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Central obesity and hypertension among rural adults of Paschim Medinipur, West Bengal, India

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Abstract: Obesity is generally classified into generalized obesity (BMI ≥30 kg/m²) and abdominal or central obesity (WC ≥90 cm for men and WC ≥80 cm for women) based on World Health Organization recommendation for Asians. Hypertension is one of the most common obesity-related complications, and about 30% of hypertensive individuals can be classified as being obese. The present study aimed to investigate the effect of different age groups (years) on the anthropometric and derived variables. It determined the correlation between anthropometric and derived variables and also estimated the frequency of central obesity and hypertension. Finally, it investigated the relationship between central obesity and blood pressure among rural Bengalee adults of Dirghagram village of Ghatal Block, Paschim Medinipur, West Bengal, India. The present cross-sectional study was undertaken among 310 rural adults (154 males; 156 females) aged over 18 years. Our study was carried out during March, 2017. Height (cm), weight (kg), waist circumference (cm), hip circumference (cm) and blood pressure (systolic and diastolic) were measured using standard procedures. One way ANOVA analysis on most of the anthropometric and derived variables showed a statistically significant increase from younger to older age group in both sexes ($p<0.001$;$p<0.01$; $p<0.05$). In addition to that, more females had central obesity using waist circumference (55.8% vs. 19.5%), waist hip ratio (87.2% vs. 35.7%), waist height ratio (73.7% vs. 44.2%), and conicity index (87.2% vs. 57.8%) criteria, and hypertension (52.5% vs. 27.3%). The prevalence of central obesity was much higher in case of hypertensive individuals. Therefore, the present study showed a high prevalence of central obesity among the rural adults of Dirghagram village. Furthermore, central obesity contributed in increasing hypertension among the villagers.

Key words: rural adults, central obesity, waist circumference, waist to hip ratio, waist height ratio, conicity index, hypertension

Introduction

Overweight and obesity refer to excessive accumulation of fat that may result in health damage and its usually measured based by high body mass index (BMI) (WHO 2017; Darebo et al. 2019). Overweight and obesity increase the risk of several types of cancers (especially breast cancer among females) and raise blood pressure, cholesterol and insulin resistance (WHO 2003; Darebo et al. 2019). In the last few decades, in both developed and developing countries a considerable

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increase in the prevalence of overweight and obesity has been observed (WHO 2015, Darebo et al. 2019). In 2016, more than 1.9 billion adults aged 18 years and over were overweight. Of these over 650 million adults were obese. The worldwide prevalence of overweight among adults (18 years and over) was 39% (39% of men and 40% of women) and obese was 13% (11% of men and 15% of women). The worldwide prevalence of obesity nearly tripled between 1975 and 2016 (WHO 2016; Darebo et al. 2019). In developed and developing countries, people consume more quantities of high-energy food and perform less physical activity, thereby resulting in the increase in number of overweight and obese individuals (WHO 2002).Over the past years, the number of people with overweight and obesity were considered the main problem of the high-income countries, but for the last three decades, the prevalence of overweight and obesity had risen significantly in the low- and middle-income countries, and especially in the urban areas (Amugsi et al. 2017). Obesity is generally classified into generalized obesity (BMI ≥30 kg/m^2) and abdominal or central obesity (CO) [Waist Circumference (WC) ≥90 cm for men and WC ≥80 cm for women] based on World Health Organization recommendation for Asians (WHO 1995; WHO 2000). Both general obesity and CO are associated with increased risk of morbidity and mortality (WHO 2008; Mogre et al. 2014). The development of both general and CO has been associated with potentially changeable lifestyle factors such as physical inactivity, alcohol consumption and smoking (Sobngwi et al. 2002; Yahia et al. 2008; Addo et al. 2009; Mogre et al. 2014).

Worldwide the prevalence of CO is higher among females (Abolfotouh et al. 2008; Sarkar et al. 2009; Amole et al. 2011; Kaur et al. 2013; Wang et al.2014; Chauhan et al. 2015; Zhang et al. 2016). Hypertension (HT), diabetes and hyperlipidemia are significantly associated with CO among adults with normal BMI (Zhang et al. 2016). Moreover CO is also associated with hypertension, physical inactivity and the consumption of high-energy diets (Amole et al. 2011).

In India, the prevalence of generalized obesity was 24.6%, 31.3%, 16.6%, 11.8% and among residents of Tamil Nadu, Chandigarh, Maharashtra, and Jharkhand, while the prevalence of CO was 26.6%, 36.1%, 18.7%, and 16.9%, respectively. Overall, in the whole country, 135 and 153 million individuals have general obesity and CO, respectively. However, these figures have been estimated from three states (Tamil Nadu, Maharashtra, and Jharkhand) and one Union Territory (Chandigarh) of India and thereby, the results may be viewed in this light (Pradeepa et al. 2015).

High blood pressure may or may not have any symptoms. In fact, many people have reported a high blood pressure not known to them for years. That is the reason it is also called the “Silent Killer” (Black 1998). HT is triggered by various factors such as age, genes, overweight, obesity, sedentary lifestyle, alcohol consumption and excessive intake of salt. It has been observed that overweight and obesity could be a major factor in determining the increasing rates of coronary heart disease by its influence on blood pressure (Reddy et al. 2002). The prevalence of HT and blood pressure levels are related to adiposity and the main constituents of adiposity are BMI, waist-hip ratio (WHR), waist-height ratio (WHtR) and percent body fat (Kotchen et al. 2008).

