Original Article

WAIST-TO-HEIGHT RATIO AND SOCIO-DEMOGRAPHIC CHARACTERISTICS OF BANGLADESHI ADULTS

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Abstract

Anthropometric indicators of abdominal obesity are associated with cardiovascular risk factors, such as type 2 diabetes, hypertension, and dyslipidemia. Controversy remains regarding the best anthropometric indices for cardiovascular risk. Waist-to-height ratio has been reported to be an effective predictor of metabolic risks and it may be a better measure of relative fat distribution amongst subjects of different age and statures. Bangladeshi data lack in this perspective. To determine waist-to-height ratio of Bangladeshi adults along with its variation with socio-economic status, cross-sectional studies were conducted in 2002 and 2003. Data were collected through interviewing and measuring height and waist circumference of 22,995 adult males and females of an urban (Mirpur, Dhaka City) and rural area (Kaliganj sub-district). The mean waist-to-height ratio of 0.48 significantly varied with socio-demographic variables and it was markedly higher in females, older age groups, urban residents and the better educated. Urban residents, females, older people, better educational status, the non-paid and married individuals were more likely to have high waist-to-height ratio (≥0.5). High waist-to-height ratio levels using sex-specific cut-offs were more common in females, urban residents, Christians, older individuals, married, the better educated and the non-paid. Age and locality were identified as best predictors in males and females, respectively.

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Key words: Waist-to-height ratio, adult, Bangladeshi

Introduction

Bangladesh is having a double burden of health problems; the occurrence of non-communicable diseases is also increasing in addition to existence and emergence of infectious diseases. Moreover, it faces nutrition transition with over-nutrition and under-nutrition occurring simultaneously. While about a quarter of rural, and lower class urban people have chronic energy deficiency; the prevalence of obesity in the upper and middle class urban people is between 9-11%.[1] It is being increasingly recognised that central, rather than general obesity, is likely to coexist with type 2 diabetes and lead to complications including cardiovascular diseases. Although its importance is acknowledged, no unified definition exists for central obesity; several anthropometric indexes such as waist circumference (WC), waist-hip ratio (WHR), waist-to-height ratio (WHtR), conicity index (Cindex) etc, are being used.[2] These anthropometric indices are associated with cardiovascular risk factors, such as type 2 diabetes, hypertension, and dyslipidemia. However, controversy remains regarding the best anthropometric indices for cardiovascular disease (CVD) risk.[3] WC was the main variable used as a measure of central obesity as it is much simpler and more practical to use and because it associates more strongly with cardio-vascular diseases and is a better predictor of future risk of metabolic diseases.[4] However, WC measurement has been criticized for

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not taking into account differences in body height, and the WHtR value is a better predictor of cardiovascular risk factors.[3] The ratio of waist circumference to height may be a superior measure for women as well as men[5] and a simple index for measuring coronary risk. Waist circumference reflects abdominal obesity, and height is relatively constant in adults and can be used to compensate for variations in frame size.[6] WHtR has been reported to be an effective predictor of metabolic risks and it may be a better measure of relative fat distribution amongst subjects of different age and statures.[7] The index, especially for women, is a better indicator for predicting obesity-related CVD risk factors than other indices.[8]

Although it was thought previously that there might be a sex difference, waist-to-height ratio has been reported to have closer values between men and women than body mass index (BMI) and WC.[5] The distribution of the ratio is broadly similar in both sexes, mean values being only slightly higher in men than women (0.54 ± 0.06 versus 0.51 ± 0.07). Therefore the same boundary value may be applied to both men and women. One particular advantage of using WHtR might be that 'unisex' action levels could be specified.[5] A cut-off of 0.5 of WHtR has been considered as a simple and effective index to identify overweight and normal weight Japanese with higher metabolic risk.[7] Lin *et al.* (2002) suggested WHtR cut-offs of 0.48 and 0.45 in men and women, respectively, as appropriate for defining high risk in Taiwan.[8]

Collection of good quality national data on different indicators of central obesity is needed. So far data available in this regard, are mostly on WC and WHR. In an earlier publication of this study the Cindex of Bangladeshi population is described.[9] The current attempt is to explore WHtR. A small scale study, which was done on rural adults only, provide mean WHtR data of adult male (0.43 ± 0.04) and female (0.44 ± 0.05) Bangladeshi.[10] Therefore, the current study attempted to find out the WHtR of rural as well as urban adults from a large sample.

