ORIGINAL RESEARCH PAPER
Volume - 11 | Issue - 01 | January - 2022 | PRINT ISSN No. 2277 - 8179 | DOI : 10.36106/ijsr
INTERNATIONAL JOURNAL OF SCIENTIFIC RESEARCH

RELATIONSHIP OF NECK CIRCUMFERENCE WITH HYPERTENSION AND OBESITY AMONG EARLY ADOLESCENT, SCHOOL GOING CHILDREN (10 - 15 YEARS)

Paediatrics

Prabodh Chandra Mondal Associate Professor, Dept. of Pediatrics, Midnapore Medical College, Midnapore, West Bengal.

Dhruba Kumar Mahata* RMO cum Clinical Tutor, Dept. of Pediatrics (Neonatology), Midnapore Medical College, Midnapore, West Bengal. *Corresponding Author

ABSTRACT

The prevalence of child obesity is rapidly increasing worldwide. These conditions pose a major public health problem because they are associated with various chronic disease. Obesity having several risk factors for later cardiovascular and metabolic problems. Chronic and insidious nature of these disorders close monitoring in childhood is required to prevent long-term effects. The present study was undertaken to evaluate the relationship between the risk of HTN and high NC alone and also in the combinations with other anthropometric indices among the adolescents. This community based cross sectional study was carried out during November 2019 to January, 2020 among the adolescents aged 10-15 years living in Midnapore, a district town of eastern India and its adjacent areas. This study indicated that 6.53% of the adolescents were suffering from hypertension and the prevalence of obesity as determined by BAZ>1SD were 7.42% while 20.18% of the participants were suffering from central obesity as diagnosed by high WC. High NC was observed among 8.31% participants. The present study clearly indicated that high NC is the most important predictor of hypertension among the adolescents.

KEYWORDS

Neck Circumference (NC), Hypertension (HTN), Body mass index (BMI), Waist circumference (WC), Waist-to-height ratio (WHtR), Body roundness index (BRI)

INTRODUCTION:

The epidemiological studies have showed that the occurrence of hypertension (HTN) has considerably increased among the children and the adolescents globally in current period.[1] It is responsible for significant rise in risk of ischaemic stroke, ischaemic heart disease, intracerebral haemorrhage, peripheral artery disease, chronic kidney disease and end-stage renal disease. [2] It is recognized as the leading cause of death globally.[3]

Many factors including environmental and genetic factors has been playing important role for elevation of blood pressure.[4] Studies showed the increasing trend of HTN in adolescents was attributed to obesity epidemic.[5]

Recent studies have revealed that general obesity measured by anthropometric indices like body mass index (BMI), and central/abdominal obesity measured by anthropometric indices including waist circumference (WC), waist-to-height ratio (WHtR), and body roundness index (BRI) are related with the risk of different cardio-metabolic disorders including hypertension, dyslipidaemia, elevation of fasting plasma glucose concentrations, type 2 diabetes mellitus etc.[6] While, neck circumference (NC) is considered as an important predictor of upper body fat distribution.[7] Furthermore, NC measurement has been revealed to be a simple, convenient time-saving, and non-intimidating screening method to determine the overweight or obesity.[6,7] Many studies have focused that high NC is connected with the risk of cardiovascular disorders in adults.[8] Yet, a few studies have examined the relationship between high NC and HTN in the adolescents.[6]

Thus, the present study was undertaken to evaluate the relationship between the risk of HTN and high NC alone and also in the combinations with other anthropometric indices among the adolescents.

OBJECTIVES

1. To determine whether NC alone is an index to determine overweight and obesity in early adolescents.
2. To assess the relationship between NC & WC to evaluate overweight and obese in early adolescent children.
3. To assess the relationship between NC & WC to evaluate hypertension in early adolescent children.

METHODS

This community based cross sectional study was carried out during November 2019 to January, 2020 among the adolescents aged 10-15 years living in Midnapore, a district town of eastern India and its adjacent areas. This study was conducted among the apparently healthy adolescents and those with any major health complications were excluded from this study. All the adolescent girls and boys were identified by name, age and sex. Date of birth was noted from the hospital record.

