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S. Majumdar[1], A. Gorain[2], P. Bharati[3] and S.K. Murmu[4]

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Authors and affiliations

[1]Saikat Majumdar, Public Health Professional, Government of West Bengal and Research Scholar in Anthropology, Ranchi University, Jharkhand, India. Email: soikat2005@rediffmail.com

[2]Ashoke Gorain, Public Health Professional, Government of West Bengal and Academic Councilor, IGNOU, New Delhi, India. Email: ashoke.gorain@rediffmail.com

[3]Premananda Bharati, Retired Professor, Biological Anthropology Unit, Indian Statistical Institute, Kolkata 700 108, West Bengal, India. pbharati@gmail.com

[4]Sadhan Kumar Murmu, Head of the Department, PhD, Anthropology, Gossner College, Ranchi University, Ranchi. Email:sadhanmurmu91@gmail.com

Corresponding Author:
Saikat Majumder, Public Health Professional, Government of West Bengal and Research Scholar in Anthropology, Ranchi University, Jharkhand, India. Email: soikat2005@rediffmail.com, Mobile no: 07866810590

BMI, Waist to Height Ratio and Waist Circumference as a screening tool for Hypertension of Birbhum District, West Bengal, India

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ABSTRACT

Background: *The waist-height ratio (WHtR) is increasingly being studied as a simple and effective measure of central obesity. BMI does not reflect regional fat distribution. Reports have shown that WHtR is a better predictor of hypertension and cardiovascular diseases than traditional obesity indices body mass index (BMI) and waist circumference (WC). It remains controversial which anthropometric indicator could be the best predictor as a screening tool for hypertension.*

Objectives: *To examine the relative power of body mass index (BMI), waist circumference (WC), and waist-to-height ratio (WHtR) as a screening tool for hypertension among sampled population of Birbhum district, West Bengal.*

Methods: *Height, weight, waist, systolic and diastolic blood pressure, age, socio-economic and demographic data were recorded from 3640 adult population aged 40 years and above in rural and peri-urban areas (Suri-1 block) of Birbhum district, from June to December 2023. The study included 1822 men and 1818 women. Continuous variables are shown as mean, standard deviation and categorical variables as frequency and percentage. We used logistic regression analysis separately to find the effect of different obesity metrics. Odd Ratios (ORs) were reported within a 95% CI.*

Results*: The prevalence of obesity or overweight to body mass index (BMI) was 29.62%, by waist-to-height ratio (WHtR) was 62.17% and by waist circumference was 41.10%. The paper has shown among other things, the prevalence of hypertensive, pre-hypertensive was 22.17%, 46.98% among adults. Nearly 31.85% participants were normal.*

Conclusion*: This study showed that WHtR and WC are not inferior to BMI as a metric for obesity detection and hypertension prediction. Because of its low cost, simplicity of measurement and better ability to predict hypertension, it may become a more usable metric in health facilities of low and middle-income countries. The paper also suggests the urgent need to launch preventive programs to reduce prehypertension before it develops to be hypertension as a precautionary measure.*

Key Words*: Waist-to –height-ratio, BMI, Waist circumference, Hypertensive, Pre-hypertensive*

INTRODUCTION

Hypertension has been considered one of the major contributing factors to the burden of diseases all over the world. Overall, the prevalence of hypertension is about 25% in adults, but this value is expected to increase to 29% by 2025 (**Mittal and Singh, 2010**).

Hypertension is a one of the risk factors for obesity-related CVDs (Fuchs et al. 2005). Studies show that shorter individuals are at greater risk of developing certain diseases, such as lung disease, some cancers, cardiovascular diseases (CVD) (Koch et al. 2011, Mccarron et al. 2002) and metabolic syndrome (Schneider et al. 2011).

Although BMI has been the gold standard for obesity determination for years, recent work has indicated that waist circumference (WC) and waist to height ratio (WHtR) may be more accurate predictors of health because they measure central obesity (Pischon et al. 2008, Kodama et al. 2012).

