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Original Research Article

TO INVESTIGATE THE RELATIONSHIP BETWEEN BLOOD PRESSURE AND AGE AND BMI IN CHILDREN'S

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Abstract

Background: An important predictor of future developments in adult hypertension is the longitudinal blood pressure pattern seen in children throughout time. While it is typical for blood pressure to rise as children grow, those with elevated blood pressure levels tend to maintain this status compared to their peers as they age. Additionally, higher levels of blood pressure in childhood are associated with an increased likelihood of developing hypertension and body mass index (BMI) plays a significant role in this risk, both in adults and children. **Aim:** To investigate the relationship between blood pressure and age and BMI in children's. **Materials and Methods:** This research included children between the ages of 10 -16, regardless of their gender. A semi-structured questionnaire was created to gather demographic information about the children. Additionally, weight and height measurements were taken for all the children, and their BMI and blood pressure were evaluated. The blood pressure was measured using a mercury sphygmomanometer, along with a high-quality stethoscope suitable for individuals of all ages. When the systolic blood pressure (SBP) and diastolic blood pressure (DBP) exceeded the 95th percentile for age and sex, they were classified as hypertensive. **Results:** The average age of men was 12.88±1.69 years, while the average age of females was 13.25±1.88 years. The average BMI of 10-year-old children was 16.15±1.34, while it was 20.77±2.54 for 16-year-old children. Our study observed a consistent rise in BMI as children's age increased. The prevalence of hypertension in males was 13.33% and in females it was 11.82%. The highest prevalence of hypertension, both in males (30%) and females (22.22%), was observed in the 10-year age group. In all other age groups, the prevalence of hypertension ranged between 7-14% in males and 7-13% in females. **Conclusions:** We concluded that the high blood pressure (BP) and body mass index (BMI) demonstrated a strong positive correlation, which was statistically significant.

INTRODUCTION

The global significance of both hypertension and obesity, as significant public health issues, is on the rise. The prevalence of hypertension in adults is projected to rise by 60% from the year 2000 to reach a total of 1.56 billion individuals by 2025.[1] The growing incidence of obesity is becoming more widely acknowledged as a crucial risk factor in the development of hypertension. Childhood obesity, although seen as a worldwide health issue, was once regarded as a concern only in wealthier nations. Today, the issue has begun to arise even in developing nations such as India, where the primary concern for health personnel used to be under-nutrition. To address the widespread issue of obesity and hypertension connected to obesity, it is necessary to conduct research that are tailored to the local population. These studies should take into account the variations in ethnicity, lifestyles, and dietary habits that exist across different regions in India.[1] Obesity is the condition of having an excessive amount of fat in the body, which leads to a weight that is higher than what is deemed healthy based on age, height, and bone structure. This accumulation of fat may either be widespread or selectively target certain compartments of adipose tissue. The global prevalence of overweight and obesity has emerged as a significant public health problem in recent decades. The occurrence of overweight and obesity is on the rise, with obesity being a significant contributor to both illness and death. It is estimated that obesity is responsible for around 2.6 million deaths globally and accounts for 2.3% of the overall burden of disease worldwide.[2] In the United States, the obesity rate among adults is at 30%, while an additional 35%