Ethical Issues:

The study was approved by the Institutional Board of Ethics. The necessary permission for carrying out this study was also obtained from the administrative authority. Written consent was taken from the legal guardians/caregivers of the children/adolescents before conducting the study.

Sample Size:

The minimum estimated sample size was calculated using the standard formula: $n=(z^2pq)/d^2$.[9] The calculation $((1.96^2 \times 0.241 \times 0.759) / (0.05^2))$ was based on 24.1% prevalence (p) of underweight (BMI-for-age Z-score <-2SD) for the adolescents (at the age of 10-19) according to the recent report of the fourth National Family Health Study (NFHS-4) conducted during 2015–2016 in India.[10] Where, z=1.96, q=p-1 and desired precision (d) was ±5%. Thus, the estimated sample size with a dropout rate of 10% was 309.

Anthropometric And Body Composition Assessment:

All the anthropometric data of the adolescents including weight, height, neck circumference (NC), waist circumference (WC), hip circumference was measured using standard techniques.[11] Weight was measured by a digital scale and recorded to the nearest 0.01kg. During weight measurement asepsis was maintained. All observations were made by visiting the families at home. If the respondent was not contactable during the first visit, three consecutive visits were made in order to avoid dropouts. Body mass index (BMI) was computed using the following standard equations[12] BMI= Weight (kg)/Height $(m)^2$, BAZ (BMI for age Z-score) was determined by age and sex specific z scores of BMI and the children had WAZ over +1SD was considered as overweight[13] Neck circumference (NC) was measured by using a flexible tape, with children in standing position; head held erect, at the level of the thyroid cartilage.[14] WC (cm) and hip circumference (cm) was measured using plastic tape as per WHO guideline.[15] Waist-to-Height Ratio (WHtR), body fat percentage (PBF), Conicity index (Cindex), body roundness index (BRI) was calculated by the following formulas. WHtR= Waist circumference (cm)/height (cm)[16] PBF= $(1.20 \times BMI) + (0.23 \times Age) - (10.8 \times sex) - 5.4$. where sex is 1 for males and 0 for females.[17] Cindex = Waist Circumference (m) / [0.109 X $\sqrt{\{Body\ weight\ (kg) / Height\ (m)\}}$[18] $BRI = 364.2 - 365.5 \times \sqrt{[(WC/2\pi)^2 / (0.5 \times Height)^2]}$[19] NC≥30.75 cm for boys and NC≥29.75 cm for girls were considered as adolescent obesity. While the WC of the boys and girls more than 70.75 cm and 69.25 cm were as suffering from adolescent obesity.[20] The cut-off value of 0.5 was considered for WHtR.[21]

***Hypertension*:**
The systolic blood pressure (SBP) and diastolic blood pressure (DBP) were measured using the standard protocol.

Statistical Tests:
The data were analysed using SPSS for Windows statistical software package, data were presented as number (percentage) or mean±SD as appropriate. Student's t-test was done to study the difference in anthropometric parameters and blood pressure among the boys and girls. Pearson Productmoment correlation was done to find out the association between anthropometric parameters and blood pressure. Odd ratio and relative risk were calculated to study the hypertension in overweight adolescents.

RESULTS AND DISCUSSION

Altogether 337 adolescents (boys=175) were included in the present study. The mean age of the studied adolescents was 12.57±1.57 years. This study showed that there was no significant difference in the weight, height, BMI and BAZ among the boys and girls. But sexual dimorphism was noted in the mean values of NC (t=2.826; P<0.01), WC (t=5.309; P<0.001), WHtR (t=7.641; P<0.001), PBF (t=8.228; P<0.001), Cindex (t=7.258; P<0.001), BRI (t=7.448; P<0.001) (Table 1). The mean values of SBP and DBP was not significantly different among girls and boys. While, studying sexual dimorphism in each of 10–15-year age group, it was noted that boys had significantly higher NC than the girls in the age group of 15 years (t=3.502; P<0.001), though in other age groups no significant difference was observed (Fig 1).