Materials and methods

This cross-sectional study was undertaken in an urban (Mirpur, Dhaka City) and rural area (Kaliganj sub-district) in 2002 and 2003. Every alternate household which fulfilled the selection criteria (at least one male and one female ≥18 years were available), were recruited. A total of 22,995 adult males and females were interviewed. Anthropometric measurements were taken using validated equipment based on standard procedures.[11] A pre-tested structured questionnaire printed in Bangla was used for data collection. Verbal consent was obtained from every respondent and interviews were held in a private place. Ethical clearance was obtained from the Institutional Ethical Committee.

Subjects were measured wearing minimal attire. All the equipment was checked regularly to minimise random errors. Height was measured to the nearest 0.1 cm with a specially constructed wooden height stand to which a plastic measuring tape was attached. The subject stood without shoes or head gear (cap, ribbon etc) in an upright posture with their head in the Frankfurt plane. Subjects were asked to keep their heels close together with their hands hanging freely by their side, palms facing inwards. The horizontal blade of the stadiometer was gently placed on the crown of the head to take the measurement. A flexible plastic tape was used to measure waist circumference, accurate up to the nearest 0.1cm. Waist circumference was measured at the level mid way between the lowest rib margin and the superior iliac crest on the mid-axillary line in a horizontal plane. The subjects stood erect with abdomen relaxed, the arms at the side and feet together and breathing normally.

The analyses were carried out primarily using the Statistical Package for Social Sciences (SPSS) version 14.0. Univariate statistical tests used to determine the association between exposure and outcome variables included Student t-test and χ^2 test. A result was considered significant at a p value level <0.05 but given the large sample sizes a more stringent cut-off of $p<0.01$, or less, was usually used. In addition because a number of statistical tests were conducted, the Bonferroni correction (α/K, where α is the p value & K is the number of tests used) was used. Effects of exposure variables were also assessed after adjusting for other variables by multivariate analyses.

Results

The mean (SD) waist-to-height ratio was 0.48 (0.07), but there was considerable variation in relation to socio-demographic status (Table 1). Age showed a curvilinear association (3rd order polynomial) with WHtR; WHtR gradually increased with age, ending

Table 1: *Waist-to-Height Ratio in Relation to the Socio-demographic Variables*

Variables	N	Waist-to-Height Ratio		F	p-value	Adjusted for Other Socio-demographic Variables		
		Mean	SD			B	F-change	p-value
Sex								
Male*	10460	0.46	0.05	-38.6[a]	<0.001			
Female	12544	0.49	0.07	1819.5^	<0.001	.035	648.4	<0.001
Total	23004	0.48	0.07					
Age in Years								
<20*	2508	0.44	0.05					
20-29	7359	0.47	0.06			.015		
30-39	4951	0.48	0.06			.040		
40-49	3722	0.49	0.07	257.4†	<0.001	.048	201.7	<0.001
50-59	2249	0.49	0.07			.053		
60-69	1398	0.49	0.08			.059		
70 & above	817	0.47	0.06			.045		
Total	23004	0.48	0.07					
Area								
Rural*	11796	0.47	0.06					
Urban	11208	0.49	0.07	1209.3ˇ	<0.001	.024	631.3	<0.001
Total	23004	0.48	0.07					
Religion								
Islam*	21454	0.48	0.07					
Hinduism	1215	0.47	0.06	16.0ˇ	<0.001	.004	8.3	<0.001
Christianity	333	0.48	0.07			.012		
Total	23002	0.48	0.07					
Marital Status								
Married*	17892	0.48	0.07					
Unmarried	4079	0.45	0.05	10.1ˇ	<0.001	-.008	18.4	<0.001
Widow/ Divorced	1032	0.49	0.09			-.007		
Total	23003	0.48	0.07					
Educational Status								
No Schooling*	6481	0.47	0.07					
1-5 yrs of Schooling	5045	0.48	0.07			.012		
6-10 yrs of Schooling	8070	0.48	0.07	452.9ˇ	<0.001	.024	215.3	<0.001
Higher Secondary +	3403	0.49	0.06			.038		
Total	22999	0.48	0.07					
Occupation								
Non-paid*	11047	0.49	0.08					
Students	1598	0.45	0.05			-.023		
Manual Labourer	575	0.44	0.04			-.022		
Farmer	2661	0.45	0.05	54.1ˇ	<0.001	-.005	27.1	<0.001
Skilled Labourer	887	0.46	0.05			-.014		
Business	2527	0.47	0.06			-.006		
Service/ Professionals	3575	0.48	0.06			-.010		
Total	22870	0.48	0.07					