WHO has estimated that 1.13 billion people worldwide have HTN; among them, two-thirds live in low-income and middle-income countries (LMICs). The rising burden of non-communicable diseases (NCDs)—major killers of the world’s population closely parallel with the rise in the burden of obesity (Ritchie and Roser 2017).

In the overweight persons aged 40 to 64 years, the prevalence of hypertension was 50% higher than that of persons with a normal weight and 100% higher than that of underweight persons (Stamler et al. 1978).

Insurance industry data have also shown a positive relationship between overweight or obesity with hypertension (Harsha and Bray 2008). Becoming normal weight reduced the risk of developing hypertension to a level similar to persons who were never obese (Juonala et al. 2011).

Early detection of individuals at high CVD risk is the cornerstone of primary prevention. Simple routine screening methods such as measuring waist to height ratio (WHtR), waist circumference (WC), blood pressure (BP), which help detect CVDs early, are not routinely practiced in LMICs because of heavy patient loads and staff shortages. Hypertension forms a critical risk factor for several non-communicable diseases (NCDs), such as ischemic heart disease, stroke, and chronic kidney disease. It has been reported that the brain tissue in hypertensive patients is more susceptible to ischemic damage compared to its normal counterparts (Cipolla et al. 2018).

One of the targets of Sustainable Development Goals was to reduce the prevalence of raised blood pressure by 25% in 2030 (Loewe and Rippin 2015). If not tackled timely through appropriate interventions, the NCDs will continue claiming the lives of many adults in the productive age group.

METHODS

Inclusion and exclusion criteria

All outpatients between 40 and 75 years of age who provided written consent during the study period were included. Pregnant women and people unable to stand correctly were excluded from data analysis for this study. Participants with any abnormal body composition which did not allow measuring height, weight and WC were excluded from the analysis.

Age of the participants was confirmed on the basis of birth certificate. For those who did not have a birth certificate, the school certificate, Voter ID card or Aadhaar card was carefully considered as a secondary source.

Anthropometric Measurements

Participants were asked to remove bulky clothes, shoes and cap before taking measurements. The WC in cm was measured at the midpoint between the lower edge of the rib cage and the iliac crest after a full expiration. BMI was calculated as weight (kg) divided by height in metres squared (m2). Using this, the patients were categorized as underweight (<18.5 kg/m2), normal or lean BMI (18.5–22.99 kg/m2), overweight (23- 24.99 kg/m2) & Obese (≥25 kg/m2) based on the revised consensus guidelines for WHO (WHO, 2010).

WHtR was calculated as waist circumference (cm) (WC) divided by height (cm). The standard value for WHtR was considered as ‘no increased risk’ (WHtR <0.5); ‘increased risk’ (WHtR ≥0.5. The cut-off value for WHtR was considered as 0.5**.** (NICE guideline, 2022). Similarly, WC ≥90 cm for males and ≥80 cm for females were considered ‘cut-off values’ (WHO guideline 2008). We stratified participants by sex (male and female) and age group 40 -59 years and ≥60 years.

The response variable in our empirical model has three categories: “normal,” “prehypertensive,” and “hypertensive.” Respondents with systolic and diastolic being 140 mm Hg over and 90 mm Hg over, respectively, are considered hypertensive. Those respondents with systolic between 120 and 139 or with diastolic between 80 and 89 are classified as prehypertensive. On the other hand, respondents with systolic being less than 120 mmHg and diastolic less than 80 mmHg are considered as normal (JNC 7 2003). Blood pressure was measured in left arm placing the cuff at the level of heart, placing the artery mark in the cuff at the level of brachial artery. Blood pressure in participants with initial high blood pressure was re-measured after 15 minutes.