In India, HT exerts a notable public health burden on cardiovascular health status and healthcare systems (Leeder et al. 2004; Srinath Reddy et al. 2005; Anchala et al. 2014). HT is directly responsible for 57% of all stroke deaths and 24% of all coronary heart disease deaths (Gupta et al. 2004; Anchala et al. 2014). About 33% urban and 25% rural Indians are hypertensive. Of these, 25% rural and 42% urban people are aware of their hypertensive status, but only 25% rural and 38% of urban people are being treated for HT (Anchala et al. 2014). A lot of studies exist on the relationship between blood pressure and obesity measures. Studies have been undertaken among women (Atallah et al. 2007), children (Sung et al. 2007; Martin-Espinosa et al. 2017), adolescents (Turconi et al. 2006; Cao et al. 2012), adults (Sarkar et al. 2009; Kaur et al. 2013) urban subjects (Feldstein et al. 2005; Singh et al. 2017) and the elderly population (Rurik et al. 2004; Wang et al. 2014).Studies have shown that WC plays a key role in the prevalence HT (Da Silva and Rosa 2006; Sung et al. 2007; Roka et al. 2015; Rouf et al. 2018). Sex differences in the prevalence of HT have also been reported in some studies (Turconi et al. 2006; Siziya et al. 2012). Associations between HT and WHtR have been documented in some studies wherein WHtR has been considered as the best indicator of HT and estimation of body fat (Nagai et al. 2008; Zhou et al. 2008; Choi et al. 2018).

The worldwide prevalence of CO as well as HT is dramatically increasing. However, the impact of CO is comparatively less studied in rural areas. Globally, there are numerous studies related to obesity and its consequences. In the Indian context, although there are numerous studies on obesity and HT from urban regions, such studies are scanty from rural areas. Hitherto, in West Bengal, there is very limited information on CO and HT among rural adults. Hence, the present study was undertaken in a rural region (Dirghagram village) of Ghatal Block, PaschimMedinipur, West Bengal, to investigate the interrelationships between age, CO and HT.

Materials and methods

Study area and participants

The present cross-sectional study was conducted during March 2017, among the villagers of Dirghagram under the Mansuka I gram panchayat of Ghatal Block, Paschim Medinipur, West Bengal. This study was undertaken among 310 adults (154 males; females 156) of Bengalee ethnicity aged 18 to 86 years. The participants were selected using opportunity sampling method. A well structured schedule has been administered to collect information, age (in years), sex, ethnicity, etc. from each participant. The objectives and methods of the study were explained to each participant before data collection. Verbal consent has been taken from each participant before commencing of the study. For the present study house-to-house visits have been utilized for data collection. All the participants were apparently free from any physical deformity. They were not suffering from any diseases during the time of data collection. Only those individuals who were not taking medication for hypertension have been included in the present study. Age (years) of the individuals was recorded from the birth certificates, voter identity cards and other official documents issued by the Government. The objectives and the methods of the present study were explained to them in a simple, yet in a detailed manner and finally 310 Bengalee adults (154 males; females 156) agreed to take part in the study.

Anthropometric measurements

All anthropometric measurements were taken by the first author (MC) using standard procedures (Lohman et al. 1988). Height (cm), weight (kg), waist circumference WC (cm), hip circumference HC (cm), were measured. Height (cm) was measured using Martin's anthropometric rod to the nearest 0.10 cm with the participant standing in erect position on a flat surface and the head oriented in the Frankfort horizontal plane. Weight (kg) was recorded with the subject standing motionless on a portable weighing machine to the nearest 0.5 kg. Waist circumference WC (cm) was measured at the midpoint between the iliac crest and lower margin of the ribs with the participant remaining in the standing position with two feet together. Hip circumference HC (cm) was measured at the maximum elevation of buttocks wearing minimum clothes (WHO 2011). The WC (cm) and HC (cm) were measured using a non-stretchable measuring tape without compression of skin.

The technical error of measurement (TEM) of anthropometric measurements was calculated using the standard procedure (Ulijaszek and Kerr 1999). For calculating TEM, a total of 50 adults were selectedrandomly. The TEM was calculated using the following standard equation:

$$TEM=\sqrt{(\Sigma D^2/2N)}$$

where: D – difference between the measurements, N – number of individuals.

The coefficient of reliability (R) was calculated from TEM using the following standard equation:

$$R= 1-(TEM)^2/SD^2$$

where: SD – standard deviation of the measurements.

The values of 'R' were subsequently determined from TEM. The intra-observer and inter-observer TEM values were observed to be within the cut-off value (R=0.95) as recommended (Ulijaszek and Kerr 1999).

The sample size was determined by using the standard formula ($n = z^2pq/d^2$) according to Naing et al. (2006) where z – 1.96 (95% Confidence Interval), p – prevalence, q – (1−p), and d – precision. The minimum sample size estimated was 296.

Measurement of blood pressure

Systolic blood pressure (SBP) and diastolic blood pressure (DBP) were measured on the left arm using an Omron HEM 7120 (Japan) digital blood pressure monitor. The participants were seated at least for five minutes in the chair before measurement.

All measurements (height, weight, WC, HC, SBP and DBP) were taken twice and the average of the two values was adopted.

Assessment of central obesity and blood pressure

The WHR, WHtR and CI were derived by using following standard equations:

- WHR – waist circumference (cm)/hip circumference (cm);
- WHtR: waist circumference (cm)/height (cm);

– CI: waist circumference (m)/0.109×√ weight (kg)/height (m) (Valdez et al. 1993).