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of persons are classified as overweight. According to the National Health and Nutrition Examination Survey (NHANES) IV conducted from 1999 to 2002, 31% of children over the age of 2 were classified as overweight or obese. Additionally, 16% of children and adolescents between the ages of 6 and 19 were determined to be obese. Obesity rates in Iran exhibit variation between rural and urban populations, with a notable increase of 30% among women residing in Tehran. The prevalence of obesity among adults in Japan is on average 20%, but it increases to 30% in men over the age of 30 and women over the age of 40. This is a three to fourfold increase compared to the rates seen 40 years ago. The prevalence of childhood obesity was uncommon in previous times. However, in recent years, there has been a growing trend of seeing this creature. The global prevalence of paediatric obesity ranges from more than 30% in the United States to less than 2% in sub-Saharan Africa. The current rates of obesity among school students are as follows: 20% in the UK and Australia, 15.8% in Saudi Arabia, 15.65% in Thailand, 10% in Japan, and 7.8% in Iran.[3] There is a lack of national data on childhood obesity in India. However, studies conducted in Chennai and Delhi have shown prevalence rates of 6.2% and 7.4% respectively.[4,5]
Although obesity and hypertension are increasingly prevalent in developing nations, there is a lack of comprehensive data on the correlation between body mass index and blood pressure in these people.
The occurrence of high blood pressure associated with obesity varies depending on the age, race, and gender of the population being examined. Research has shown that over 30% of instances of high blood pressure in males below the age of 45 may be linked to fat. However, in some instances, this percentage may reach up to 60%.[6] Ghosh et al. conducted a study on Hindu males from West Bengal, with an average age of 37.5 years. They found that the risk of getting hypertension was higher in those with rising BMI, as shown by obesity indicators such as Waist Stature Ratio and BMI.[7]
The majority of data about the prevalence of obesity and the patterns of obesity and blood pressure are derived from research performed at the national or state level. There is little information available about the frequency of obesity and high blood pressure in smaller political divisions such as states or cities. Given India's multi-ethnic composition, it is essential to gather statistics on overweight and obesity rates that are distinct to each state. This understanding of the local population standards will aid in the development of proactive steps to alleviate the possible strain.

MATERIALS AND METHODS

A department of paediatric did a cross-sectional research. This research included children between the ages of 10 -16, regardless of their gender. The research excluded children who had acute sickness, a medical history indicating cardiovascular, pulmonary, or other systemic disease, as well as impaired children and children with any impairment.

Methodology

Our research included a cohort of 200 childrens. The investigation began after approval from the institutional ethical committee and after obtaining informed permission from the ethics board. A semi-structured questionnaire was created to gather demographic information about the children. Additionally, weight and height measurements were taken for all the children, and their BMI and blood pressure were evaluated. The height was determined by using a vertical scale with an accuracy of 0.5 centimetres. The weight was determined using a conventional weighing scale with an accuracy of 0.5 kilogrammes. The worldwide thresholds for body mass index were used to categorise children as overweight and obese. The blood pressure was measured using a mercury sphygmomanometer, along with a high-quality stethoscope suitable for individuals of all ages. Brachial artery was consistently palpated in all instances, and subsequently, the right upper limb was used for measuring blood pressure due to its direct connection to the ascending aorta. The measurement of blood pressure was taken in the right upper limb. The conventional BP cuff was securely positioned on the brachial artery and pressurised to a level 30mm higher than the systolic BP determined by palpation. Subsequently, the cuff is gradually depressurized at a rate of 2-4 mm of Hg per second. The identification of the first korotkoff sound and the attenuation of subsequent korotkoff sounds were used to determine the systolic and diastolic pressure, respectively. Three measurements were recorded at 5-minute intervals, and the average of these values was used to determine the systolic and diastolic blood pressure. Every possible measure was taken to avoid any potential influences on blood pressure, such as worry, fear, sobbing, laughing, and recent activities, in order to ensure accurate blood pressure measurements under controlled "basal" or "near basal" settings. The blood pressure measurements were taken only after the youngster had grown familiar with the observer, device, and environment. Following a 5-10-minute period of rest, the individual's blood pressure was measured while sitting, with their back supported, feet on the floor, and right arm supported at heart level using the cubital fossa. The right arm was selected for the sake of uniformity and to facilitate comparison with established benchmarks. Additionally, this choice was made due to the potential presence of aortic coarctation, which might result in inaccurate (underestimated) measurements if the left arm were utilised. The blood pressure measurements were rounded to the closest 2 mm Hg. The blood pressure measurements were consistently collected throughout the afternoon hours by the same individual using the same device. A comprehensive examination was also conducted to rule out any cardiovascular, renal, or other conditions that might