Chi-square test was used to compare the distribution of the number of participants with high SBP and high DBP under different fat anthropometric indicators. Univariate and Multivariate logistic regression analysis was used to identify the anthropometric indices influencing the hypertension during the study.

Odds ratio (OR) was estimated with 95% confidence interval (CI). Statistical significance was determined at a p-value ≤ 0.05. Data entry was performed in the MS excel spreadsheet. Data analysis was carried out using STATA software.

The hypertensive indicator is generated as a binary variable by categorizing the original question (hypertensive) such as normal <90 mmHg and/or <140 mmHg as 0 and hypertensive ≥140 mmHg and/or diastolic blood pressure on both readings is ≥90 mmHg as 1.

RESULTS

The mean (SD) age of the participants was 52.48 (8.76) years. In study male participants were 50.05% and female 49.95%. Among them around 77.58 % were 40-59 years old and 22.42% were 60 – 75 years.

Table-1: Mean (SD) of anthropometric variables regarding age and gender

Anthropometric variables	Age Group(Years)				p-value *	Gender				p-value *
	40-59		60-75			Male		Female		
	Mean	SD	Mean	SD		Mean	SD	Mean	SD	
SBP (mm Hg	125.27	17.57	132.63	19.65	0.000	127.28	18.02	126.55	18.60	0.225
DBP(mm Hg	77.25	9.86	76.12	10.19	0.005	77.92	9.81	76.06	10.00	0.000
Weight (kg)	52.23	11.12	49.54	12.62	0.000	54.69	11.53	48.55	10.67	0.000
Height(cm)	156.54	9.02	155.25	9.72	0.000	162.67	7.03	149.82	6.09	0.000
WC	81.36	11.65	81.17	12.65	0.281	81.57	11.39	81.06	12.34	0.194
WHtR	0.52	0.074	0.52	0.078	0.531	0.50	0.065	0.54	0.079	0.000
BMI	21.25	3.85	20.42	4.32	0.000	20.58	3.69	21.54	4.19	0.000

* Independent t-test BMI, body mass index; SBP, systolic blood pressure; DBP, diastolic blood pressure; WC, waist circumference; WHtR, waist to height ratio

The mean (SD) BMI was 20.58(3.69) kg/m2 and 21.54 (4.19) kg/m2 for male and female participants respectively ($p<0.01$). The mean BMI was observed to gradually decrease with advancing age in both male and female participants. The mean (SD) WHtR was 0.50 (0.065) and 0.54 (0.079) for male and female ($p<0.01$), respectively. Similarly, the mean (SD) WC was 81.57(11.39) cm and 81.06 (12.34) cm for males and females ($p<0.01$), respectively.

Table-2: Distribution of the number of participants with hypertensive, pre-hypertensive and normal under different obesity indices

Obesity Indicator	Category	normal	Prehypertension	Hypertension	p-value
BMI (kg/m2)	<25	1015(32.90)	1416(45.90)	654(21.20)	0.000
	>=25	108(19.46)	294(52.97)	153(27.57)	
WHtR	<0.5	570(41.39)	576(41.83)	231(16.78)	0.000
	>=0.5	553(24.44)	1134(50.11)	576(25.45)	
WC	Low Risk	765(35.68)	962(44.87)	417(19.45)	0.000
	High Risk	358(23.93)	748(50.00)	390(26.07)	

The results showed that patients with BMI ≥25 (kg/m2), WC ≥90 cm for males and ≥80 cm for female and WHtR ≥0.5 had a significantly higher probability of developing non-hypertension and hypertension than participants with normal fat anthropometric indicators, and the differences were statistically significant (all $P < 0.05$), as shown in Table-2

Table-3: Univariable and multivariable odds ratios (95% CI) for predictors of hypertensive study population

