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Association of Anthropometric Indices with Cardiometabolic Risk Factors in Adult Bangladeshi Population

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Abstract

Background and Objectives: Excess fat in body badly contributes to diverse health hazards particularly to develop multiple chronic diseases including diabetes, hypertension, stroke etc. This study examined the association of anthropometric measures related to excess body fat such as body-mass-index (BMI), waist-hip ratio (WHR), waist-height-ratio (WHtR) with cardiometabolic risk factors such as hypertension, diabetes and dyslipidemia among adult mass population in Bangladesh.

Methods: A large scale cross-sectional study was carried out during August-November, 2017 among the patients (male 644, female 556), who didn't have any major illness, visiting the outpatient department of a tertiary level government hospital in capital Dhaka city. To examine the association between metabolic profile and anthropometric indices two-sample t-test and multivariable logistic regression were performed separately for each risk factor and combination of them (none, 1, 2+ risk factors) after adjusting for the effect of age and sex. Further area under the receiver operating characteristics (ROC) curve was used to assess the performance of the indices in predicting cardiometabolic risks.

Results: All these indices are found to be significantly associated with each of the risk factors. Of them, very strong positive association of WHtR with hypertension (OR: 1.39 with 95% CI: 1.05-3.93) and WHR with dyslipidemia (OR:1.79 with 95% CI: 1.19-3.32) were found. Similar findings were observed when the predictive performance was assessed with the estimated area under the ROC curve. Furthermore, all these indices showed stronger association of having more than one risk factors compared to those having only one risk factor. Of them, the WHR showed relatively stronger association having both one (OR: 2.53 with 95% CI: 1.13-7.19) and multiple risk factors (OR: 3.11 with 95% CI: 1.74-5.44).

Conclusions: Findings suggest that making a balance in the measurement of all anthropometric indices is essential to reduce the risk of cardiometabolic risks. Therefore, urgent policies and programs should be initiated to make the people aware of keeping control bodyweight and excess fat.

Keywords: Anthropometric Measures; Cardiometabolic Risk; Body Fat; Odds Ratio, ROC Curve

Introduction

Non-communicable diseases (NCDs) are playing a significant role in clinical and public health problems worldwide. Although chronic energy deficiency and infectious diseases are highly prevalent, 41% of the disease burden and 52% of the total mortality are due to non-communicable diseases excluding injury [1-3]. Among the NCDs, cardiovascular diseases (CVDs) such as stroke, kidney failure, and heart disease are considered as major contributors of the NCD related deaths [4,5]. Hypertension and diabetes are two major metabolic risk factors of NCDs. Diabetes is an increasing epidemic which is projected to increase from 240 million in 2007 to 380 million in 2025, of which 80% patients belong to low and middle income countries [6]. More than 60% of the diabetic patients live in South Asia Pacific region, particularly in South Asia [7,8].The prevalence of hypertension has been rapidly increasing in developing countries such as India, China, Nepal and Bangladesh [9-12]. According to the World Health Organization, more than 35%of adult population in South Asia are affected by hypertension [7].

Bangladesh is one of the developing countries in South Asia, which has been experiencing an epidemiological transition from communicable diseases to NCDs [13-15] due to fast urbanization, unhealthy diet, sedentary life style, increased use of tobacco consumption, excess alcohol intake and so on [16,17]. Some recent studies and systematic reviews of studies between 1995 and 2000 reported a pooled estimate of 14% for hypertension prevalence [18]. Another systematic review and meta-analysis of the studies during 1995-2013 on diabetes prevalence [13] stated that the prevalence of diabetes ranges between 4.5% and 35.0% with the pooled prevalence of 7.4%.

A number of studies reported that overweight and obesity are well recognized predictors of cardiometabolic risks due to its close association with increased prevalence of hypertension, diabetes mellitus and dyslipidemia [19-21]. Central obesity, suggesting excess intra-abdominal fat deposition is also an important predictor of cardiometabolic risks [22]. Although there are several instruments to measure total body fat and its distribution, there is still no diagnostic definitions that would be regarded as accurate, precise, detailed and accepted worldwide determining obesity [21]. Body Mass index (BMI), waist circumference (WC), waist Hip Ratio (WHR), Waist Height Ratio (WHtR) are all useful anthropometric measurements that provide major information on obesity and therefore on cardiometabolic risks [23].