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potentially impact blood pressure. A body mass index (BMI) that falls between the 85th and 95th percentiles is classified as overweight, while a BMI beyond the 95th percentile is considered obese. Conversely, a BMI below the 5th percentile is categorised as underweight. When the systolic blood pressure (SBP) and diastolic blood pressure (DBP) exceeded the 95th percentile for age and sex, they were classified as hypertensive according to the charts provided in the 'Fourth Report On the Diagnosis, Evaluation, And Treatment of High Blood Pressure In Children And Adolescents' from the book 'Evaluation And Management of Hypertension' by Bagga A. et al.[8]

Statistical Analysis

The data was inputted and analysed using SPSS version 25.0. Mean and standard deviation were computed for all the parametric variables. The statistical inference between the two variables, BMI and blood pressure, was derived using the chi-square test and Pearson's correlation coefficient.

RESULTS

Among the 200 childrens in our research, 90 (45%) were boys and 110 (55%) were girls, resulting in a male-to-female ratio of 0.82:1. The age distribution of the participants, ranging from 10 to 16 years, reveals that the largest proportion, 31.5%, falls within the 12-year-old category. This is followed by 20.5% of participants who are 13 years old, 13.5% who are 14 years old, and just 4.5% who are 16 years old. The average age of men was 12.88±1.69 years, while the average age of females was 13.25±1.88 years. [table 1]

The average BMI of 10-year-old children was 16.15±1.34, while it was 20.77±2.54 for 16-year-old children. Our study observed a consistent rise in BMI as children's age increased. This increase in BMI with age was found to be statistically significant, as indicated in. [Table 2]

The prevalence of hypertension in males was 13.33% and in females it was 11.82%. The highest prevalence of hypertension, both in males (30%) and females (22.22%), was observed in the 10-year age group. In all other age groups, the prevalence of hypertension ranged between 7-14% in males and 7-13% in females. [Table 3]

The BMI was categorised as normal, overweight, obese, or underweight based on the percentile. Table 4 reveals that the occurrence of hypertension was higher among overweight and obese students compared to those in the normal or underweight group, for both men and females. This correlation between BMI and hypertension was shown to be statistically significant. [Table 4]

The relationship between BMI and hypertension demonstrated a robust positive correlation between BMI and systolic blood pressure in both males (r=0.77) and females (r=0.69). This correlation was statistically significant. However, when examining the correlation between BMI and diastolic blood pressure, a statistically significant correlation was observed among males (r=0.74), but not among females (r=0.61). [Table 5]

Table 1: Age and gender of the participants

	Number=200	Percentage	P value
Gender			0.27
Male	90	45	
Female	110	55	
Age in years			0.12
10	19	9.5	
11	23	11.5	
12	63	31.5	
13	41	20.5	
14	27	13.5	
15	18	9	
16	9	4.5	
Mean Age	13.11±1.83		

Table 2: Weight, height and BMI of the participants

Age	Weight(kg)	Height(cm)	BMI	P-value
10	26.04±2.52	128±2.85	16.15±1.34	
11	30.11±2.74	133±4.58	16.24±1.22	
12	32.25±2.69	139±3.87	16.74±1.27	
13	37.58±2.87	145±3.74	17.88±1.09	0.001
14	39.11±2.78	146±3.94	17.99±1.54	
15	41.96±2.99	153±3.64	18.76±2.25	
16	50.87±2.97	156±3.25	20.77±2.54	

Table 3: Age and gender wise prevalence of hypertension

Age	Male			Female		
	Total	Hypertension	%	Total	Hypertension	%
10	10	3	30	9	2	22.22
11	11	1	9.09	12	1	8.33
12	27	3	11.11	36	4	11.11

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13	18	2	11.11	23	2	8.69
14	12	1	8.33	15	2	13.33
15	8	1	12.5	10	1	10
16	4	1	25	5	1	20
Total	90	12	13.33	110	13	11.82

