WAIST CIRCUMFERENCE AND WAIST-HEIGHT RATIO OF SCHOOL-GOING CHILDREN AGED 5 - 15 YRS. OF MANIPUR, A NORTH-EASTERN STATE OF INDIA AND ITS ASSOCIATION WITH HYPERTENSION

Rajendra Singh Thangjam¹, Abujam Indrajit Singh², Rothangpui³, Laishram Cindy⁴, Thounaojam Rameshchandra⁵

¹Associate Professor, Department of Medicine, JNIMS, Imphal.

²Assistant Professor, Department of Medicine, JNIMS, Imphal.

³Associate Professor, Department of Medicine, JNIMS, Imphal.

⁴Medical Officer, Nambol CHC, Manipur Health Services, Manipur.

⁵Senior Resident, Department of Medicine, JNIMS, Imphal.

ABSTRACT

BACKGROUND

Childhood obesity is a precursor of metabolic syndrome in adulthood, characterized by hypertension and abnormal glucose metabolism. Waist circumference and waist-to-height ratio are an indicator of fat distribution in children and hence a useful predictor of cardiovascular risk.

Objectives- To develop the waist circumference (WC) and waist height ratio (WHtR) percentile reference values of school going children aged 5-15yrs of Manipur, a north-eastern state of India and to look its association with hypertension.

MATERIALS AND METHODS

A prospective, cross-sectional study was performed in school going children aged 5-15yrs in different districts of Manipur. Height, weight, WC and blood pressure (BP) were measured in 2334 children (1241 boys). Elevated BP was defined as either systolic BP or diastolic BP >95th percentile. Sex-specific reference percentiles were computed which construct reference percentiles. WC of 70th, 75th and 90th percentile, WHtR of 0.5 cut off were tested for its association with hypertension.

RESULTS

Age- and sex-specific WC and WHtR percentiles (5th, 10th, 25th, 50th, 70th, 75th, 90th, and 95th) are presented. WC values increased with age in both the boys and the girls. Statistically significant association of higher WC values with hypertension was shown in the overall age group and 10-15yrs group, but not in younger age group of 5-10yrs.

CONCLUSION

Simple easily measurable parameters like WC and WHtR can help in a long way in identifying children with and at risk of developing metabolic syndrome. Further regional studies should be conducted to better define the reference standard of WC and WHtR of children.

KEYWORDS

Waist Circumference, Waist Height Ratio, Hypertension.

HOW TO CITE THIS ARTICLE: Thangjam RS, Singh AI, Rothangpui, et al. Waist circumference and waist-height ratio of school-going children aged 5 - 15 yrs. of Manipur, a North-Eastern State of India and its association with hypertension. J. Evolution Med. Dent. Sci. 2018;7(09):1121-1125, DOI: 10.14260/jemds/2018/255

BACKGROUND

Globalization in the last few decades, influencing the lifestyle, nutrition transition and eating pattern has resulted in increased proportion of overweight and obese children in our society, and childhood obesity has been shown to be a precursor of myriad of health problems in adulthood including hypertension and abnormal glucose metabolism, characteristics of metabolic syndrome.¹ Visceral adipose tissue or central obesity measured as waist circumference (WC) has been shown to be a better predictor of cardiovascular disease in children than the body mass index (BMI)² and is included in the various definitions of metabolic

syndrome in children including IDF³ and modified Cook definition.⁴ BMI, because of its low sensitivity may misclassify children with high body fat as normal weight.⁵ Moreover, waist circumference is regarded as an obligate for the definition of metabolic syndrome in adults. Apart from BMI, waist circumference and waist hip ratio, waist-to-height ratio (WHtR) has been suggested for a more accurate estimation of fat distribution and body shape of children and also shown to be a useful predictor of cardiovascular risk, superior to BMI or waist to hip ratio.^{6,7} However in children, no uniform definition of WC cut off to define metabolic syndrome exists due to variation in physiological growth and development of different ethnicities, and therefore the development of ethnic specific WC percentiles to define central obesity has been strongly advocated.³ For this reason, although small but a significant step towards this goal, we try to develop the WC and WHtR percentiles of school going children of Manipur and look for its association with hypertension.