Obesity Indicators	**Univariable**			**Multivariable**		
Body Mass Index	Unadjusted OR	95% Confidence Level	p-value	Adjusted OR	95% Confidence Level	p-value
Underweight(Reference)						
Normal	1.21	.99 1.47	0.051	1.19	.98 1.45	0.085
Overweight	1.68	1.32 2.15	0.000	1.61	1.25 2.08	0.000
Obese	1.85	1.46 2.35	0.000	1.75	1.36 2.25	0.000
Waist-to height ratio						
< 0.50(Reference)						
>=0.50	1.81	1.54 2.14	0.000	1.76	1.48 2.09	0.000
Waist Circumference						
Low Risk(Reference)						
High Risk	1.56	1.34 1.82	0.000	1.49	1.27 1.75	0.000

Adjusted OR * Religion, Caste and quintile

In table-3 unadjusted and mutually adjusted odds ratios and 95% confidence intervals from logistic regression analyses with hypertension as the dependent variable in sample population Adjusted for the confounding effects of religion, caste and wealth index, overweight population were hypertensive (odds ratio :1.61; 95% confidence interval: 1.25 2.08) and obese were hypertensive(odds ratio : 1.75; 95% confidence interval: 1.36 2.25).

Waist-to- height ratio >=0.50 study population were hypertensive (odds ratio: 1.76; 95% confidence interval: 1.48 2.09). Again high risk waist circumference study population were hypertensive (odds ratio: 1.49; 95% confidence interval: 1.27 1.75).

P-values were highly significant for all obese indicators.

DISCUSSION

Abdominal adiposity is suggested to be more closely associated with CVD risk and has been highlighted as a growing problem particularly in countries of Asia-Pacific region where individuals may exhibit a relatively normal BMI (<25 kg/m2) but have a disproportionately large waist circumference (Reddy et al. 2002). Obesity is a major contributor to cardiovascular disease, metabolic syndrome, and hypertension, which is on the rise in India.

As we observed that the prevalence of overweight and obesity increases with age, it is imperative to address adult obesity. Efforts can be directed toward training healthcare workers in identifying overweight and obese among adult population and planning relevant interventions, as well as counseling the participants to encourage future strategies targeted at healthy diet and lifestyle.

The overall 24.86 % and 24.37% prevalence of hypertension among older males and females, respectively, indicates that the condition affects a sizable proportion of older population in study area. In this study, the overall prevalence of general obesity, abdominal obesity and hypertension was 15.25 %, 62.17%, and 24.62%, respectively.

Up to date, there was no consistent conclusion on the relative power and effectiveness of different anthropometrics in predicting the incidence of hypertension. Some studies reported that BMI or WC was the best predictor of incident hypertension (Lee and Kim 2014, Sakurai et al. 2006, Yu et al. 2016). While others declared that WHTR was superior to predict the incidence of hypertension (Li et al. 2013, Sayeed et al. 2003, Meseri et al. 2014).

The observed higher prevalence of body fat in women than men, using all three metrics of obesity in our study, is supported by other studies (Ford, et al. 2017, Vaidya et al. 2010, Nepal Health Research Council (2013). The reported increase in abdominal obesity with each pregnancy independent of total body fat (International Diabetes Federation (IDF), 2006) may possibly explain higher abdominal obesity among women.

Rather than considering a large cross sectional sample, the present study considered mainly the urban affluent population (Suri 1 block and adjacent areas) with a moderate sample size in view of the fact that the increasing prevalence of non-communicable diseases is primarily reported in such populations.

Conclusion

The current stage of the obesity in study area presents an opportunity for policy and intervention efforts related to prevention. This opportunity necessitates developing a clear strategy for the control of NCDs through rigorous program management at national and state levels. The increasing prevalence of obesity and hypertension in India has enormous implications for the healthcare system. Policy makers, government officials, and public health professionals can focus policy and intervention efforts on obesity as an important risk factor to prevent cardiovascular diseases such as stroke, ischemic heart disease, heart failure etc.

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Conflict of interest

The authors declared no potential conflicts of interest with respect to the research, authorship, and publication of this article.

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