The correlation study showed that BMI, NC, WC and PBF were significantly associated with the SBP and DBP of the adolescents.

Table 1: Impact Of Sexual Dimorphism On Anthropometric Variables And Blood Pressure

Variables	Total (n=337)	Boys (n=175)	Girls (n=162)	P#
Age	12.57±1.57	12.55±1.48	12.59±1.66	>0.05
Weight	34.38±9.89	34.53±9.93	34.23±9.88	>0.05
Height	145.01±12.15	146.25±11.63	143.68±12.59	>0.05
BMI	16.05±2.88	15.83±2.69	16.30±3.05	>0.05
BAZ	(-)1.41±1.42	(-)1.53±1.47	(-)1.28±1.35	>0.05
NC	26.97±2.22	27.30±2.31	26.62±2.07	<0.01
WC	62.77±8.42	60.52±7.59	65.21±8.62	<0.001
WHtR	0.43±0.05	0.41±0.05	0.45±0.05	<0.001
PBF	20.68±5.37	18.56±5.11	22.96±4.68	<0.001
Cindex	1.20±0.12	1.16±0.09	1.24±0.12	<0.001
BRI	2.25±0.88	1.93±0.75	2.59±0.89	<0.001
SBP	113.75±11.80	113.18±10.93	114.37±12.67	>0.05
DBP	74.36±9.62	74.53±9.44	74.18±9.83	>0.05
#Boys versus girls				

A study among the Greek boys and girls of 9-13 years old,[22] indicated that BMI, NC, WC, HC, WHR and WHtR were associated with SBP and DBP.[23] found that HTN was related with weight, BMI and WC among the young adults in India. In a similar study in Lithuania,[6] showed that children and adolescents were suffering from high BP had significantly higher mean values of weight, children and adolescents were suffering from high BP had significantly higher mean values of weight, BMI, BAI, WC, HC, NC, MUAC, WHtR, and WHR compared to normotensive participants.

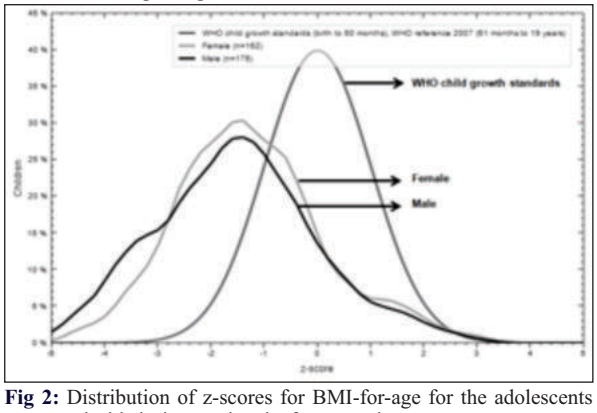

Fig 2: Distribution of z-scores for BMI-for-age for the adolescents compared with the international reference values

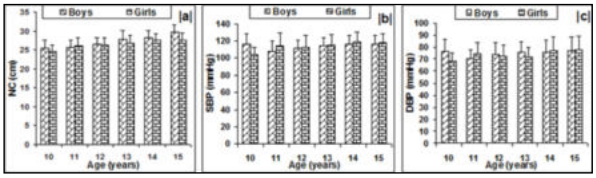

Fig 1: Age Wise Comparison Of NC, SBP And DBP Between Boys And Girls.

The study documented that 6.53% of the adolescents were suffering from hypertension and the prevalence of high BAZ, high NC, high WC and high WHtR were 7.42%, 8.31%, 20.18% and 14.24% respectively (Table 3). BAZ of the boys (-1.53±1.47) were lower than the girls (-1.28±1.35) that was presented in Table 1 and it is reflected in Fig 2. This study also showed that 8.64% of the girls were suffering from obesity as per WAZ>+1SD, while in case of boys it was 6.29%. The boys (34.86%) were more prone underweight than the girls (30.86%).