To determine the frequency of central obesity the following standard cut-off values were used:

Variables	Male	Female	Reference
WC (cm)	≥90	≥80	WHO 2000
WHR	>0.95	>0.85	WHO 1989
WHtR	≥0.5	≥0.5	Hsieh and Muto 2004
CI	≥1.25	≥1.18	Flora et al. 2009

The frequency of HT was determined using the JNC VII classification of blood pressure:

Category	SBP (mmHg)		DBP (mmHg)
Normal	<120	and	<80
Prehypertension	120–139	or	80–89
Hypertension Stage1	140–159	or	90–99
Hypertension Stage2	≥160	or	≥100

Statistical analyses

All statistical analyses were undertaken using the SPSS Statistical Packages (version 16.0). A *p*-value of $p<0.05$ was considered to be statistically significant. One way ANOVA test was performed to test for significant differences in anthropometric variables between age group categories. Correlation analysis was employed to determine the association between the variables (anthropometric and derived). The Chi square (χ^2) test analysis was performed to test for sex differences in the frequency of CO. Age groupswere constructed using percentiles (25th, 50th, and 75th). The age groups were thus categorised into three: ≤ 25(years), 26–37(years), 38–49(years) and ≥50 (years).

Results

Details of anthropometric (both simple as well as derived) and blood pressure variables (Mean±SD) among different age groups in studied participants are presented in Table 1.

It was observed that among male participants the mean WC, WHR, WHtR, CI, SBP and DBP increased from lower age group to higher age group. Using One Way ANOVA, it has been observed that there existed highly significant ($p<0.001$) age group differences in WHR, WHtR, CI, SBP and DBP. Among females, mean WC, WHR, WHtR, CI, SBP and DBP increased from the lower age group. Significant age group differences existed in WHR ($p<0.001$), CI ($p<0.01$), SBP ($p<0.01$) and DBP ($p<0.01$).

Results of correlation analyses among studied participants are presented in Table 2.

Age had significant association with all CO measures, SBP and DBP among males. Both the blood pressure variables had significant correlations with all CO measures. As expected, all CO measures were significantly inter-correlated. All these correlations were highly positively significant ($p<0.001$). Similar results were found among females except age with WCand WHtR, WC with SBP and CI with SBP.

The frequency of CO and HT among the participants is presented in Table 3. The frequency of CO (55.8% vs. 19.5%; 87.2% vs. 35.7%, 73.7% vs. 44.2%, 87.2% vs. 57.8% respectively, $p<0.001$) and HT (52.5% vs. 27.3%) were higher among females. There was statistically highly significant ($p<0.001$) sex difference in the frequency of CO and HT.

Table 1. Age group specific anthropometric, derived and blood pressure variables. (Mean±SD) among the participants

Variables		Age group ≤25	26–37	38–49	≥50	F
WC	M	78.35±.8.55	80.67±.8.88	82.87±.7.46	83.29±.8.41	3.04^NS
	F	80.34±10.49	83.58±10.86	83.43±12.44	80.08±10.40	1.17^NS
WHR	M	0.88±.04	0.90±.06	0.94±.03	0.96±.07	20.01***
	F	0.88±.05	0.90±.05	0.92±.07	0.93±.05	6.39***
WHtR	M	0.47±.04	0.48±.05	0.51±.05	0.51±.05	6.96***
	F	0.52±.07	0.54±.07	0.55±.08	0.54±.06	2.23^NS
CI	M	1.23±.07	1.24±.08	1.29±.08	1.35±.09	20.46***
	F	1.27±.09	1.30±.10	1.33±.11	1.34±.10	3.98**
SBP	M	115.71±12.45	123.32±16.30	127.76±17.65	138.57±20.26	13.58***
	F	125.77±23.24	128.84±17.98	135.19±21.10	145.28±24.87	6.16**
DBP	M	70.40±9.77	78.85±9.35	83.36±9.81	85.42±9.31	20.22***
	F	77.51±12.07	83.11±11.11	85.08±11.07	86.84±11.13	5.11**

Mean± Standard deviation; Statistically significant at ** – $p< 0.01$, *** – $p< 0.001$ and NS – Not significant; M – Male, F – Female.

Table 2. Results of correlation analyses

Variable		WC	WHR	WHtR	CI	SBP	DBP
Age	M	0.19*	0.45***	0.26**	0.53**	0.48***	0.49***
	F	−0.05^NS	0.34***	0.09^NS	0.26**	0.34***	0.26**
WC	M		0.71***	0.92***	0.68***	0.41***	0.36***
	F		0.59***	0.94***	0.73***	0.11^NS	0.25**
WHR	M			0.75***	0.79***	0.52***	0.51***
	F			0.68***	0.81***	0.16*	0.25**
WHtR	M				0.66***	0.39***	0.37***
	F				0.74***	0.17*	0.30***
CI	M					0.55***	0.48***
	F					0.13^NS	0.22**
SBP	M						0.80***
	F						0.80***

Statistically significant at * – $p< 0.05$, ** – $p< 0.01$, *** – $p< 0.001$. M – Male, F – Female; NS – statistically not significant.

Table 3. Frequency of CO and HT among the participants

Variables	Male	Female	Total	χ^2
Central obesity(WC based)	30(19.5)	87(55.8)	117(37.7)	43.43***
Central obesity(WHR based)	55(35.7)	136(87.2)	191(61.6)	86.79***
Central obesity(WHtRbased)	68(44.2)	115(73.7)	183(59.0)	28.00***
Central obesity(CI based)	89(57.8)	136(87.2)	225(72.6)	33.63***
Hypertension	42(27.3)	82(52.5)	124(40.0)	21.82***

Percentages are presented in the parentheses; statistically significant at *** – $p< 0.001$.