Due to lack of exact methods for assessing body composition directly, anthropometrics are often used as surrogates for assessing obesity and body fat distribution [24]. Body mass index (BMI) is the most commonly used anthropometric index and gives information on fat mass and lean mass [21]. Some studies have suggested waist-hip ratio (WHR) as an important anthropometric index to predict CVD risk and metabolic syndrome [20]. One prospective study reported that hip circumference (HC) is inversely associated with diabetes, CVD morbidity and mortality [25]. In another study, Onat et al. stated that both WC and WHR had strong association with BMI, age, diastolic blood pressure and plasma triglyceride (TG), and WHR was significantly associated with prevalence of CHD in Turkish women [26].

Given the high risk of cardiovascular diseases in Bangladeshi adult population, very limited studies, to the best of our knowledge, were performed to examine the association of anthropometric measurements with cardiometabolic risk factors among mass population in Bangladesh. A few studies were performed for a specific group or region and hence findings from them cannot be generalized to general population of Bangladesh. This study focuses on general population of Bangladesh based on data collected in an outpatient department of the tertiary level government hospital under the Bangabandhu Sheikh Mujib Medical University (BSMMU) where people from diverse socio-economic groups, ethnic community and various regions of the country come, because of its cost-effective quality medical service. Therefore, findings of this study will reflect the true picture of the general population of Bangladesh and help the stakeholders to design urgent appropriate policies and programs for preventing and reducing the risks of CVDs.

Materials and Methods

Study population and Design

Data for this study obtained from a cross-sectional survey with structured questionnaire among the adult individuals attending outpatient department (OPD) of the BSMMU for providing blood sample for diagnostic test prescribed by a doctor from the same hospital or other different clinics during the period from August, 2017 to November, 2017. The diagnostic test services in OPD of the BSMMU is open for all patients either admitted in the same hospital of the BSMMU or from other clinics/private chamber run by a doctor and has been served by qualified technicians who were informed in advance about selection of patients for this study. The technicians selected those patients who reported about their fasting for 12 hours over the night and referred to the enumerators (a group of physicians who involved as co-researchers in this study). A total of 1250 adult subjects aged 20 to 65 years who did not reported to have any major illness (acute myocardial infarction and transient ischaemic attack in last 3 months, malignancy, pregnancy, or any condition of weight gain like ascites, hypothyroidism, nephrotic syndrome etc.) participated in the study. Of them, 50 subjects who had missing observation for some important variables were excluded from the analysis and hence data on a total of 1200 subjects (male:644 and female: 556) were used for analysis.

Data collection and measuring the variables

Information about lifestyle, habits, education, physical activity, monthly family income and past medical history were obtained through face to face interview with structured questionnaire conducted directly by a group of physicians who involved as co-researchers in this study. Body weight was measured with a standard scale while dressed in very light clothing without shoes, and height was measured by using a height bar fixed on the wall, with subjects standing without shoes with back, buttocks, and heals pressed together against the wall. Then BMI was calculated as weight (kilograms) divided by squared height (meters squared). Waist circumference (WC) was measured at the midpoint between the last rib and the superior iliac crest during mild expiration and hip circumference (HC) was measured at the level of the greater trochanter. In addition, both waist to hip ratio (WHR) and waist to height ratio (WHtR) were also used in the analysis. After at least 5 minutes of sitting, blood pressure (BP) was measured twice 5 min apart using a standard sphygmomanometer with the participants seated. Then mean value of two readings measured was used. For measuring diabetes, overnight fasting (9-12 hours) blood samples were collected from study subjects to estimate the serum glucose and lipid profile. Fasting serum glucose was measured by hexokinase method using the Architect system. Serum cholesterol was measured by enzymatic method on Beckman coulter AU analyser. Serum HDL-C was measured by enzymatic color-test for quantitative determination of HDL done by Beckman Coulter analyser. Serum triglyceride was measured by enzymatic Glycerol Phosphate Oxidase method by using the by Beckman Coulter analyser.

Diagnosis of Diabetes, Hypertension and Dyslipidemia

Diabetes was defined as fasting blood glucose (FBG) values of ≥ 7.0 mmol/L, or self-reported diabetes medication use prior to the interview date [27]. Hypertension was defined as if the blood pressure values were systolic blood pressure (SBP) ≥ 140 mmHg or diastolic blood pressure (DBP) ≥ 90 mmHg, or if they reported currently taking antihypertensive medication [28]. Dyslipidemia was defined as serum total cholesterol ≥ 200mg/dL (5.17mmol/l), and/or triglyceride ≥ 150mg/dL (1.7mmol/l) and/or high density lipoprotein cholesterol <40mg/dL (1.03 mmol/l).