MATERIALS AND METHODS

This study was a prospective cross sectional study conducted in selected schools in different districts of Manipur between 2012 and 2015. Sample size was taken as per our

'Financial or Other Competing Interest': None.

Submission 31-10-2017, Peer Review 08-02-2018,

Acceptance 14-02-2018, Published 26-02-2018.

Corresponding Author:

Dr. Abujam Indrajit Singh,

Assistant Professor,

Department of Medicine,

Jawaharlal Nehru Institute of Medical Sciences,

Imphal-795005, Manipur.

E-mail: abujamindrajit@gmail.com

DOI: 10.14260/jemds/2018/255

convenience. Sampling method used is purposive sampling. The study was conducted as a part of the study of the burden of Rheumatic Heart Disease (both clinical and subclinical) in both the rural and urban population of the state. The ethics committee of Jawaharlal Nehru Institute of Medical Sciences, Imphal, approved the study.

Children between the age of 5 and 15 years were enrolled after obtaining written informed consent from their parents and the school authority, done through proper channel. Taking the prevalence rate of childhood hypertension around 7.6% in India, target sample size was kept at the minimum of 2000.⁸ Children with any systemic illness and on antihypertensive medication were excluded. 2D Echo with Doppler study was done at the site with portable 2D Echo machine (Sonosite M Turbo, USA) and those with detectable significant abnormality of the heart, either congenital or acquired, were further excluded from the study.

The age was recorded from the school chart. Procedures being undertaken were properly explained to them beforehand. Height and weight were measured using stadiometer with beam balance with sensitivity of 0.1 cm and 0.1 kg respectively. BMI was calculated using the Quetelet index i.e. weight in kg/height in m² and values were compared with WHO Growth charts.⁹ Children with a body mass index (BMI) <5th percentile of reference data were considered underweight, >85th percentile were considered overweight and those with a BMI >95th percentile were considered obese.¹⁰ Waist circumference was measured with a non-stretchable tape at the midpoint of the lowest rib cage and the iliac crest, to the nearest 0.1 cm, in a standing position during end-tidal expiration. Taking the reference of Anuradha Khadilkar et al study, 70th percentile waist circumference cut-off values were used to compare with the blood pressure.¹¹ Blood pressure was measured using cuff of appropriate size with aneroid sphygmomanometer in the right arm sitting position after resting them for at least 5 minutes. An average of three readings was noted. In case of higher than expected value of BP, the measurement was

repeated on the left arm as well. The BP values were compared with the value given by the update of 1987 task force report of NHBEP (National High BP Education Programme) co-ordination committee and children were classified as normal, prehypertension and hypertension.¹² Prehypertension was defined as SBP and/or DBP between the 90th and 95th percentile for height for age and sex or $\geq 120/80$ mmHg and hypertension as $\geq$ the 95th percentile for height for age and sex.

Statistical Analysis

Data analysis was done using IBM SPSS Statistics version 22. Descriptive statistics like percentages, mean, median, standard deviation were generated. Analytical statistics like chi-square test was performed to see for association. A p-value of <0.05 was taken as significant.

RESULTS

The final sample selected from different schools of different districts of Manipur consisted of 2334 children, boys comprising of 1241 and girls 1093, the characteristics of the children participating in the study being displayed in table 1. The mean ($\pm$ SD) WC, WHtR and BMI of the overall study population were 60.1 $\pm$ 7.9cm, 0.43 $\pm$ 0.04 and 18.2 $\pm$ 4.1kg/m² respectively. Gender wise, the mean WC (cm) of boys in the age group 5-10 yrs. (52.4 $\pm$ 4.7 cm) and 10-15 yrs. (62.5 $\pm$ 6.9 cm) were almost comparable with girls of corresponding age group 5-10 yrs. (52.0 $\pm$ 4.9 cm) and 10-15 yrs. age group (62.0 $\pm$ 7.7 cm). The 70th and 75th percentile of WC distribution, as chosen significant in Indian children in earlier studies,^{11,13} of both the boys and girls in overall felt in 64 and 63cm; 67 and 66cm respectively. 14.0% and 14.5% of children with the WC above 70th and 75th percentile respectively were found to be hypertensive, which were statistically significant. The age wise and sex wise distribution of mean WC, BMI, SBP, DBP and WHtR were depicted in Table 1; the WC and WHtR percentile were given in Table no. 2.