The odd ratio showed the risk of hypertension among the adolescents who had high BAZ, high NC, high WC and high WHtR were 4.34, 6.53, 3.69 and 3.93 times respectively (Table 2).

Table 2: Impact Of Overweight/Obesity On Hypertension

	N	Hypertension#	χ^2 test	OR (95%CI)	RR (95%CI)
BAZ					
Overweight /Obesity	25	5 (20.00)	8.031**	4.34 (1.45-12.97)	3.67 (1.48-9.12)
Non-obese	312	17 (5.45)			
NC					
Obese	28	7 (25.00)	17.076***	6.53 (2.40-17.77)	5.15 (2.29-11.57)
Non-obese	309	15 (4.85)			
WC					
Obese	68	10 (14.71)	9.336**	3.69 (1.52-8.96)	3.30 (1.49-7.31)
Non-obese	269	12 (4.46)			
WHtR					
Obese	48	8 (16.67)	9.429**	3.93 (1.55-9.96)	3.44 (1.53-7.76)
Non-obese	289	14 (4.84)			
#Data presented as n (%) Significance level at **P<0.01; ***P<0.001					

Similar observation was documented[21] in the study among the Greek children (9-13 years) with NC was recorded to be related with most CVD risk factors. Also showed that NC associated significantly with high BP among the Lithuanian children and adolescents.[24] also found that NC was positively related with the metabolic syndrome, insulin resistance, and abdominal visceral fat. It is well known that visceral adipose tissue was more strongly associated with metabolic risk factors than subcutaneous abdominal adipose tissue,[25] documented that the elevated levels of free fatty acids cause obesity-related insulin resistance and cardiovascular disease. These may the probable explanation of being the NC as better predictor of risk estimation for cardio-metabolic disorders.

CONCLUSION

This study indicated that 6.53% of the adolescents were suffering from hypertension and the prevalence of obesity as determined by BAZ>1SD were 7.42% while 20.18% of the participants were suffering from central obesity as diagnosed by high WC. High NC was observed among 8.31% participants. The present study clearly indicated that high NC is the most important predictor of hypertension among the adolescents.

Acknowledgements
We sincerely thank Prof. Panchanan Kundu, Principal, Midnapore Medical College, Midnapore, W.B., for constant encouragement throughout the study. We also thankful to Shubhankar Dutta, Head Master, Manikpara High School (H.S.) and team for their continue support and managing school student during data collection.

REFERENCES:

1. Kollias A, Antonodimitrakis P, Grammatikos E, Chatziantonakis N, Grammatikos EE, Stergiou GS. Trends in high blood pressure prevalence in Greek adolescents. J Hum Hypertens. 2009;23(6):385–90.
2. Flint AC, Conell C, Ren X, Banki NM, Chan SL, Rao VA, Melles RB, Bhatt DL. Effect of Systolic and Diastolic Blood Pressure on Cardiovascular Outcomes. N. Engl. J. Med. 2019; 381: 243–251.