Table 4. Distribution of CO and HT among the participants

Central obesity based on		Blood Pressure: Normal	Pre-hyper-tension	Hypertension-Stage I	Hypertension-Stage II	Total	χ^2
WC	M	5(16.7)	10(33.3)	12(40.0)	3(10.0)	30(19.5)	12.49**
	F	15(17.2)	17(19.5)	47(54.0)	8(9.2)	87(55.8)	5.34*
WHR	M	5(9.1)	19(34.5)	23(41.8)	8(14.5)	55(35.7)	47.53***
	F	28(20.6)	29(21.3)	67(49.3)	12(8.8)	136(87.2)	15.23**
WHtR	M	16(23.5)	22(32.4)	23(33.4)	7(10.3)	68(44.2)	21.15***
	F	20(17.4)	25(21.7)	59(51.3)	11(9.6)	115(73.7)	15.97**
CI	M	22(24.7)	31(34.8)	26(29.2)	10(11.2)	89(57.8)	27.53***
	F	32(23.5)	31(22.8)	61(44.9)	12(8.8)	136(87.2)	1.38^{NS}

Percentages are presented in the parentheses. Statistically significant at * – $p< 0.05$, ** – $p< 0.01$, *** – $p< 0.001$ and NS – Not significant. M – Male, F – Female.

Distribution of CO and blood pressure among the studied participants is presented in Table 4.

This table indicated that the frequency of CO was much higher in case of hypertensive individuals. The frequency of CO increased from normal stage to hypertension stage II in both sexes. It was observed that the prevalence of CO was higher in case of hypertensive females than in case of hypertensive males. In addition to that, WC had a significant association with blood pressure among males ($p<0.01$) and females ($p<0.05$). The WHR and WHtR had also significant association with blood pressure among males ($p<0.001$) as well as females ($p<0.01$). The CI had a highly significant association with blood pressure among males ($p<0.001$).

Discussion

At present, obesity and HT are major public health problems in India and globally. The prevalence of CO and HT in developing countries like India has seen an increasing trend. The present study investigated CO and HT among rural adults of Ghatal Block, Paschim Medinipur, West Bengal, India.

Our study has shown that females were more centrally obese than males when WC (55.8% vs. 19.5%), WHR (87.2% vs. 35.7%), WHtR (73.7% vs. 44.2%) and CI (87.2% vs. 57.8%) cut-offs were used. The prevalence of HT among females (52.5%) was higher as compared to males (27.3%), the difference was highly significant ($p<0.001$). We found that CO and HT had statistically highly significant association with gender ($p<0.001$). One way ANOVA analysis on most of the anthropometric and derived variables showed a statistically significant ($p<0.001$; $p<0.01$)increase from younger age group to older age group in both sexes. Mean WC, HC, WHR, WHtR, CI increased from low age group to high age group in both sexes. Therefore, on the basis of findings, we can confirm that age is a risk factor for CO and HT.

The present study demonstrated that WHR was significantly correlated with DBP among both males (r=0.515, $p<0.001$) and females (r=0.250, $p<0.01$). Similar results were also found by

Kaur and coauthors (2013) in their study. The present study reported that SBP was highly correlated with WC among males (r=0.413, $p<0.001$). High correlations between SBP and WC have also been reported in previous studies (Deshmukh et al.2006; Nagai et al.2008; Kaur et al. 2013).

The overall prevalence of HT in the present study was found to be 40%. There was a significant increase (except CO among females) in the prevalence of CO in concordance with blood pressure in both sexes. Our study revealed that CO was associated with increasing blood pressure in both sexes indicating that CO is a risk factor for HT. In our study, the overall prevalence of CO was 61.6% based on WHR cut-offs wherein females were more centrally obese than males (87.2% vs. 35.7%). This result was found to be similar with some previous studies (Abolfotouh et al. 2008; Sarkar et al. 2009; Nalawade and Prabhu 2012;Kaur et al. 2013; Bindhu et al. 2014; Goon et al. 2014; Siddiquee et al. 2015; Chauhan et al. 2015; Veghari et al. 2016; Bakir et al. 2017; Nagendra et al. 2017). On the other hand males have shown consistently lower prevalence in comparison to females in all the mentioned studies. Our study found that the prevalence of CO among females (87.2%) was higher in comparison to the other countries.

In Indian context, the presentstudy demonstrated the prevalence of CO among females (87.2%) was higher in comparison to the other states (West

Table 5. Prevalence of central obesity based on WHR: worldwide and Indian comparisons

Studied population	Studied area	Sample	Age (years)	Prevalence (%) of CO M	Prevalence (%) of CO F	Reference
Worldwide studies						
Egyptian adults	Egypt	1,800	18 and above	12.4	44.9	Abolfotouh et al. 2008
Adult nurses (both sexes)	Vhembe and Capricorn, South Africa	153	19–50⁺	37.2	43.8	Goon et al. 2014
Rural adults	Chandra, Bangladesh	2,293	20 and above	58.4	79.1	Siddiquee et al. 2015
Turkman & Non-Turkman	Iran (North)	464	15–70	62.7	63.1	Veghari et al. 2016
Indian studies						
Bengali Kayastha	Jalpaiguri, West Bengal	155	30–50	100	100	Sarkaret al. 2009
Mumbaiworking adults	Mumbai, Maharashtra	1,946	21–45	53.5	47.9	Nalawade and Prabhu 2012
Punjabi adults	Amritsar, Punjab	400	30–50	73.0	93.5	Kauret al.2013
Rural adults	Trivandrum, Kerala	224	18 and above	48.5	77.7	Bindhuet al. 2014
Ruralcoastal adults	Villupuram, Tamil Nadu	207	15 and above	50.0	60.1	Chauhanet al. 2015
Urban adults	Shivamogga, Karnataka	2,000	15–64	36.8	45.5	Nagendraet al. 2017
Rural adults	Ghatal, West Bengal	310	18 and above	35.7	87.2	Present study

M – Male, F – Female.