	n	Height (cm)	Weight (kg)	BMI (kg/m ²)	BMI(P) (kg/m ²)	WC (cm)	WHtR	SBPmm Hg (P)	DBPmm Hg (P)
Boys (Age)									
5	33	105.6 $\pm$ 5.8	18.2 $\pm$ 2	16.2 $\pm$ 1.5	64.8 $\pm$ 32.5	49.6 $\pm$ 3.4	0.47 $\pm$ 0.03	52.1 $\pm$ 26.4	68.7 $\pm$ 18.8
6	36	110.2 $\pm$ 4.7	18.9 $\pm$ 2.3	15.6 $\pm$ 1.4	53.8 $\pm$ 28.1	50.7 $\pm$ 3.6	0.46 $\pm$ 0.03	51.7 $\pm$ 26.6	66.3 $\pm$ 25.0
7	59	115.5 $\pm$ 6.1	21.5 $\pm$ 3.5	16.1 $\pm$ 1.8	56.8 $\pm$ 29.5	51.9 $\pm$ 3.7	0.45 $\pm$ 0.03	60.9 $\pm$ 29	63.9 $\pm$ 25.7
8	51	121.0 $\pm$ 6.8	23.7 $\pm$ 4.4	16.1 $\pm$ 1.6	51.3 $\pm$ 27.3	53.0 $\pm$ 4.4	0.44 $\pm$ 0.03	51.8 $\pm$ 26.9	63.6 $\pm$ 20.7
9	62	125.5 $\pm$ 6.2	25.9 $\pm$ 4.1	16.4 $\pm$ 1.5	49.3 $\pm$ 22.6	54.8 $\pm$ 5.6	0.44 $\pm$ 0.04	56.7 $\pm$ 28.2	69.5 $\pm$ 23.5
10	119	128.6 $\pm$ 7.1	27.6 $\pm$ 6.1	16.7 $\pm$ 2.2	45.5 $\pm$ 27.3	57 $\pm$ 6	0.44 $\pm$ 0.03	56.6 $\pm$ 27	66.9 $\pm$ 24.8
11	117	133.3 $\pm$ 6.8	29.5 $\pm$ 4.2	16.6 $\pm$ 1.7	37 $\pm$ 23.7	57 $\pm$ 4.7	0.43 $\pm$ 0.03	55.0 $\pm$ 24.9	70.8 $\pm$ 22
12	171	140.2 $\pm$ 7.8	34.5 $\pm$ 6.4	17.5 $\pm$ 2.1	41.2 $\pm$ 26.3	60.1 $\pm$ 5.4	0.43 $\pm$ 0.03	50.5 $\pm$ 27.9	65.5 $\pm$ 24.8
13	218	147.9 $\pm$ 9.4	40.7 $\pm$ 7.8	18.5 $\pm$ 2.4	45.6 $\pm$ 27.6	62.7 $\pm$ 6.1	0.42 $\pm$ 0.04	42.1 $\pm$ 28.7	62.4 $\pm$ 24
14	180	154.7 $\pm$ 8.2	46.7 $\pm$ 7.3	19.3 $\pm$ 2.3	48.8 $\pm$ 26	65.5 $\pm$ 5.6	0.42 $\pm$ 0.03	42.1 $\pm$ 27.7	65.8 $\pm$ 22.8