Statistical analyses

Continuous variables were summarized in terms of mean and standard deviation while the categorical variables were summarized in terms of percentage as part of univariate analysis. To examine the association of each anthropometric variable with the cardiovascular risk factors such as diabetes, hypertension and dyslipidemia, two independent sample t-test was performed separately for each risk factor and ANOVA F-test was performed for the status of the presence of the risk factors (none, 1, 2+). Further, multivariable logistic regression model was fitted separately for each risk factor to examine the association of the anthropometric variables with the outcome (risk factors) after adjusting for the effect of demographic variables such as age and sex. Finally, the area under the receiver operating curve (AUC) was estimated to assess the performance of the anthropometric variables for predicting cardiovascular risks. All these analyses were conducted using statistical software Stata version 14.

Results

Table 1 shows summary statistics (mean and SD) of the anthropometric, clinical and demographic characteristics of the study participants. The mean age of participants is 39.64yrs (SD=12.67) with almost no difference between male and female. Male had greater mean of weight, height, WHR and TG value than female, while BMI, WC, HC, WHtR, total cholesterol, HDL, LDL and fasting blood glucose level were found to be less in male than in female. Table 2 shows participants having only hypertension, diabetes and dyslipidemia is 26.55%, 27.6% and 83% respectively. With respect to combination of these risk factors, 11.3%, subjects have had none of these risk factors, while it is 50.2% have had one risk factor and 38.5% had 2 or more risk factors.

Table 1: Summary Statistics of variables under study

	Male (N=644)		Female(N=556)		Both (N=1200)	
	Mean	SD	Mean	SD	Mean	SD
Age (Yrs)	39.89	12.16	39.34	11.08	39.64	11.67
Height (cm)	164.00	6.56	152.09	7.91	158.54	9.34
Weight(kg)	69.39	10.73	63.55	11.91	66.71	11.65
BMI (kg/m^2)	25.82	3.89	27.54	5.15	26.61	4.59
WC(cm)	91.64	9.27	93.63	10.69	92.55	9.99
HC(cm)	98.00	8.37	100.80	10.45	99.28	9.48
WHRatio	0.94	0.05	0.93	0.07	0.93	0.06
WHt Ratio	0.56	0.06	0.617	0.08	0.58	0.07
TC (mg/dl)	192.29	49.78	193.67	44.27	192.92	47.30
HDL (mg/dl)	37.87	10.39	43.40	14.40	40.42	12.70
LDL (mg/dl)	119.74	44.20	119.27	36.38	119.52	40.74
TG (mg/dl)	182.45	101.22	157.23	91.67	170.85	97.72
FBS(mmol/L)	5.84	2.47	6.17	3.10	5.99	2.78

Table 2: Distribution of the subjects with the status of each risk factors and their combinations

Risk factors	Status	N	Percent
Hypertension	no	882	73.5
	yes	318	26.5
Diabetes	no	869	72.4
	yes	331	27.6
Dyslipidemia	no	204	17
	yes	996	83
Combinations of the above factors	none	136	11.3
	1	602	50.2
	2+	462	38.5

The separate bivariate analysis (Table 3) for male and female showed that the variable age, weight, BMI, waist circumference, waist hip ratio and waist height ratio were related to the occurrence of diabetes mellitus (p-value <0.05). In case of combined data, all these indices were found to be significantly associated with the diabetes, except for height and hip circumference. Regarding hypertension, in both male and female group, except for height all other indices were found to be significantly associated (p value <.05). Similar findings were observed in the combined data (Table 4). In case of dyslipidemia, for male, weight, BMI, HC, WHR and WHtR showed significant association with the outcome (p <0.01 in case of weight, BMI and HC and p<0.05 in case of WH ratio). For female stratum, only WHR is significantly associated with dyslipidemia (p-value<.01). For combined data, except for age and WC, all indices are significantly associated the cardiovascular risk factors (Table 5). Similar results were observed (Table 6) when all these indices were summarized by the status of the presence of any of these risk factors (none, any one, 2 or more).