**Reference Group; [a]t-test before Adjustment ^Age Adjusted; †Sex Adjusted; ˇAge and Sex Adjusted*

in a plateau in the 40-69 age group and falling slightly in the 70+ group; after correcting for sex the trend was more pronounced with greater increments between each age group. Females had higher WHtR than males, before and after, controlling for age effects. Urban residents had, on average, a higher WHtR while Hindus, unmarried individuals and manual labourers had, on average, a lower WHtR. There was a general

Table 2: *Wais- to-Height Ratio Categories Using a Common Cut-off (both sex) in Relation to the Socio-demographic Variables*

Variables	Waist to Height Ratio				Total		χ^2	p-value
	Normal (<0.5)		High (≥0.5)					
	n	%	n	%	n	%		
Area								
Rural	8959	75.9	2837	24.1	11796	51.3		
Urban	6721	60.0	4487	40.0	11208	48.7	676.6	<0.001
Total	15680	68.2	7324	31.8	23004	100.0		
Sex								
Male	8261	79.0	2199	21.0	10460	45.5		
Female	7419	59.1	5125	40.9	19249	54.3	1033.9	<0.001
Total	15680	68.2	7324	31.8	23004	100.0		
Age in years								
<20	2185	87.1	323	12.9	2508	10.9		
20-29	5308	72.1	2051	27.9	7359	32.0		
30-39	3151	63.6	1800	36.4	4951	21.5		
40-49	2215	59.5	1507	40.5	3722	16.2	753.3	<0.001
50-59	1353	60.2	896	39.8	2249	9.8		
60-69	860	61.5	538	38.5	1398	6.1		
70 & above	608	74.4	209	25.6	817	3.6		
Total	15680	68.2	7324	31.8	23004	100.0		
Geometric Mean ±SD	31.59±15.34		35.73±14.23		32.85±15.09		-22.7^	<0.001
Religion								
Islam	14570	67.9	6884	32.1	21454	93.3		
Hinduism	890	73.3	325	26.7	1215	5.3	16.0	<0.001
Christianity	219	65.8	114	34.2	333	1.4		
Total	15679	68.2	7323	31.8	23002	100.0		
Marital Status								
Married	11621	65.0	6271	35.0	17892	77.8		
Unmarried	3455	84.7	624	15.3	4079	17.7	644.3	<0.001
Widow/ Divorced	603	58.4	429	41.6	1032	4.5		
Total	15679	68.2	7324	31.8	23003	100.0		
Educational Status								
No Schooling	4778	73.7	1703	26.3	6481	28.2		
1-5 yrs of Schooling	3471	68.8	1574	31.2	5045	21.9		
6-10 yrs of Schooling	5341	66.2	2729	33.8	8070	35.1	182.3	<0.001
Higher Secondary +	2085	61.3	1318	38.7	3403	14.8		
Total	15675	68.2	7324	31.8	23999	100.0		
Occupation								
Non-paid	6414	58.1	4633	41.9	11047	48.3		
Students	1330	83.2	268	16.8	1598	7.0		
Manual Labourer	546	95.0	29	5.0	575	2.5		
Farmer	2277	85.6	384	14.4	2661	11.6	1315.7	<0.001
Skilled Labourer	706	79.6	181	20.4	887	3.9		
Business	1811	71.7	716	28.3	2527	11.0		
Service/ Professionals	2479	69.3	1096	30.7	3575	15.6		
Total	15563	68.0	7307	32.0	22870	100.0		