Bengal, Mumbai, Punjab, Kerala, Tamil Nadu and Karnataka). Interestingly a study conducted in West Bengal (Sarkar et al. 2009) showed 100.00% central obesity (WHR) among both sexes. The present study revealed the lowest prevalence of male CO, i.e. 35.7% followed by adult males of Karnataka (36.8%).

In different parts of the world (Nigeria, Northwest Ethiopia, Bangladesh, India, Indonesia) numerous studies (Aimole et al. 2011; Awoke et al. 2012; Chowdhury et al. 2016; Gani et al. 2016; Peltzer and Pengpid 2018) have been undertaken by various scholars on the prevalence of HT among adults and they have revealed significantly higher prevalence of HT in females than males (Table 6).

The prevalence of HT among females ranged from 9.7% to 69.0%. In the present study, it was observed that 52.5% females were hypertensive which is in con-

Table 6. Prevalence of hypertnesion: worldwide and Indian comparisons

Studied population	Studied area	Sample size	Age (years)	Prevalence (%) of HT			Reference
				M	F	T	
Worldwide studies							
Nigerian adults	Nigeria	400	18 and above	49.3	52.0	50.5	Aimole et al. 2011
Zambian adults	Kitwe, Zambia	1,627	25 and above	33.5	31.1	32.3	Siziya et al. 2012
Ethiopian adults	Northwest Ethiopia	679	35 and above	26.0	30.3	28.3	Awoke et al. 2012
Chinese adults	Jinan, China	1,870	50 and above	66.7	59.0	61.4	Wang et al. 2014
Bangladeshi adults	Bangladesh	7,839	35 and above	20.3	32.4	26.4	Chowdhury et al. 2016
Urban adults	Kirtipur, Nepal	580	20–59	41.6	32.2	37.0	Maharajan 2018
Indonesian adults	Indonesia	29,965	18 and above	31.0	35.4	33.4	Peltzer and Pengpid 2018
Indian studies							
Urban adults	Nellore, Andhra Pradesh	933	25–64	30.9	27.7	29.3	Prabakaran J et al. 2013
Bengalee adults	Midnapore, West Bengal	498	18 and above	40.5	13.6	31.9	Sing HS et al. 2014
Urban adults	Trichy, Tamil Nadu	373	16 and above	42.3	69.0	30.5	Gani P et al. 2016
Urban slum dwellers	Kolkata, West Bengal	10,175	20 and above	47.0	39.0	42.0	Banerjee S et al. 2016
Rural adults	Thrissur, Kerala	423	25–64	51.6	38.4	43.3	Simon C et al. 2017
Urban adults	Puducherry	236	35 and above	63.3	56.5	52.1	Paul PJ et al. 2017
Urban adults	Varanasi, Uttar Pradesh	640	25–64	40.9	26.0	32.9	Singh S et al. 2017
Rural adults	Uttarakhand	300	18–45	18.2	9.7	14.7	Thapllyal V et al. 2018
Rural adults	Ghatal, West Bengal	310	18 and above	27.3	52.5	40.0	Present study

M – Male, F – Female, T – Total.

cordance with the earlier studies. Our study showed that females had higher prevalence of HT than males but in some parts of world (Zambia, China, Nepal, India) various scholars found in their studies that the prevalence of HT was higher among males (Siziya et al. 2012; Wang et al. 2014; Maharajan 2018; Prabakaran et al. 2013; Sing et al. 2014; Banerjee et al. 2016; Simon et al. 2017; Paul et al. 2017; Singh et al. 2017; Thapllyal et al. 2018).

In India, Puducherry (Paul et al. 2017) has shown the highest prevalence of HT (43.3%). Kerala (Simon et al. 2017) has reported the second highest prevalence (42.0%) of HT. Another study conducted in Kolkata by Banerjee et al. in 2016 has shown that the prevalence of HT was 42.2%.

In the present study, the overall prevalence of HT was 40%.In the Indian context, Tamil Nadu (Gani et al. 2016) has reported the highest prevalence (69.0%) of HT among females. In Nellore, adult males (30.9%) and females (27.7%) had almost equal prevalence of HT. Uttarakhand males (18.2%) and females (9.7%) showed the lowest prevalence of HT. The present study revealed moderate prevalence of male HT (27.3%).

There may be various reasons for increasing HT among rural adults, one being higher salt intake (Du et al. 2014). In both sexes, CO was closely associated with income. Some studies have reported that CO increased in higher income groups (Basu et al. 2013; Pradeepa et al. 2015), middle income groups (Zhang et al. 2016) while a few others have reported that lower income groups (Sousa et al. 2011; Wu et al. 2014) had higher CO. One of the probable reasons behind this phenomenon could be the consumption of high calorie food which was abundantly available simultaneous with the presence of comparatively less energy expenditure (Monteiro et al. 2001; Yoon et al. 2006).