Table 3: Summary statistics of anthropometric variables by status of diabetes and gender

Gender	Status of diabetes	Sum. Stat.	Age (Yrs)	Height (cm)	Weight (kg)	BMI (kg/m²)	WC (cm)	HC (cm)	WH Ratio	WHtR
	non-diab	Mean	37.1	164.1	69.4	25.8	90.7	97.7	0.93	0.55
Male		SD	11.17	6.28	10.68	3.87	9.28	8.48	0.05	0.06
	Diab	Mean	48.03	163.72	71.21	26.84	94.32	98.72	0.95	0.57
		SD	11.19	7.32	10.92	3.98	8.74	8.00	0.05	0.06
		P-value	<0.01	0.531	<0.05	<0.05	<0.01	0.19	<0.01	<0.01
	non-diab	Mean	36.5	152.4	63.9	27.6	92.9	100.8	0.92	0.61
Female		SD	10.42	7.80	11.90	5.11	10.71	10.27	0.07	0.08
	Diab	Mean	46.1	151.6	64.7	28.5	95.4	100.7	0.95	0.63
		SD	9.62	8.12	11.92	5.26	10.48	10.90	0.07	0.07
		P-value	<0.01	0.111	<0.01	<0.05	<0.05	0.82	<0.01	<0.01
	non-diab	Mean	36.8	158.9	66.9	26.6	91.7	99.1	0.9	0.57
Both		SD	10.84	9.09	11.56	4.55	9.99	9.45	0.06	0.07
	diab	Mean	47.07	157.62	68.02	27.63	94.86	99.68	0.95	0.60
		SD	10.47	9.92	11.86	4.71	9.63	9.57	0.06	0.07
		P-value	<0.01	<0.05	<0.01	<0.05	<0.01	0.32	<0.01	<0.01

Table 4: Summary statistics of anthropometric variables by status of hypertension and gender

Gender	Status of HT	Sum. Stat.	Age (yrs)	Height (cm)	Weight(kg)	BMI (kg/m²)	WC (cm)	HC (cm)	WH Ratio	WHt Ratio
	non-HT	Mean	37.21	163.94	68.84	25.64	90.60	97.45	0.93	0.55
Male		SD	11.08	6.52	10.74	3.91	9.06	8.31	0.05	0.05
	HT	Mean	47.25	164.14	72.90	27.33	94.49	99.47	0.95	0.57
		SD	11.99	6.69	10.58	3.81	9.27	8.36	0.05	0.05
		P-value	<0.01	0.72	<0.05	<0.05	<0.01	<0.01	<0.01	<0.01
	non-HT	Mean	36.52	152.34	63.07	27.23	92.28	100.02	0.92	0.61
Female		SD	10.47	7.81	11.43	5.00	10.54	10.19	0.07	0.07
	HT	Mean	47.22	151.39	65.89	29.38	97.33	102.94	0.95	0.64
		SD	8.70	8.15	13.07	5.48	10.25	10.89	0.07	0.07
		P-value	<0.01	0.21	<0.05	<0.05	<0.01	<0.05	<0.01	<0.01
	non-HT	Mean	36.89	158.63	66.20	26.36	91.37	98.63	0.93	0.58
Both		SD	10.80	9.19	11.42	4.51	9.80	9.30	0.06	0.07
	HT	Mean	47.23	158.28	69.14	28.27	95.79	101.06	0.95	0.60
		SD	10.59	9.75	12.15	4.76	9.82	9.74	0.06	0.07
		p-value	<0.01	0.53	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

Table 5: Summary statistics of anthropometric variables by status of dyslipidemia and gender

Gender	Status of Dys	Sum. Stat.	Age (yrs)	Height (cm)	Weight (kg)	BMI (kg/m²)	WC (cm)	HC (cm)	WHR	WHtR
	non-dys	Mean	37.97	163.20	63.94	24.04	87.72	95.28	0.92	0.54
Male		SD	12.68	6.38	10.21	3.86	9.92	7.95	0.06	0.06
	Dys	Mean	40.14	164.10	70.11	26.06	92.16	98.35	0.94	0.56
		SD	12.07	6.58	10.60	3.84	9.07	8.36	0.05	0.06
		P-value	0.14	0.26	<0.01	<0.01	<0.01	<0.01	<0.05	<0.01
	non-dys	Mean	36.15	153.11	63.73	27.23	91.68	100.87	0.91	0.60
Female		SD	10.90	6.92	13.33	5.63	12.45	11.10	0.07	0.08
	Dys	Mean	40.32	151.77	64.50	28.63	94.23	101.78	0.94	0.62
		SD	10.97	8.18	11.45	5.00	10.04	10.26	0.07	0.07
		P-value	<0.01	0.09	0.13	0.16	<0.05	0.24	<0.01	<0.01
	non-Dys	Mean	36.82	156.82	63.81	26.05	90.22	97.80	0.91	0.58
Both		SD	11.59	8.30	12.25	5.27	11.71	10.39	0.07	0.08
	Dys	Mean	40.22	158.89	67.32	27.72	93.03	99.38	0.94	0.59
		SD	11.61	9.50	11.44	4.43	9.54	9.28	0.06	0.07
		P-value	<0.01	<0.01	<0.01	<0.05	<0.01	<0.05	<0.01	<0.01