^*t-test*

Table 3: *Socio-demographic Predictors of Waist-to-Height Ratio Categories Using a Common Cut-off: Sequential Logistic Regression Analysis Adjusted for the Other Socio-demographic Variables*

Variables	Adjusted for Other Socio-demographic Variables		Odds Ratio	95% CI for Odds Ratio
	χ^2	p-value		
Area				
Rural*	526.0	<0.001		
Urban			2.345	2.178–2.526
Sex				
Male*	529.4	<0.001		
Female			3.537	3.169–3.948
Age in Years				
<20 *				
20-29			1.969	1.705–2.273
30-39			4.338	3.698–5.088
40-49	893.1	<0.001	5.540	4.700–6.530
50-59			6.618	5.540–7.906
60-69			8.065	6.608–9.843
70 & above			6.490	5.118–8.231
Religion				
Islam*				
Hinduism	8.1	ns°	1.112	0.964–1.283
Christianity			1.390	1.078–1.792
Marital Status				
Married*				
Unmarried	45.3	<0.001	0.678	0.593–0.775
Widow/ Divorced			0.779	0.672–0.902
Educational Status				
No Schooling*				
1-5 yrs of Schooling	569.2	<0.001	1.628	1.483–1.787
6-10yrs of Schooling			2.422	2.210–2.655
Higher Secondary +			3.921	3.470–4.430
Occupation				
Non-paid*				
Students			0.511	0.420–0.622
Manual Labourer			0.186	0.125–0.276
Farmer	153.6	<0.001	0.823	0.704–0.962
Skilled Labourer			0.683	0.564–0.872
Business			0.933	0.816–1.066
Service/ Professionals			0.786	0.699–0.883

**Reference group; CI-Confidence Interval; °Bonferroni Corrected*

upward trend in mean WHtR with improvement in educational status.

To see the effect of each socio-demographic variable after controlling for other socio-demographic variables, sequential multiple regression analyses were undertaken. The model was significant ($F = 259.7$; $p < 0.001$) and explained 19.3% variation in WHtR. Strong influences of sex and locality with WHtR remained after adjustment for the other socio-demographic variables and the association with education was more marked. Females, urban residents, married individuals and the non-paid had, on average, higher WHtR than their counterparts, while younger individuals, Muslims, non-educated respondents had lower WHtR, on average.

Waist-to-height ratio was categorised as normal and high based on a cut-off of 0.5 for both sexes. Overall 32% of the sample were found in the high category although the percentages varied widely by socio-demographic variable (Table 2). Females and urban residents were almost twice more likely to have high WHtR. The proportion of high WHtR increased with age up to 40-49 years, then gradually decreased with advancing age. The proportion also increased with educational attainment. Manual labourers, unmarried individuals and Hindus were less likely to have a high WHtR.

Sequential logistic regression analyses were undertaken to see the effect of each socio-demographic variable on WHtR levels after correcting for the other socio-demographic variables. The analyses revealed significant associations with all socio-demographic variables except for religion (Table 3). The odds ratio showed that urban residents were 2.3 times and females 3.5 times more likely to have a higher WHtR than their counterparts. The likelihood of high WHtR increased with age and educational attainment. The non-paid and married individuals were more likely to have high WHtR levels than other occupations and marital groups. When all the variables were entered together into a binary logistic regression analysis the model was highly significant ($\chi^2 = 4014.8$; $p < 0.001$; Nagelkerke $R^2 = .225$); overall 73.5% of WHtR level was correctly classified but there was imbalance in the model with 89.9% of normal WHtR correctly predicted but only 38.5% of high WHtR. A forward logistic regression analysis revealed that the most significant predictors of WHtR levels were occupation and locality.