15	195	160.8 $\pm$ 5.8	53.5 $\pm$ 6.7	21.4 $\pm$ 10.3	55.8 $\pm$ 24.9	68.3 $\pm$ 5.4	0.42 $\pm$ 0.03	44.7 $\pm$ 31.1	66.5 $\pm$ 23.2
Girls (Age)									
5	42	101.3 $\pm$ 4.9	16.1 $\pm$ 2.2	15.6 $\pm$ 1.4	57.3 $\pm$ 29.2	48.2 $\pm$ 3.6	0.48 $\pm$ 0.03	60.0 $\pm$ 29.3	66.8 $\pm$ 21.5
6	27	113.3 $\pm$ 8.5	20.7 $\pm$ 5.4	15.9 $\pm$ 2.3	56.1 $\pm$ 29.4	50.7 $\pm$ 5.9	0.45 $\pm$ 0.05	55.1 $\pm$ 28.3	59.2 $\pm$ 21.9
7	63	115.0 $\pm$ 5.6	20.8 $\pm$ 2.8	15.7 $\pm$ 1.2	51.6 $\pm$ 23.1	51.3 $\pm$ 3.9	0.45 $\pm$ 0.03	58.5 $\pm$ 28.2	72.2 $\pm$ 24.1
8	56	122.7 $\pm$ 6.5	23.9 $\pm$ 3.8	15.9 $\pm$ 1.6	45.6 $\pm$ 27	52.8 $\pm$ 4.3	0.43 $\pm$ 0.03	58.1 $\pm$ 25.9	70.6 $\pm$ 25.6
9	79	124.8 $\pm$ 6.2	25.6 $\pm$ 3.9	16.5 $\pm$ 1.7	48.0 $\pm$ 22	54.6 $\pm$ 4.7	0.44 $\pm$ 0.03	55.5 $\pm$ 31.2	68.9 $\pm$ 25.8
10	138	129.4 $\pm$ 7.7	28.3 $\pm$ 4.7	16.8 $\pm$ 1.8	46.8 $\pm$ 24.9	55.6 $\pm$ 5	0.43 $\pm$ 0.03	53.1 $\pm$ 28.2	66.5 $\pm$ 25.8
11	86	136.5 $\pm$ 5.8	32.3 $\pm$ 6.2	17.3 $\pm$ 2.5	43.2 $\pm$ 28.8	57.2 $\pm$ 6.6	0.42 $\pm$ 0.03	58.5 $\pm$ 29.6	65.9 $\pm$ 24.9
12	145	142.1 $\pm$ 7	35.8 $\pm$ 7.3	17.6 $\pm$ 2.5	40.4 $\pm$ 28.1	60.1 $\pm$ 6.4	0.42 $\pm$ 0.04	53.8 $\pm$ 27.8	65.6 $\pm$ 26.3
13	157	146.7 $\pm$ 6.3	41.9 $\pm$ 6.6	19.4 $\pm$ 2.6	53.2 $\pm$ 28.2	62.9 $\pm$ 6.6	0.43 $\pm$ 0.04	51 $\pm$ 30.8	66.0 $\pm$ 25.9