Table 6: Summary statistics for of anthropometric variables by presence of risk factors and gender

Gender	Risk factors	Sum Stat.	Age (yrs)	Height (cm)	Weight (kg)	BMI (kg/m²)	WC (cm)	HC (cm)	WHR	WHtR
	none	mean	33.85	163.29	63.38	23.83	85.61	94.34	0.91	0.52
		SD	11.19	6.80	10.69	4.11	10.30	8.66	0.06	0.06
Male	1	mean	36.15	164.05	69.50	25.85	90.67	97.62	0.93	0.55
		SD	10.51	6.42	10.47	3.82	8.78	8.30	0.05	0.06
	2+	mean	46.55	164.06	70.41	26.17	94.24	99.27	0.95	0.57
		SD	11.65	6.73	10.77	3.85	8.97	8.17	0.05	0.06
		P-value	<0.01	0.74	<0.01	<0.01	<0.01	0.87	<0.01	<0.01
	none	mean	31.86	153.54	62.30	26.40	89.69	99.28	0.90	0.58
		SD	8.22	6.54	12.56	4.95	12.00	10.61	0.06	0.08
Female	1	mean	36.06	152.43	64.36	27.78	92.73	100.86	0.92	0.61
		SD	10.34	7.73	11.35	5.04	10.10	10.12	0.07	0.08
	2+	mean	46.10	151.10	63.16	27.72	96.25	101.34	0.95	0.64
		SD	9.14	8.52	12.24	5.32	10.18	10.75	0.06	0.07
		P-value	<0.01	<0.05	0.31	0.08	<0.01	0.65	<0.01	<0.01
	none	mean	32.57	156.98	62.68	25.49	88.23	97.52	0.90	0.56
		SD	9.39	8.10	11.90	4.81	11.55	10.20	0.06	0.08
Both	1	mean	36.11	159.32	67.41	26.64	91.51	98.95	0.93	0.58
		SD	10.43	9.01	11.12	4.46	9.39	9.22	0.06	0.07
	2+	mean	46.33	157.98	67.00	26.90	95.18	100.24	0.95	0.60
		SD	10.53	10.00	12.03	4.66	9.60	9.51	0.06	0.07
		P-value	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

Table 7 summarizes the results of the multivariable logistic regression analysis separately for each risk factor. In case of age, the odds of having hypertension in people of age group 40-50 yrs is 3.98 times of the odds in subjects with 18-39 yrs (p-value<0.01) and 9.27 times of the odds in subjects with 50+ yrs age (p-value<0.05). Similar results can be observed for diabetes and dyslipidemia. Comparing with male, female participants are 14% less likely to have hypertension. BMI is positively associated with hypertension with 6% greater odds for every one unit increase of BMI (p-value<0.01). Again, 1% greater odds of having diabetes and 5% greater odds of having dyslipidemia for every one unit increase in BMI. For WHR, 7% greater odds of having hypertension for one additional unit of WHR (p-value<0.05), which is 11% in case of diabetes and 3% in case of dyslipidemia. For WHtR, the odds of having hypertension, diabetes and dyslipidemia are respectively 39%, 1% and 3% greater for addition one unit of WHtR. Table 8 shows the estimated AUCs for predicting the risk of hypertension, diabetes and dyslipidemia by BMI, WHR and WHtR for different age groups and gender. The estimated AUC for the combined effect of all these covariates for predicting the risk of hypertension is reported to 0.76 with 95% CI (0.73-0.79). Of these covariates, higher age group (50+ yrs) is reported to have greater predictive value, which is followed by WHtR and WHR. Similar pattern was observed in predicting the risk of diabetes. However, slightly different pattern was observed for dyslipidemia with relative lower predictive value by the combined effect of the covariates. Of them, WHR showed greatest predictive value, which is followed by sex. Table 9 shows adjusted relative risk ratio obtained from fitting multinomial logistic model for number of risk factors. All the indices and sex have significant association with one of the risk factors, and age along with all indices and sex has showed significantly associates with 2 or more cardiovascular risk factors. In particular, for every unit increase of BMI value there is 9% increase in relative risk of developing one of the risk factors (p-value <.01). In case of WHR, relative risk is found to be 3.11 times higher with each additional unit (p-value <0.05). Similar findings can be observed for WHtR.