3. World Health Organization. Global status report on noncommunicable diseases 2010. 2011. http://www.who.int/nmh/publications/ncd_report_full_en.pdf.
4. Appel LJ, Brands MW, Daniels SR, Karanja N, Elmer PJ, Sacks FM, et al. Dietary approaches to prevent and treat hypertension: a scientific statement from the American Heart Association. Hypertension. 2006;47(2):296–308.
5. Kelly RK, Magnussen CG, Sabin MA, et al. Development of hypertension in overweight adolescents: a review. Adolesc Health Med Ther 2015; 6:171–87.
6. Kuciene R, Dulskiene V, Medzioniene J. Association of neck circumference and high blood pressure in children and adolescents: a case-control study. BMC Pediatr. 2015; 15:127.
7. Ben-Noun L, Sohar E, Laor A. Neck circumference as a simple screening measure for identifying overweight and obese patients. Obes Res. 2001;9(8):470–7.
8. Ben-Noun L, Laor A. Relationship of neck circumference to cardiovascular risk factors. Obes Res. 2003;11(2):226–31.
9. Cochran WC. Sampling techniques. New York: Wiley, 1963.
10. Ministry of Health and Family Welfare (MoHFW), Government of India, UNICEF and Population Council. Comprehensive National Nutrition Survey (CNNS) National Report. New Delhi. 2019. https://nhm.gov.in/WriteReadData/l892s/1405796031571201348.pdf. Date of Retrieve 14.07.2020.
11. Lee RD, Nieman DC. Nutritional assessment. 3rd ed. New York: McGraw Hill. 2003.
12. World Health Organization. Physical Status: The Use and Interpretation of Anthropometry. Report of a WHO Expert Committee. Technical Report Series, No. 854. Geneva: World Health Organization. 1995.
13. World Health Organization. 2007. Growth reference 5–19 years: BMI-for-age (5–19 years). https://www.who.int/toolkits/growth-reference-data-for-5to19-years/indicators/bmi-for-age.
14. Nafiu OO, Burke C, Lee J, Voepel-Lewis T, Malviya S, Tremper KK. Neck circumference as a screening measure for identifying children with high Body Mass Index. Pediatrics. 2010;126: e306-10.
15. World Health Organization. Waist Circumference and Waist–Hip Ratio: Report of a WHO Expert Consultation. Geneva: World Health Organization. 2008.
16. Peng Y, Li W, Wang Y, Bo J, Chen H: The Cut-Off Point and Boundary Values of Waist-to- Height Ratio as an Indicator for Cardiovascular Risk Factors in Chinese Adults from the PURE Study. PLoS ONE.2015; 10(12): e0144539.
17. Deurenberg P, Weststrate JA, Seidell JC: Body mass index as a measure of body fatness: age- and sex-specific prediction formulas. Br J Nutr. 65.2(1991): 105-114.
18. Flora MS, Mascie-Taylor CGN, Rahman M: Conicity index of adult Bangladeshi population and their socio-demographic characteristics. Ibrahim Med Coll J, 3.1(2009): 1-8.
19. Thomas DM, Bredlau C, Bosy-Westphal A, Mueller M, Shen W, Gallagher D, Maeda Y, McDougall A, Peterson CM, Ravussin E, Heymsfield SB. Relationships between body roundness with body fat and visceral adipose tissue emerging from a new geometrical model. Obesity (Silver Spring, Md). 2013;21(11): 2264–2271.
20. Patnaik L, Pattnaik S, Rao EV, Sahu T. Validating Neck Circumference and Waist Circumference as Anthropometric Measures of Overweight/Obesity in Adolescents. Indian Pediatr. 2017 May 15;54(5):377-380.
21. Browning LM, Hsieh SD, Ashwell M. A systematic review of waist-to-height ratio as a screening tool for the prediction of cardiovascular disease and diabetes: 0.5 could be a suitable global boundary value. Nutr Res Rev 2010; 23:247–269.
22. Androutsos O, Grammatikaki E, Moschonis G, Roma-Giannikou E, Chrousos GP, Manios Y, Kanaka-Gantenbein C. Neck circumference: a useful screening tool of cardiovascular risk in children. Pediatr Obes. 2012 Jun;7(3):187-95.
23. Srivastava A, Kandpal S, Negi K, Srivastava A. Prevalence and risk factor of hypertension among medical college students, HIMS, Dehradon. Indian J Prev Soc Med. 2012; 1:43.
24. Stabe C, Vasques AC, Lima MM, Tambascia MA, Pareja JC, Yamanaka A, et al. Neck circumference as a simple tool for identifying the metabolic syndrome and insulin resistance: results from the Brazilian Metabolic Syndrome Study. Clin Endocrinol (Oxf) 2013;78(6):874–81.
25. Fox CS, Massaro JM, Hoffmann U, Pou KM, Maurovich-Horvat P, Liu CY, et al. Abdominal visceral and subcutaneous adipose tissue compartments: association with metabolic risk factors in the Framingham Heart Study. Circulation. 2007;116(1):39–48.