Table 4: Association between BMI and hypertension

BMI	Male			Female			Total		
	Total=90	Hypertension=12	%	Total=110	Hypertension=13	%	Total	Hypertension=25	%
Normal	40	3	7.5	50	4	8	90	7	7.78
Overweight	18	3	16.67	22	5	22.73	40	8	20
Obese	7	3	42.86	13	5	38.46	20	8	40
Underweight	25	1	4	25	1	4	50	2	4
P value	<0.001			<0.001			<0.001		

Table 5: Correlation between BMI and hypertension

Blood pressure	BMI	Male	Female
Systolic BP	Normal(80-85thpercentile)	117.06±3.74	123.07±2.22
	Over Weight(85–95thpercentile)	124.22±3.79	124.05±2.71
	Obese(>95thpercentile)	129.04±2.29	125.08±2.07
	Under Weight(<5thpercentile)	116.14±3.08	117.25±2.11
R value (p value)		0.77(<0.001)	0.69(<0.001)
Diastolic BP	Normal(80-85thpercentile)	80.57±0.79	78.88±1.24
	Over Weight(85–95thpercentile)	81.69±1.85	81.24±1.08
	Obese(>95thpercentile)	89.74±1.74	82.05±1.56
	Under Weight(<5thpercentile)	79.07±1.06	77.11±1.36
R-value (p value)		0.74(<0.001)	0.61(0.08)

DISCUSSION

The cost of living in a prosperous and advanced civilization is a lifestyle characterised by lack of physical activity and unhealthy eating patterns, resulting in an energy imbalance that ultimately leads to obesity. The prevalence of overweight and obesity is quickly rising and poses a significant danger to the health of communities in several nations. The presence of obesity and overweight in children has substantial long-term health implications, including the development of adult obesity, elevated levels of cholesterol, increased likelihood of hypertension, and a greater risk of coronary artery disease in the future. Hypertension is a significant determinant for cardiovascular and cerebrovascular disorders.[9-11] The majority of hypertension research conducted on various populations have shown an increase in blood pressure with advancing age.[12] Kotchen et al's investigation revealed a gradual and persistent development of hypertension in adults, suggesting that it may originate throughout infancy and adolescence yet remain unnoticed.[13] In a recent study, Agarwal et al. proposed that there is a stronger correlation between body mass index and blood pressure levels in children and adolescents compared to age.[14] The specific threshold for categorising blood pressure as significantly abnormal in relation to age or BMI is unclear. The incidence of hypertension in children has been shown to vary from 1.0% to 16.2% in various studies.[15-17] The increased occurrence of hypertension seen in the aforementioned studies may be attributed to the inclusion of temporary hypertension. Childhood hypertension was defined as having blood pressure measurements that exceeded the 95th percentile on three separate occasions. Multiple writers concur that it is essential to repeatedly measure blood pressure in order to establish and record sustained increases.[18,19] The presence of a clear cause may usually be attributed to cases of long-lasting and severe hypertension. However, research conducted on a large scale within a community indicate that primary hypertension is the most common kind seen in seemingly healthy youngsters. In their research, Aggarwal et al. said that many criteria have been used to diagnose hypertension in teenagers, and subsequent re-screening has led to a decrease in the prevalence rate in some studies.[14] To examine the fluctuations in blood pressure across different age groups, it is important to investigate the standard range of blood pressure among youngsters. Extensive efforts have been made in various regions of India to determine the standard range of blood pressure fluctuations for different age categories. However, there is a scarcity of research about blood pressure among children in Tamilnadu. In the present research, the incidence of hypertension in boys is 13.33% and in girls it is 11.82%. The current research found that females generally had somewhat lower systolic blood pressure and diastolic blood pressure compared to boys. However, it is important to note that this difference was not statistically significant in the majority of age groups. This is in line with the discoveries made by Laroia et al., Voors et al., Anand and Tandon et al., Chadha et al.[20-23] The prevalence of hypertension in overweight children is 20%, while in obese children it is 40%. In contrast, children with a normal body mass index have a prevalence of just 7.78%. The average body mass index of those with hypertension was substantially greater than that of individuals without hypertension. Overweight and obese children had higher average systolic and diastolic blood pressure compared to children with