Conclusion

The present study highlighted the problems of CO and HT among rural Bengalee adults, especially females, which may have serious public health implications. One of the major limitations of our study was it's cross sectional nature. Such investigations can at best explore the association between CO and HT but can not be used to infer causation. Another limitation is a small sample size from a limited geographical locality. Moreover, dietary intake was not studied. Despite these limitations, our investigation clearly demonstrated that there existed a strong relationship between CO and HT in this ethnic group. The nature and extent of the relationship between CO and HT may vary across ethnic groups. India is a land of vast ethnic heterogeneity. Thus, further studies are required in other rural areas of the country among different ethnic groups to fully understand the extent of the health problems of CO and HT among rural populations of India. Results of such investigations may be helpful in the formulation of appropriate ethnic and region specific health promotion and intervention programmes. Hitherto, in the Indian context, such studies are scanty.

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Authors' contributions

MC planned the study, collected and analyzed the data and prepared the man-

uscript. KB planned the study, analyzed the data and edited the manuscript.

Conflict of interest

The authors declare that there is no conflicts of interest regarding publication of this paper.

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References

Abolfotouh MA, Soliman LA, Mansour E, Farghaly ME, Dawaiaty AA. 2008. Central obesity among adults in Egypt: prevalence and associated morbidity. East Mediterr Health J 14:57–68.

Addo J, Smeeth L, Leon DA. 2009. Obesity in urban civil servants in Ghana: association with pre-adult wealth and adult socio-economic status. Public Health 123:365–70.

Amole IO, Ola Olorun AD, Owolabi AO. 2011. Prevalence of obesity and hypertension among adults in Ogbomoso, Nigeria. IJMU 6:9–14.

Amugsi DA, Dimbuene ZT, Mberu B, Muthuri S, Ezeh AC. 2017. Prevalence and time trends in overweight and obesity among urban women: an analysis of demographic and health surveys data from 24 African countries, 1991–2014. BMJ Open 7:1–12.

Anchala R, Kannuri NK, Pant H, Khan H, Franco OH, Angelantonio ED, Prabhakaran D. 2014. Hypertension in India: a systematic review and meta-analysis of prevalence, awareness, and control of hypertension. J Hypertens 32:1170–77.

Atallah A, Inamo J, Lang T, Larabi L, Chatellier G, Rozet JE, De Gaudemaris R. 2007. Obesity and high blood pressure in French West Indies women, some difference according to definition of obesity; BMI or abdominal obesity. Arch Mal Coeur Vaiss 100:609–14.

Awoke1 A, Awoke T, Alemu S, Megabiaw B. 2012. Prevalence and associated factors of hypertension among adults in Gondar, Northwest Ethiopia: a community based cross-sectional study. BMC Cardiovascular Disorders 12:1–6.

Bakir MA, Hammad K, Mohammad L. 2017. Prevalence of obesity, central obesity, and associated socio-demographic variables in Syrian women using different anthropometric indicators. Anthropol Rev 80:191–205.

Banerjee S, Mukherjee TK, Basu S. 2016. Prevalence, awareness, and control of hypertension in the slums of Kolkata. Indian Heart J 68:286–94.

Basu G, Baur B, Mondal S, Chatterjee C, Saha D, Roy SK. 2013. Risk factors of obesity among 15–64 yrs age group: picture in a village of West Bengal. IOSR-JDMS 6:1–7.

Bindhu A, Thankam K, Jose R, Benny PV, Beevi N, Haran JC. 2014. Prevalence of obesity and overweight among adults in a rural area in Trivandrum – a cross sectional study. Int J Prev Ther Med 2:1–4.

Black HR. 1992. New concepts in hypertension. Focus on the elderly. Am Heart J 135:S2–S3.

Cao Z, Zhu L, Zhang T, Wu L, Wang Y. 2012. Blood pressure and obesity among adolescents: a school-based population study in China. Am J Hypertens 25:576–82.

Chauhan RC, Chauhan NS, Manikandan, Purty AJ, Mishra AK, Singh Z. 2015. Obesity among adult population of a rural coastal area in South India. Int J Sci Rep 1:155–58.

Chobanian AV, Bakris GL, Black HR, Cushman WC, Green LA, Izzo JL Jr, Jones DW, Materson BJ, Oparil S, Wright JT, Roccella EJ. 2003. The seventh report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure: the JNC 7 report. JAMA 289:2560–72.

Choi JR, Koh SB, Cho E. 2018. Waist-to-height ratio index for predicting incidences of hypertension: the ARIRANG study. BMC Public Health 18:1–6.

Chowdhury MAB, Uddin Md. J, Haque Md. R, Ibrahimou B. 2016. Hypertension among adults in Bangladesh: evidence from a national cross-sectional survey. BMC Cardiovasc Disord 16:1–10.

Darebo T, Mesfin A, Gebremedhin S. 2019. Prevalence and factors associated with overweight and obesity among adults in Hawassa city, southern Ethiopia: a community based cross-sectional study. BMC Obes 6:1–10.

da Silva AC, Rosa AA. 2006. Blood pressure and obesity of children and adolescents association with body mass index and waist circumference. Arch Latinoam Nutr 56:244–50.

Du S, Batis C, Wang H, Zhang B, Zhang J, Popkin BM. 2014. Understanding the patterns and trends of sodium intake, potassium intake, and sodium to potassium ratio and their effect on hypertension in China. Am J Clin Nutr 99:334–43.