Table 4: *Waist-to-Height Ratio Categories Using Sex-specific Cut-offs in Relation to the Socio-demographic Variables*

Variables	Waist to Height Ratio*				Total		χ^2	p-value
	Normal		High					
	n	%	n	%	n	%		
Area								
Rural	6536	55.4	5260	44.6	11796	51.3		
Urban	4777	42.6	6431	57.4	11208	48.7	376.0	<0.001
Total	11313	49.2	11691	50.8	23004	100.0		
Sex								
Male	7328	70.1	3132	29.9	10460	45.5		
Female	3989	31.8	8559	68.2	19249	54.3	3345.8	<0.001
Total	11313	49.2	11691	50.8	23004	100.0		
Age in years								
<20	1674	66.7	834	33.3	2508	10.9		
20-29	3680	50.0	3679	50.0	7359	32.0		
30-39	2306	46.6	2645	53.4	4951	21.5		
40-49	1505	40.4	2217	59.6	3722	16.2	512.4	<0.001
50-59	991	44.1	1258	55.9	2249	9.8		
60-69	657	47.0	741	53.0	1398	6.1		
70 & above	500	61.2	317	38.8	817	3.6		
Total	11313	49.2	11691	50.8	23004	100.0		
Geometric Mean ±SD	31.73±15.77		33.97±14.36		32.85±15.09		-12.9^	<0.001
Religion								
Islam	10516	49.0	10938	51.0	21454	93.3		
Hinduism	651	53.6	564	46.4	1215	5.3	13.9	0.001
Christianity	145	43.5	188	56.5	333	1.4		
Total	11312	49.2	11690	50.8	23002	100.0		
Marital Status								
Married	8180	45.7	9712	54.3	17892	77.8		
Unmarried	2756	67.6	1323	32.4	4079	17.7	704.5	<0.001
Widow/ Divorced	376	36.4	656	63.6	1032	4.5		
Total	11312	49.2	11691	50.8	23003	100.0		
Educational Status								
No Schooling	3390	52.3	3091	47.7	6481	28.2		
1-5 yrs of Schooling	2512	49.8	2533	50.2	5045	21.9		
6-10 yrs of Schooling	3897	48.3	4173	51.7	8070	35.1	60.5	<0.001
Higher Secondary +	1509	44.3	1894	55.7	3403	14.8		
Total	11308	49.2	11691	50.8	23999	100.0		
Occupation								
Non-paid	3670	33.2	7377	66.8	11047	48.3		
Students	1017	63.6	581	36.4	1598	7.0		
Manual Labourer	503	87.5	72	12.5	575	2.5		
Farmer	2054	77.2	607	22.8	2661	11.6	2665.9	<0.001
Skilled Labourer	577	65.1	310	34.9	887	3.9		
Business	1525	60.3	1002	39.7	2527	11.0		
Service/ Professionals	1886	52.8	1689	47.2	3575	15.6		
Total	11232	49.1	11638	50.9	22870	100.0		

**Waist to Height Ratio Cut-offs: 0.48 for men and 0.45 for women; ^t-test*

Table 5: *Socio-demographic Predictors of Waist-to-Height Ratio Categories Using Sex-specific Cut-offs: Sequential Logistic Regression Analysis Adjusted for the Other Socio-demographic Variables*