14	150	150±5.8	41.2±6.5	20.5±2.5	57.4±24.6	65.5±6.6	0.44±0.04	53.9±30.9	69.6±23.1
15	150	150.9±5	48.6±6.2	21.1±2.5	59.4±24.0	68.1±6.8	0.45±0.05	50.8±30.1	65.8±27
Total (Mean±SD)	2334	138.9±16.3	36.4±12.1	18.2±4.1	49.3±27	60.1±7.9	0.43±0.4	51.3±29.2	66.5±24.4

Table 1. Anthropometric characteristics of school going children aged 5 to 15 years by age and gender. (MEAN ± SD) P= percentile

	WC PERCENTILE								WHtR PERCENTILE							
	5 th	10 th	25 th	50 th	70 th	75 th	90 th	95 th	5 th	10 th	25 th	50 th	70 th	75 th	90 th	95 th
Boys																
5	43.5	46.0	48.0	50.0	51	52.0	54.0	56.0	0.41	0.43	0.43	0.47	0.49	0.49	0.51	0.52
6	44.0	46.0	48.0	51.0	53	53.0	55.3	57.1	0.39	0.41	0.43	0.45	0.48	0.48	0.50	0.52
7	47.0	48.0	49.0	51.0	54	54.0	57.0	59.0	0.39	0.40	0.42	0.45	0.47	0.47	0.49	0.50
8	48.0	48.0	50.0	52.0	55	56.0	57.0	60.0	0.39	0.40	0.41	0.43	0.45	0.46	0.47	0.48
9	48.1	50.0	52.0	54.0	56	57.2	61.7	62.0	0.37	0.40	0.41	0.44	0.45	0.46	0.47	0.48
10	50.0	51.0	52.0	57.0	58	59.0	62.0	70.0	0.39	0.39	0.41	0.44	0.45	0.46	0.48	0.51
11	49.9	51.0	54.0	56.0	59	60.0	63.0	66.0	0.37	0.38	0.40	0.42	0.44	0.45	0.47	0.49
12	53.0	54.0	56.0	59.0	62	63.0	67.0	69.4	0.37	0.38	0.40	0.42	0.44	0.44	0.46	0.48
13	53.9	56.0	59.0	62.0	65	66.0	70.0	73.0	0.36	0.37	0.40	0.42	0.44	0.44	0.46	0.48
14	57.0	58.0	61.0	65.0	68	69.0	73.0	75.0	0.37	0.38	0.40	0.42	0.43	0.44	0.47	0.48
15	60.8	62.0	65.0	68.0	71	72.0	75.0	78.0	0.37	0.39	0.40	0.42	0.44	0.44	0.46	0.47
Avg.	49	51	55	60	64	66	71	73	0.38	0.39	0.40	0.42	0.44	0.45	0.48	0.49
Girls																
5	42.0	44.0	46.0	48.0	50	51.0	54.0	54.8	0.41	0.43	0.45	0.47	0.49	0.49	0.52	0.53
6	36.	43.6	48.0	52.0	53	54.0	56.4	61.0	0.33	0.38	0.42	0.44	0.47	0.48	0.50	0.52
7	44.2	46.0	49.0	51.0	53	54.0	56.2	58.6	0.39	0.40	0.42	0.44	0.46	0.47	0.49	0.49
8	46.	47.7	49.0	52.0	56	56.0	58.0	58.6	0.37	0.38	0.40	0.43	0.44	0.44	0.49	0.50
9	48.0	48.0	52.0	53.0	57	58.0	61.0	66.0	0.38	0.39	0.41	0.43	0.45	0.45	0.47	0.50
10	48.0	50.0	52.7	55.0	58	58.0	62.1	65.1	0.38	0.38	0.40	0.42	0.45	0.45	0.48	0.49
11	47.3	48.0	52.0	56.0	61	62.0	65.3	68.9	0.34	0.36	0.38	0.42	0.43	0.44	0.48	0.49
12	50.3	52.0	56.0	60.0	63	65.0	68.0	70.0	0.36	0.37	0.39	0.42	0.44	0.45	0.47	0.48
13	53.0	55.	58.0	62.0	66	67.0	71.2	76.0	0.36	0.37	0.39	0.42	0.44	0.45	0.48	0.52
14	56.	58.	61.0	65.0	68	69.00	74.00	77.90	0.37	0.38	0.40	0.42	0.45	0.46	0.50	0.52
15	57.5	59.1	63.0	68.0	71	72.0	78.0	80.0	0.37	0.39	0.41	0.44	0.47	0.48	0.51	0.53
Avg	48	50	53	59	63	65	70	74	0.37	0.38	0.40	0.43	0.45	0.46	0.49	0.51

Table 2. waist circumference and waist to height ratio percentiles by age and gender