Feldstein CA, Akopian M, Olivieri AO, Kramer AP, Nasi M, Garrido D. 2005. A comparison of body mass index and waist-to-hip ratio as indicators of hypertension risk in an urban Argentine population: A hospital-based study. Nutr Metab Cardiovasc Dis 15:310–15.

Flora MS, Mascie-Taylor CGN, Rahman M. 2009. Conicity index of adult Bangladeshi population and their socio-demographic characteristics. Ibrahim Med Coll J 3:1–8.

Gani P, Priya KJ, Paramasivam S.2016. Prevalence of hypertension in an urban area: a community-based survey in Trichy, Tamilnadu, India. Int J Community Med Public Health 3:2325–29.

Goon DT, Maputle MS, Olukoga A, Lebese R, Khoza LB, Mothiba TM. 2014. Anthropometrically determined abdominal obesity among nurses in Vhembe and Capricorn Districts, Limpopo, South Africa Biomed Res 25:567–72.

Gupta R. 2004. Trends in hypertension epidemiology in India. Hum Hypertens 18:73–8.

Hsieh SD, Muto T. 2004. A simple and practical index for assessing the risk of metabolic syndrome during the routine health checkups. Nippon Rinsho 62:1143–49.

Kaur J, Singh M, Pal Singh Batra A, Garg R, Kaur M, Punia N. 2013. Blood pressure and obesity variation among population of Amritsar district. Int J of Basic App Med Sci 3:113–21.

Kotchen TA, Grim CE, Kotchen JM., Krishnaswami S, Yang H, Hoffmann RG, McGinley EL. 2008. Altered relationship of blood pressure to adiposity in hypertension. Am J Hypertens 21:284–89.

Leeder S, Raymond S, Greenberg H, Liu H. 2004. A race against time. The challenge of cardiovascular disease in developing economies. The Center for Global Health and Economic Development. New York: Columbia University.

Lohman TG, Roche AF, Martorell R. 1988. Anthropometric Standardization Reference Manual. Chicago: Human Kinetics Books.

Maharajan B. 2018. Prevalence and awareness of hypertension among adults and its related risk factors. J Nepal Health Res Counc 15:242–46.

Martín-Espinosa N, Díez-Fernández A, Sánchez-López M, Rivero-Merino I, Lucas-De La Cruz L, Solera-Martínez M. Martínez-Vizcaíno V; Movi-Kids group. 2017. Prevalence of high blood pressure and association with obesity in Spanish schoolchildren aged 4–6 years old. PLoS ONE 12:1–11.

Mogre V, Nyaba R, Aleyira S. 2014. Lifestyle risk factors of general and abdominal obesity in students of the School of Medicine and Health Science of the University of Development Studies, Tamale, Ghana. ISRN Obes 508382:1–10.

Monteiro CA, Conde WL, Popkin BM. 2001. Independent effects of income and education on the risk of obesity in the Brazilian adult population. J Nutr 131:881S– 6S.

Nagai M, Komiya H, Mori Y, Ohta T. 2008. Developments in estimating visceral fat area from medical examination data. J Atheroscler Thromb 15:193–98.

Nagendra K, Nandini C, Belur M. 2017. A community based study on prevalence of obesity among urban population of Shivamogga, Karnataka, India. Int J Community Med Public Health 4:96–99.

Naing L, Winn T, Rusli BN. 2006. Practical issues in calculating the sample size for preventive studies. Arch Orofac Sci 1:9–14.

Nalawade S, Prabhu D. 2012. Prevalence of obesity and abdominal obesity in working adults of Mumbai Population. Int J Med Sci 5:52–54.

Paul PJ, Samson R, William A, Akila B, Purty AJ, Bazroy J. 2017. Prevalence and factors associated with hypertension: a community based cross-sectional study among adults in an urban area of Puducherry, South India. Int J Community Med Public Health 4:1620–26.

Peltzer K, Pengpid S. 2018. The prevalence and social determinants of hypertension among adults in Indonesia: a cross-sectional population-based national survey. Int J Hypertens 5610725:1–9.

Prabakaran J, Vijayalakshmi N, Venkatarao E. 2013. Prevalence of hypertension among urban adult population (25–64 years) of Nellore, India. Int J Res Dev Health 1:42–9.

Pradeepa R, Anjana RM, Joshi SR, Bhansali A, Deepa M, Joshi PP, Dhandania VK, Madhu V, Rao PV, GeethaL, Subashini R, Unnikrishnan R, Shukla DK, KaurT, Mohan V, Das AK. 2015. Prevalence of generalized and abdominal obesity in urban and rural Indian-the ICMR-INDIAB Study (Phase-I) [ICMR-INDIAB-3]. Indian J Med Res 142:139–50.

Reddy KS, Prabhakaran D, Shah P, Shah B. 2002. Differences in body mass index and waist: hip ratios in North Indian rural and urban populations. Obes Rev 3:197–202.

Roka R, Michimi A, Macy G. 2015. Associations between hypertension and body mass index and waist circumference in U.S. adults: a comparative analysis by gender. High Blood Press Cardiovasc Prev 22:265–73.

Rouf A, Rasool M, Khan SM S, Haq I, Hamid A, Bashir K, Saleem SM. 2018. Prevalence of hypertension and its association with waist circumference in adult population of Block Hazratbal, Srinagar, India. Ann Med Health Sci Res 8:68–73.

Rurik I, Nagy K, Antal M. 2004. Correlation of anthropometric parameters and blood-pressure in elderly people. Orv Hetil1 45:1237–41.