Variables	Adjusted for Other Socio-demographic Variables		Odds Ratio	95% CI for Odds Ratio
	χ^2	p-value		
Area				
Rural*	227.6	<0.001		
Urban			1.733	1.613–1.863
Sex				
Male*	1694.4	<0.001		
Female			7.898	7.110–8.774
Age in Years				
<20 *	595.1	<0.001		
20-29			1.720	1.527–1.938
30-39			3.156	2.746–3.628
40-49			4.038	3.490–4.672
50-59			4.204	3.583–4.932
60-69			5.283	4.403–6.340
70 & above			4.394	3.551–5.437
Religion				
Islam*	13.6	0.001		
Hinduism			1.050	0.919–1.200
Christianity			1.609	1.242–2.085
Marital Status				
Married*	56.4	<0.001		
Unmarried			0.732	0.651–0.823
Widow/ Divorced			0.667	0.575–0.775
Educational Status				
No Schooling*	496.0	<0.001		
1-5 yrs of Schooling			1.413	1.292–1.544
6-10yrs of Schooling			2.024	1.854–2.209
Higher Secondary +			3.621	3.210–4.084
Occupation				
Non-paid*	146.4	<0.001		
Students			0.602	0.508–0.714
Manual Labourer			0.342	0.258–0.454
Farmer			0.954	0.829–1.098
Skilled Labourer			0.896	0.751–1.069
Business			1.178	1.036–1.340
Service/ Professionals			1.118	0.997–1.253

* *Reference group; CI-Confidence Interval*

WHtR was also categorised using sex-specific cut-offs (male 0.48 and female 0.45) and half of the sample were found to have high WHtR. Considerable heterogeneity was observed in the WHtR categories in relation to the socio-demographic variables (Table 4). Females, urban residents, the better educated, older individuals, widows/divorcees, the non-paid and Christians were more likely to have a high WHtR.

After correcting for the other socio-demographic variables by sequential logistic regression analyses, an association of WHtR with each socio-demographic variable remained. The odds ratio presented in Table 5 revealed that females were almost 8 times more likely to have a higher WHtR than males. High WHtR was more likely to occur in urban residents, Christians, older individuals, married, the better educated and the non-paid. The model correctly predicted 64.2% of the normal and 76.6% of the high WHtR and overall 70.5% were correctly predicted by the model (χ^2 = 5643.0; $p<0.001$; Nagelkerke R^2 = .292). A forward logistic regression analysis found that sex and age group were the best predictors of WHtR categories. The analyses were repeated for each sex separately and in males, age and educational status, and in females, locality and age, were the best predictors of WHtR categories.

Discussion

Vague was the first to observe that women with android obesity had a high prevalence of diabetes and atherosclerosis.[12] Subsequent studies have shown that abdominal obesity, as measured by the waist circumference or related indexes, is associated with the subsequent development of type 2 diabetes[13-16] and ischemic heart disease[17-19] as well as with risk factors for CVD.[20]

The waist-to-height ratio was first used in the Framingham Study[21] and subsequently other studies[7, 22] have concluded that this ratio is more strongly

Table 6: *Comparison of Mean BMI, WC, WHtR and Cindex between the Current and Other Asian Studies*

Studies	Male	Female	Sample characteristics
Lin *et al.*, 2002	0.48±0.05	0.45±0.05	Taiwanese Adults
Sayeed *et al*, 2003	0.43±0.04	0.44±0.05	Rural Bangladeshi Adults
Goh *et al.*, 2004	0.50±0.002	0.47±0.002	30-70 years old Adults of Singapore
Ghosh & Bandyopadhyay, 2006	0.49±0.06		Bengali Indian Adult Hindu Male
Current Study	0.46±0.05	0.49±0.07	Rural and Urban Bangladesh Adults

associated with CVD risk factors than the body mass index (BMI; in kg/m²). In addition, waist-to-height ratio may be simpler to use and the same cutoff (e.g., 0.5) could possibly be used to identify adverse measures of waist-to-height ratio among both children and adults,[23,24] which would simplify the expression of obesity-related disease risk. However, relatively few studies have examined the relation of waist-to-height ratio to CVD risk factors, and it is important to examine these associations in other data.