Variables	Age (yrs)		Normal BP	Pre-HTN	HTN	P-value
WC Percentile 70 th	overall	<70 th	1039 (66.3%)	326 (20.8%)	203 (12.9%)	0.001
		≥70 th	558 (72.8%)	101 (13.2%)	107 (14.0%)	
	5-10	<70 th	214 (65.6%)	33 (10.1%)	79 (24.2%)	0.25
		≥70 th	110 (60.4%)	27 (14.8%)	45 (24.7%)	
	10-15	<70 th	844 (67.8%)	299 (24.0%)	102 (8.2%)	0.001
		≥70 th	429 (73.8%)	68 (11.7%)	84 (14.5%)	
75 th	overall	<75 th	1162 (66.6%)	359 (20.6%)	225 (12.9%)	0.001
		≥75 th	435 (74.0%)	68 (11.6%)	85 (14.5%)	
	5-10	<75 th	236 (64.3%)	37 (10.1%)	94 (25.6%)	0.12
		≥75 th	88 (62.4%)	23 (16.3%)	30 (21.3%)	
	10-15	<75 th	912 (68.0%)	315 (23.5%)	114 (8.5%)	0.001
		≥75 th	361 (74.4%)	52 (10.7%)	72 (14.8%)	
90 th	overall	<90 th	1430 (68.1%)	401 (19.1%)	269 (12.8%)	0.004
		≥90 th	167 (71.4%)	26 (11.1%)	41 (17.5%)	
	5-10	<90 th	287 (63.6%)	49 (10.9%)	115 (25.5%)	0.08
		≥90 th	37 (64.9%)	11 (19.3%)	9 (15.8%)	
	10-15	<90 th	1133 (69.6%)	344 (21.1%)	152 (9.3%)	0.001
		≥90 th	140 (71.1%)	23 (11.7%)	34 (17.3%)	
WHtR	overall	<0.5	1521 (69.1%)	408 (18.5%)	271 (12.3%)	0.001
		≥0.5	76 (56.7%)	19 (14.2%)	39 (29.1%)	
	5-10	<0.5	294 (63.4%)	57 (12.3%)	113 (24.4%)	0.57
		≥0.5	30 (68.2%)	3 (6.8%)	11 (25.0%)	
	10-15	<0.5	1227 (70.7%)	351 (20.2%)	158 (9.1%)	0.001
		≥0.5	46 (51.1%)	16 (17.8%)	28 (31.1%)	
BMI overall	Underweight		100(74.1%)	21 (15.6%)	14 (10.4%)	0.006
	Normal weight		1350(68.6%)	372 (18.9%)	246 (12.5%)	

	Overweight	126(64.0%)	28 (14.2%)	43 (21.8%)	
	Obese	216(1.8%)	6 (17.6%)	7 (20.6%)	
BMI 5-10yrs	Underweight	20(69.0%)	1 (3.4%)	8 (27.6%)	0.27
	Normal weight	255(61.6%)	55 (13.3%)	104 (25.1%)	
	Overweight	3774.0%	3 (6.0%)	10 (20.0%)	
	Obese	121(80.0%)	1 (6.7%)	2 (13.3%)	
BMI 10-15yrs	Underweight	80(75.5%)	20 (18.9%)	6 (5.7%)	0.001
	Normal weight	1095(70.5%)	317 (20.4%)	142 (9.1%)	
	Overweight	89(60.5%)	25 (17.0%)	33 (22.4%)	
	Obese	9(47.4%)	5 (26.3%)	5 (26.3%)	

Table 3. Comparison of WC, WHtR, BMI WITH BP

DISCUSSION

Abdominal adiposity was positioned as the 'sine qua non' in the IDF definition of metabolic syndrome in adults¹⁴ and is recognized to be an independent risk factor for the development of cardiovascular disease in adults.¹⁵ Similarly in children and adolescent, the importance of abdominal obesity in the definition of metabolic syndrome is clearly highlighted. Without impinging upon the complicated, not easily available means of measuring insulin resistance, simple assessment of abdominal obesity with WC can go a long way in the determination of prevalence of metabolic syndrome in children and adolescent, so that high risk groups are identified and initiated on preventive measures. Moreover, WC is known to correlate more strongly with visceral adipose tissue (VAT) than BMI in adults¹⁶ and also demonstrated recently in children too¹⁷ and is too a strong predictor of cardiovascular disease in children.¹⁸ The statement is further bolstered with the WC showing as an effective measure of abdominal obesity in the youth population.¹⁹ More importantly, WC has been shown to be an independent predictor of insulin resistance, lipid levels, and blood pressure– all components of metabolic syndrome.^{20, 21, 22} So, in a simpler fashion, an easily measurable parameter, WC can be regarded as a representative of metabolic syndrome. Along with this, WHtR has been shown to correlate inversely with insulin sensitivity and insulin sensitivity parallels the WC percentile.^{21,22,23} However the need for development of different WC in percentile form for different ethnicities has been underscored and still our country has yet to develop a common WC and WHtR percentile for the children and adolescent as reference standard.