Table 7: Adjusted OR from multivariable logistic regression model for each risk factor separately

	Hypertension		Diabetes		Dyslipidemia	
Variables	**OR**	**[95% CI]**	**OR**	**[95% CI]**	**OR**	**[95% CI]**
Age						
18-39 yrs	RC					
40-50 yrs	3.98*	[2.76, 5.74]	3.36*	[2.35, 4.79]	1.22	[0.81, 1.84]
50+ yrs	9.27*	[6.43, 13.36]	7.32*	[5.16, 10.41]	1.21	[0.78, 1.86]
Sex	0.84	[0.63, 1.14]	1.20	[0.90, 1.61]	0.40*	[0.29, 0.56]
BMI	1.06*	[1.03, 1.09]	1.01**	[1.00, 1.32]	1.05**	[1.01, 1.09]
WHR	1.07**	[1.01, 2.69]	1.11**	[1.03, 2.46]	1.79*	[1.19, 3.32]
WHtR	1.39*	[1.05, 3.93]	1.08*	[1.02, 2.85]	1.03**	[1.01, 1.57]
Intercept	0.02	[0.00, 0.20]	0.01	[0.00, 0.07]	0.04	[0.00, 0.48]

S*p<0.01, **p<0.05, RC=reference category

Table 8: Area under the ROC curve (AUC) for each of the predictors and their combination against each risk factor separately

	Hypertension		Diabetes		Dyslipidemia	
Variables	**AUC**	**[95% CI]**	**AUC**	**[95% CI]**	**AUC**	**[95% CI]**
Age						
18-39 yrs	RC					
40-50 yrs	0.55	[0.52, 0.57]	0.54	[0.52, 0.57]	0.51	[0.48, 0.54]
50+ yrs	0.66	[0.64, 0.70]	0.66	[0.63, 0.69]	0.53	[0.50, 0.56]
Sex	0.52	[0.50, 0.54]	0.53	[0.50, 0.56]	0.60	[0.56, 0.64]
BMI	0.56	[0.53, 0.60]	0.52	[0.50, 0.55]	0.56	[0.51, 0.61]
WHR	0.60	[0.56, 0.64]	0.63	[0.60, 0.67]	0.61	[0.57, 0.66]
WHtR	0.62	[0.58, 0.65]	0.60	[0.57, 0.64]	0.55	[0.51, 0.60]
Combined effect of all factors	0.76	[0.73, 0.79]	0.75	[0.72, 0.78]	0.67	[0.62, 0.71]

RC=reference category

Table 9: Adjusted relative risk ratio (RRR) from multinomial logit model for number of risk factors

Risk Factors	Variables	RRR	P-value	[95% CI]
None		Base category		
	Age 18-39yrs	RC		
	40-50 yrs	1.41	0.23	[0.81, 2.45]
Any one	50+ yrs	1.60	0.22	[0.75, 3.41]
	Sex	0.34	<0.01	[0.22, 0.51]
	BMI	1.09	<0.01	[1.04, 1.14]
	WHR	2.53	<0.05	[1.13, 7.19]
	WHtR	1.25	<0.05	[1.09, 5.23]
	Intercept	0.05	0.07	[0.00, 1.30]
	Age 18-39 yrs	RC		
	40-50 yrs	5.28	<0.01	[2.98, 9.35]
Any 2 and more	50+ yrs	8.61	<0.01	[3.94, 13.79]
	Sex	0.39	<0.01	[0.25, 0.61]
	BMI	1.11	<0.01	[1.05, 1.17]
	WHR	3.11	<0.01	[1.74, 5.44]
	WHtR	2.85	<0.01	[1.45, 4.89]
	Intercept	0.00	<0.01	[0.00, 0.02]