Sarkar D, Mondal N and Sen J. 2009. Obesity and blood pressure variations among the Bengali Kayastha population of North Bengal, India. J Life Sci 1:35–43.

Siddiquee T, Bhowmik B, Da Vale Moreira NC-DV, Mujumder A, Mahtab H, Khan AKA, Hussain A. 2015. Prevalence of obesity in a rural Asian Indian (Bangladeshi) population and its determinants. BMC Public Health 15:860.

Simon C, Saju CR, Binu J. 2017. Prevalence and risk factors of hypertension among adults aged 25–64 years in a rural area of Thrissur in Kerala. Int J Community Med Public Health 4:1714–21.

Singh HS, Das PK, Mishra PJ, Das1 S, and Bose K. 2014. Prevalence of hypertension among adults of Midnapore, West Bengal, India: A comparison between sexes. Elixir Biosciences 77:29144–47.

Singh S, Shankar R, Singh GP. 2017. Prevalence and associated risk factors of hypertension: a cross-sectional study in urban Varanasi. Int J Hypertens5491838:1–10.

Sobngwi E, Mbanya JCN, Unwin NC, Kengne1 AP, Fezeu L, Minkoulou EM, Aspray TJ, Alberti KGMM. 2002. Physical activity and its relationship with obesity, hypertension and diabetes in urban and rural Cameroon. Int J Obes 26:1009–16.

Sousa TF, Nahas MV, Silva DAS, Duca GFD, Peres MA. 2011. Factors associated with central obesity in adults from Florianópolis, Santa Caterina: a population based study. Rev Bras Epidemiol 14:296–9.

Srinath Reddy K, Shah B, Varghese C, Ramadoss A. 2005. Responding to the

threat of chronic diseases in India. Lancet 366:1744–49.
Sung RY, Yu CC, Choi KC, McManus A, Li AM, Xu SL, Chan D, Lo AF, Chan JC, Fok TF. 2007. Waist circumference and body mass index in Chinese children: cutoff values for predicting cardiovascular risk factors. Int J Obes (Lond) 31:550–58.
Thapliyal V, Singh K and Joshi A. 2018. Prevalence and associated factors of hypertension among adults in rural Uttarakhand: a community based cross sectional study. Curr Res Nutr Food Sci Jour 6:481–90.
Turconi G, Guarcello M, Maccarini L, Bazzano R, Zaccardo A, Roggi C. 2006. BMI values and other anthropometric and functional measurements as predictors of obesity in a selected group of adolescents. Eur J Nutr 45:136–43.
Ulijaszek SJ, Kerr DA. 1999. Anthropometric measurement error and the assessment of nutritional status. Br J Nutr 82:165–77.
Valdez R, Seidell JC, Ahn YI, Weiss KM. 1993. A new index of abdominal adiposity as an indicator of risk for cardiovascular disease. A cross-population study. Int J Obes Relat Metab Disord 17:77–82.
Wang S-K, Ma W, Wang S, Yi X-R, Jia H-Y, and Xue F. 2014. Obesity and its relationship with hypertension among adults 50 years and older in Jinan, China. PLoS ONE 9(12):1–10.
WHO. 1989. Measuring obesity: classification and description of anthropometric data. Report on a WHO consultation on the epidemiology of obesity, Warsaw, 21–23 October 1987. Copenhagen: World Health Organization Regional Office for Europe.
WHO. 1995. Physical status: The use of and interpretation of anthropometry. Report of a WHO Expert Committee. Technical Report Series no. 854. Geneva: World Health Organization.
WHO. 2002. The world health report 2002 – reducing risks, promoting healthy life. Geneva: World Health Organization.
WHO. 2003. Diet, nutrition and the prevention of chronic diseases: Report of the joint WHO/FAO expert consultation. Geneva: World Health Organization.
WHO. 2008. Waist circumference and waist-hip ratio: report of a WHO expert consultation. Geneva: World Health Organization.
WHO. 2011.Waist circumference and waist–hip ratio: report of a WHO expert consultation, Geneva, 8–11 December 2008.
WHO. 2015. Overweightand obesity. Available from: http://www.who.int/gho/ncd/risk_factors/overweight/en/. Accessed on Nov 22, 2018.
WHO. 2016. Obesity and overweight: Fact sheet. Availablefrom: http://www.who.int/mediacentre/factsheets/fs311/en/. Accessed on Nov 22, 2018.
WHO. 2017. Noncommunicable disease: fact sheet. Available from: http://www.who.int/mediacentre/factsheets/fs355/en/. Accessed on May 20, 2019.
WHO/IASO/IOTF. 2000. The Asia-Pacific perspective: redefining obesity and its treatment. Melbourne: Health Communications Australia.
Wu S, Wang R, Jiang A, Ding Y, Wu M, Ma X, Zhao Y, He J. 2014. Abdominal obesity and its association with health-related quality of life in adults: a population-based study in five Chinese cities. Health Qual Life Outcomes 12:1–11.
Yahia N, Achkar A, Abdallah A, Rizk S. 2008. Eating habits and obesity among Lebanese university students. Nutrition 7: 1–6.
Yoon YS, Oh SW, Park HS. 2006. Socioeconomic status in relation to obesity and abdominal obesity in Korean adults: A focus on sex differences. Obesity14:909–19.
Zhang P, Wang R, Gao C, Jiang L, Lv X, Song Y, Li B. 2016. Prevalence of central obesity among adults with normal BMI and its association with metabolic diseases in Northeast China. PLoS ONE 11:1–10.