The WC percentile value increases almost smoothly with increasing age for both genders as depicted in Table 2. The WC percentile using 70th and 75th percentile correlated significantly with obese subjects defined in terms of BMI, showing higher proportion of obese children with larger waist circumference (3.5% Vs 1.4% and 3.9% Vs 1.3% respectively), which were statistically significant ($p=0.001$). Children with the waist circumference $\geq 70^{\text{th}}$ percentile were found to be more hypertensive than children below it in overall studied population (14% vs 12.9%) and in the age group 10-15 yrs. (14.5% vs 8.2%), which were statistically significant ($p=0.001$). However, in the younger age group of 5-10 yrs. group, children with WC of $\geq 70^{\text{th}}$ percentile were more hypertensive numerically (24.7%vs24.2%) but the result was not statistically significant. Using WC of 75th and 90th percentile also observed similar trend but with more number of hypertensive children below these cut-off in the younger age group of 5-10yrs. However, the number of children in the age group of 5-10yrs in the studied population was small (508). The proportion of hypertensive children

was almost similar with WC of 70th and 75th percentile cut off (14.0% vs 14.5%). So waist circumference of 70th percentile cut off may be the better choice for the Indian children for identifying at risk for metabolic syndrome, as also suggested by Dr. Anuradha Khadilkar et al study.¹¹ But we still feel that, we need further studies in large-scale population to look for appropriate WC cut off for defining metabolic syndrome in our children and adolescent especially in younger age group of 5-10yrs group, where we could not showed positive correlation between hypertension and WC of 70th and 75th percentile cut off in our study population.

20.6% and 21.8% of obese and overweight population were found to be hypertensive, which was statistically significant, again reaffirming the strong association between the body weight and hypertension.

The WHtR is also a potential marker of metabolic syndrome as it has been shown to correlate with body adiposity irrespective of body shape and size. Using the ratio cut off of 0.5, children with higher ratio were found to be more hypertensive overall and in both the age groups, with statistical significance but in the younger age group, as it was when WC of 70th percentile was used. The importance of this ratio is shown in earlier studies too.^{7,8,24}

CONCLUSION

This study will further help in developing a WC percentile reference standard for Indian children, for better defining childhood obesity and identifying children at risk of developing metabolic syndrome. This step is important keeping in mind the growing menace of childhood obesity and its associated various metabolic disorders, which may be the harbinger of adult metabolic disorders. Identification and establishment of simple easily measurable clinical parameters like WC and WHtR as representative of metabolic syndrome in children can help a long way in figuring out various preventive measures at the initial stage in economically underdeveloped countries like India.

Limitation

1. Measurement of only WC and BP without other parameters of metabolic syndrome.
2. Measurement of BP in a single setting.

REFERENCES

- [1] Dietz WH. Health consequences of obesity in youth: childhood predictors of adult disease. *Pediatrics* 1998;101(3 Pt 2):518-25.
- [2] Janiszewski PM, Janssen I, Ross R. Does waist circumference predict diabetes and cardiovascular

