syndrome factors in children and adolescents. J Pediatr Endocrinol Metab 2020; 33: 279-88.
15. Kaçmaz N, Ersü A, Balcı UG, Öngel K. Wellness and Obesity Surgery: Case Report. Smyrna Med J 2014; 4: 3840 (Turkish).
16. Aghamohammadzadeh R, Heagerty AM. Obesity-related hypertension: epidemiology, pathophysiology, treatments, and the contribution of perivascular adipose tissue. Ann Med 2012; 44: 74-84.
17. Güneş H, Güneş H, Temiz F. The Relationship Between Epicardial Adipose Tissue and Insulin Resistance in Obese Children. Arq Bras Cardiol 2020; 114: 675-82.
18. Hansen ML, Gunn PW, Kaelber DC. Underdiagnosis of hypertension in children and adolescents. JAMA 2007; 298: 874-9.
19. Macumber I. Ambulatory blood pressure monitoring in children and adolescents: a Review of Recent Literature and New Guidelines. Curr Hypertens Rep 2017; 19; 96.