The advantages of WHtR were listed by Hsieh *et al.* (2003): "(1) closer agreement of values between men and women at all ages; (2) more accurate tracking of fat distribution and accumulation by age; (3) closer correlation with morbidity index for coronary risk factors; (4) more comprehensive identification of overweight individuals and those of normal weight facing higher risks (5) greater simplicity, in that a single rule (keep your waist circumference below half your height) may be applied both for men and women, enabling busy physicians and other professionals to screen and counsel examinees who face higher metabolic risks during physical examinations". In this way, the index can serve as a 'second stethoscope'.[25]

Hsieh & Muto (2005) explained the practicality of this ratio for screening non-obese people at a higher risk by: (i) existence of higher correlation coefficient between WHtR and the sum of coronary risk factors other than anthropometric indicators; (ii) height had a negative independent effect on the sum of coronary risk factors; (iii) WHtR of 0.5 identified more people at risk and had higher sensitivity in identification of clustering of coronary risk factors than other proposed anthropometric indices in both genders.[7] Yasmin & Masci-Taylor (2000) suggested that WHtR might be an important indicator in predicting risk and could be used routinely for purposes of health education and in large scale epidemiologic studies.[26] WHtR may be globally applicable as well, as the index may be effective in observation of fat distribution and related metabolic risks from childhood to old age.[25] People who have a prominently large WC might have needs for reducing WC for health risks irrespective of their height. But short people with moderate WC should be more attentive than tall people with similar WC.[27]

Adult anthropometric data in Bangladesh cover weight and BMI and most nutrition research has focused on under-nutrition, particularly among women and children. BMI does not give any indication of the distribution of weight in the body. Anthropometric indicators of abdominal obesity estimate the amount of visceral fat tissue which, in turn, is associated with a higher risk of development of cardiovascular diseases. So, waist circumference, waist–to-height ratio as well as conicity index were also used in order to provide some notion of central obesity. However, WC, a much studied indicator and Cindex did not show high predictive accuracy. The current study focused on this important but relatively less used indicator. The overall mean WHtR in the current study was 0.48 mean which is comparable with other Asian studies as shown in Table 6 with mean values in the current study within the Asian range. The average WHtR was higher in females suggesting consistency with the findings of Sayeed *et al.*[10] The overall WHtR seems higher than the previous Bangladeshi data because that study was done in rural samples which were lower than urban residents. The current study supports this idea showing higher WHtR in urban residents. Overall 19% of the variation in WHtR were explained by socio-demographic variables, and the main predictors were locality, age, and education.

In studies conducted in Brazil by Pitanga & Lessa[28] and Almeida *et al.*[29] suggested 0.53 and 0.55, respectively as the best cut-off point for WHtR. The cut-off point for Mexican women was similar to that which ranged from 0.53 to 0.535 for WHtR to discriminate type-2 diabetes, hypertension and dyslipidemias. Asian studies show lower cut-off values. A cut-off of 0.5 of WHtR was found in Japanese[7] and 0.48 and 0.45 in Taiwanese men and women,[8] the cut-off for women was proposed at 0.50 in China[30] and 0.48 in Singapore.[31]

The current study used both Japanese[7] and Taiwanese[8] cut-offs to detect high WHtR. About 32% and half of the samples respectively were identified as high WHtR using cut-off of 0.5 for both sex and sex-specific cut-off. Urban residents, females, older people, better educational status, the non-paid were more likely to have a high WHtR. Occupation followed by locality (for WHtR $\geq$0.5) and sex followed by age (for WHtR $\geq$0.48 for men and $\geq$0.45 for women) were the best predictors. Age and locality were identified as best predictors in males and females, respectively. No such data were available to compare with.

One third to half of the adults were with high WHtR. Specific preventive measure is required to prevent metabolic diseases. The variation in the cut-off value across different population recommends further study to identify cut-off values for the Bangladeshi population. For a national cut-off point the socio-demographic differentials need to be considered.

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