- disease beyond commonly evaluated cardiometabolic risk factors? *Diabetes Care* 2007;30(12):3105-9.
- [3] Zimmet P, Alberti KG, Kaufman F, et al. The metabolic syndrome in children and adolescents - an IDF consensus report. *Pediatr Diabetes* 2007;8(5):299-306.
- [4] Cook S, Weitzman M, Auinger P, et al. Prevalence of a metabolic syndrome phenotype in adolescents: findings from the third National Health and Nutrition Examination Survey, 1988-1994. *Arch Pediatr Adolesc Med* 2003;157(8):821-7.
- [5] Zimmermann MB, Gubeli C, Puntener C, et al. Detection of overweight and obesity in a national sample of 6-12-y-old Swiss children: accuracy and validity of reference values for body mass index from the US Centers for Disease Control and Prevention and the International Obesity Task Force. *Am J Clin Nutr* 2004;79(5):838-43.
- [6] Ashwell M, Cole TJ, Dixon AK. Ratio of waist circumference to height is strong predictor of intra-abdominal fat. *BMJ* 1996;313(7056):559-60.
- [7] Hara M, Saitou E, Iwata F, et al. Waist-to-height ratio is the best predictor of cardiovascular disease risk factors in Japanese schoolchildren. *J Atheroscler Thromb* 2002;9(3):127-32.
- [8] Borah PK, Devi U, Biswas D, et al. Distribution of blood pressure & correlates of hypertension in school children aged 5-14 years from Northeast India. *The Indian Journal of Medical Research* 2015;142(3):293-300.
- [9] World Health Organization. WHO Child Growth Standards. <http://www.who.int/childgrowth/standards/chart/catalogue/en/index.html>.
- [10] Barlow SE, Dietz WH. Obesity evaluation and treatment: Expert Committee recommendations. The Maternal and Child Health Bureau, Health Resources and Services Administration and The Department of Health and Human Services Pediatrics 1998;102(3):E29.
- [11] Khadilkar A, Ekbote V, Chiplonkar S, et al. Waist circumference percentiles in 2-18 year old Indian children. *J Pediatr* June 2014;164(6):1358-62.e2.
- [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. NIH Publication No. 05-5267. 2005.
- [13] Kuriyan R, Thomas T, Lokesh DP, et al. Waist circumference and waist for height percentiles in urban south Indian children aged 3-16 years. *Indian Pediatrics* 2011;48(10):765-71.
- [14] Alberti KG, Zimmet P, Shaw J. Metabolic syndrome - a new world-wide definition. A consensus statement from the International Diabetes Federation. *Diabet Med* 2006;23(5):469-80.
- [15] Yusuf S, Hawken S, Ounpuu S, et al. Effect of potentially modifiable risk factors associated with myocardial infarction in 52 countries (the INTER-HEART study): case-control study. *Lancet* 2004;364(9438):937-52.
- [16] Poulriot MC, Despre's JP, Lemieux S, et al. Waist circumference and abdominal sagittal diameter: best simple anthropometric indexes of abdominal visceral adipose tissue accumulation and related cardiovascular risk in men and women. *Am J Cardiol* 1994;73(7):460-8.
- [17] Brambilla P, Bedogni G, Moreno LA, et al. Cross-validation of anthropometry against magnetic resonance imaging for the assessment of visceral and subcutaneous adipose tissue in children. *Int J Obes (Lond)* 2006;30(1):23-30.
- [18] Savva SC, Tornaritis M, Savva ME, et al. Waist circumference and waist-to-height ratio are better predictors of cardiovascular disease risk factors in children than body mass index. *Int J Obes Relat Metab Disord* 2000;24(11):1453-8.
- [19] Taylor RW, Jones IE, Williams SM, et al. Evaluation of waist circumference, waist-to-hip ratio, and the conicity index as screening tools for high trunk fat mass, as measured by dual-energy X-ray absorptiometry, in children aged 3-19 y. *Am J Clin Nutr* 2000;72(2):490-5.
- [20] Flodmark CE, Sveger T, Nilsson-Ehle P. Waist measurement correlates to a potentially atherogenic lipoprotein profile in obese 12-14-year-old children. *Acta Paediatr* 1994;83(9):941-5.
- [21] Hirschler V, Aranda C, Calcagno Mde L, et al. Can waist circumference identify children with the metabolic syndrome? *Arch Pediatr Adolesc Med* 2005;159(8):740-4.
- [22] Bacha F, Saad R, Gungor N, et al. Are obesity-related metabolic risk factors modulated by the degree of insulin resistance in adolescents? *Diabetes Care* 2006;29(7):1599-604.
- [23] Inge TH, Garcia V, Daniels S, et al. A multidisciplinary approach to the adolescent bariatric surgical patient. *J Pediatr Surg* 2004;39(3):442-7.
- [24] da Silva Magalhães EI, da Rocha Sant'Ana LF, Priore SE, et al. Waist circumference, waist/height ratio and neck circumference as parameters of central obesity assessment in children. *Rev Paul Pediatr* 2014;32(3):273-81.