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normal blood pressure. In a research conducted by Sharma et al in Shimla, it was shown that those with high BMI (overweight and obese) had considerably higher rates of increased blood pressure (pre hypertension and hypertension) compared to those with normal BMI.[24] The difference in rates was found to be statistically significant (P<0.001). The research conducted by Dyson et al examined anthropometric data obtained from 12,730 school pupils between the ages of 12 and 18 in China, India, and Mexico. This study was part of the Community Interventions for Health project, which is an international study that assesses community interventions aimed at reducing non-communicable diseases..[25] They reached a similar result that there was a substantial correlation between being overweight or obese and the prevalence of hypertension. Overweight children were 1.7-2.3 times more likely to have hypertension, while obese children were 3.5-5.5 times more likely to have hypertension compared to children of normal weight. The likelihood of hypertension in both males and females in all three nations progressively rose with each body mass index (BMI) category. A study conducted by Krishna et al in Bangalore and Haveri in 2001-02 shown that malnourished children had considerably lower levels of systolic and diastolic blood pressure (P<0.05). The study also established a correlation between blood pressure and BMI in both normal and obese children.[26] As stated in the research, weight growth is consistently linked to an elevation in blood pressure. Hence, prioritising the avoidance of weight gain should be the main focus of therapy in order to mitigate the issue of hypertension.

CONCLUSION

We concluded that the high blood pressure (BP) and body mass index (BMI) demonstrated a strong positive correlation, which was statistically significant. Given the substantial correlation between high blood pressure and overweight/obesity seen in this research, we propose that regular blood pressure screenings be conducted in children and adolescents.

REFERENCES

1. Rangasamy DK, Senthamarai DMV, Shankar DR. Blood pressure and its correlation with age and BMI among the school children aged between 10 and 16 years. Int J Pediatr Res. 2019;6(1):1-7. doi: 10.17511/ijpr. 2019.i01.01.
2. James BC, Venkateswaran A, A A, Premkumar B, B S. The prevalence of elevated blood pressure and its association with obesity in children aged 6-13 years in rural India: A cross-sectional study. Cureus. 2023 Apr 21;15(4): e37916. doi: 10.7759/cureus.37916, PMID 37223154, PMCID PMC10202675.
3. Prastowo NA, Haryono IR. Elevated blood pressure and its relationship with bodyweight and anthropometric measurements among 8-11-year-old Indonesian school children. J Public Health Res. 2020;9(1):1723. doi: 10.4081/jphr.2020.1723, PMID 32550219.
4. Kaur S, Chandel S, Chandel S. The relationship between body mass index and blood pressure: A study among school going children of Rajasthan, India. Indian J Physiol Pharmacol. 2020;64(3):236-41.
5. Kapil U, Singh P, Pathak P, Dwivedi SN, Bhasin S. Prevalence of obesity amongst affluent adolescent school children in delhi. Indian Pediatr. 2002;39(5):449-52. PMID 12037275.
6. Muhihi AJ, Njelekela MA, Mpembeni RNM, Muhihi BG, Anaeli A, Chillo O et al. Elevated blood pressure among primary school children in Dar es Salaam, Tanzania: prevalence and risk factors. BMC Pediatr. 2018;18(1):54. doi: 10.1186/s12887-018-1052-8, PMID 29433455.
7. Ghosh JR, Bandyopadhyay AR. Comparative evaluation of obesity measures: relationship with blood pressures and hypertension. Singapore Med J. 2007;48(3):232-5. PMID 17342293.
8. Bagga A, Jain R, Vijayakumar M, Kanitkar M, Ali U. Evaluation and management of hypertension. Indian Pediatr. 2007 Feb;44(2):103-21. PMID 17351301.
9. Xu R, Zhang X, Zhou Y, Wan Y, Gao X. Parental overweight and hypertension are associated with their children's blood pressure. Nutr Metab (Lond). 2019; 16:35. doi: 10.1186/s12986-019-0357-4, PMID 31149019.
10. Tebar WR, Ritti-Dias RM, Farah BQ, Zanuto EF, Vanderlei LCM, Christofaro DGD. High blood pressure and its relationship to adiposity in a school-aged population: body mass index vs waist circumference. Hypertens Res. 2018;41(2):135-40. doi: 10.1038/hr.2017.93, PMID 29070828.
11. Petrovitch H, Curb JD, Bloom-Marcus E. Isolated systolic hypertension and risk of stroke in Japanese-American men. Stroke. 1995 Jan;26(1):25-9. doi: 10.1161/01.str.26.1.25, PMID 7839392.
12. 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 Aug;114(2); Suppl 4th Report (2 Suppl 4th Report):555-76. doi: 10.1542/peds.114.2. S2.555, PMID 15286277.
13. Kotchen JM, McKean HE, Kotchen TA. Blood pressure trends with aging. Hypertension. 1982 Sep-Oct;4(5 Pt 2): III128-34. doi: 10.1161/01.hyp.4.5_pt_2. iii128, PMID 7049927.
14. Agarwal VK, Sharan R, Srivastava AK, Kumar P, Pandey CM. Blood pressure profile in children of age 3-15 years. Indian Pediatr. 1983 Dec;20(12):921-5. PMID 6676304.
15. HAHN L. The relation of blood pressure to weight, height and body surface area in schoolboys aged 11 to 15 years. Arch Dis Child. 1952 Feb;27(131):43-53. doi: 10.1136/adc.27.131.43, PMID 14904114.
16. Szklo M. EPIDEMIOLOGIC PATTERNS OF BLOOD PRESSURE IN CHILDREN. Epidemiologic Reviews. 1979;1(1):143-69. doi: 10.1093/oxfordjournals.epirev.a036207.
17. Sachdev Y. Normal blood pressure and hypertension in Indian children. Indian Pediatr. 1984 Jan;21(1):41-8. PMID 6698586.
18. Rames LK, Clarke WR, Connor WE, Reiter MA, Lauer RM. Normal Blood Pressures and the Evaluation of Sustained Blood Pressure Elevation in Childhood: The Muscatine Study. Pediatrics. 1978;61(2):245-51. doi: 10.1542/peds.61.2.245.
19. Kilcoyne MM. Natural history of hypertension in adolescence. Pediatr Clin North Am1978Feb. 1978;25(1):47-53. doi: 10.1016/s0031-3955(16)33531-3, PMID 628568.
20. Laroia D, Sharma M, Diwedi V, Belapurkar KM, Mathur PS. Profile of blood pressure in normal school children. Indian Pediatr. 1989 Jun;26(6):531-6. PMID 2583803.
21. Voors AW, Foster PHTA, Frienchs RR, Webber LS, Berenson GS. Studies of blood pressure in children 5-14 years in a Total biracial commonly. ThérapieBogalusaheartstudy.Circulation.1976;54:319-27.
22. Anand NK, Tandon L. Prevalence of hypertension in school going children. Indian Pediatr;3(5):377-81:1996May.
23. Chadha SL, Tandon R, Shekhawat S, Gopinath N. An epidemiological study of blood pressure in school children (5-14 years) in Delhi. Indian Heart J1999Mar-Apr. 1999;51(2):178-82. PMID 10407546.
24. Sharma A, Grover N, Kaushik S, Bhardwaj R, Sankhyan N. Prevalence of hypertension among schoolchildren in Shimla. Indian Pediatr. 2010 Oct;47(10):873-6. doi: 10.1007/s13312-010-0148-5, PMID 20308762.
25. Dyson AP, Anthony D, Fento B. High rates ofchild hypertension associated with obesity: a community survey in China, India and Mexico. Paediatr Int Child Health. 2013;5513Y.0000000079. doi: 10.1179/204690.
26. Krishna P, PrasannaKumar KM, Desai N, Thennarasu K. Blood pressure reference tables for children and adolescents of Karnataka. Indian Pediatr. 2006;43(6):491-501. PMID 16820658.

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