RC=Reference Category

Discussion and Conclusion

This study investigated an association of anthropometric indices (BMI, WHR and WHtR) with cardiometabolic risk factors (DM, HTN and Dyslipidemia) among Bangladeshi adult population using data collected from patients visiting outpatient department of a tertial level government hospital which is accessed by general population of the country. Findings revealed that BMI, WHR and WHtR are significantly associated with cardiometabolic risk factors. In particular, all these indices are significantly associated with diabetes and hypertension for both male and female, which is also true in case of dyslipidemia in male while only WHR and WHtR are significantly associated with dyslipidemia in female. After adjusting for age and sex in the multivariable regression model, all these indices are found to be significantly associated with each of these cardiometabolic risk factors. Of these indices, the strongest association of WHtR with hypertension was found, while it is true for WHR in case of both diabetes and dyslipidemia.

The findings in another analysis performed considering the presence of one or more cardiometabolic risk factors revealed that all these indices are significantly associated with the presence of one or more risk factors after adjusting for age and sex. The degree of association is greater for having two/three risk factors compared to those for having only one risk factor. Of the indices, the magnitude of association of WHR and WHtR for having one or more risk factors are much greater than those with BMI.

All these findings are similar to the findings of the studies conducted in a similar settings, particularly in Asia [20,21,29,30]. For instance, a study in South China [31] revealed that cardiometabolic risk factors were significantly different between male and female and their anthropometric indices. Asians are known to be at an increased risk of cardiovascular disease (CVD) risk factors compared with those of European descent partly due to differences in body fat distribution and body build and frame size. Moreover, cardiometabolic risk factors associated with excess weight also vary by Asian sub-groups [9, 19]. Despite lower mean body mass index (BMI), Asian Americans are 30–50% more likely to have Type-2 Diabetes Mellitus

(T2DM) than their White counterparts [32]. Asian Indians had the highest odds of prevalent type-2 diabetes, followed by Filipinos, other Asians, and Chinese. Insulin resistance has also shown to be higher in Asian Indians, and higher prevalence of cardiometabolic diseases are seen among Filipino and Japanese compared to other Asian groups [33].

The prevalence of obesity and cardiometabolic diseases is rapidly increasing in India and other South Asian countries, leading to increased mortality and morbidity [7,9]. Approximately about one third of urban South Asians have evidence of the cardio metabolic diseases [7]. Many of such manifestations are more severe and are seen at an early age in Asian Indians than Caucasians. Cardiometabolic diseases and cardiovascular risk in Asian Indians and South Asians are also heightened by their relative increase in body fat mass, truncal subcutaneous fat mass, intra-abdominal fat mass, and also in ectopic fat deposition. Cardiovascular risk cluster also manifests at a lower level of adiposity and abdominal obesity.

It is evident in different studies [20,34] that increasing body fat among the adult population make the anthropometric indices (BMI, WHR, WHtR) imbalanced particularly among the adult population in South Asia. Over the last two decades, the prevalence of overweight and obesity rapidly increases among the adult population in Bangladesh and other south Asian countries, particularly people who live in urban settings. This is due to change in overall lifestyle of the urban residents including their food habit and work pattern (often stressful) and work load [16]. The rapid growing of modern facilities, including telecommunication and information technology under country's digitalization concept, in urban area make its resident to perform less physical work, which may influence the body to burn less body fat than the amount required [16]. In addition, due to unplanned urbanization, there is no spaces and facilities to spend leisure time during the weekend and holiday and hence people have hangout with friends and family in a food court, which may influence them to eat more fatty food than the amount required. This is another reason for a faster growing of different types of restaurants in urban settings of Bangladesh.

Based on the findings, it can be recommended that people should think alternatively to make a balance in their anthropometric indices to reduce cardiovascular risk. The most recommended practice to make a balance in anthropometric indices is to increase routine exercise, change in food habit and make a balance between work load and leisure time. Therefore, it is necessary to take urgent policy to increase awareness on routine exercise, taking healthy food and making balance between work and family life.

This study has some limitations that needed to be mentioned. This study is based on the dataset from a sample of general patients visiting the BSMMU only and hence could not generalize the findings to all patients visiting other hospitals. Further study may be conducted in large scale considering patients from other tertiary level hospitals located in the other divisions of the country. In addition, this study excluded some patients based on self-reported known illness rather than any medical report.

Statements and Declarations

Competing Interest: The authors declared none.
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Data availability

Data are freely available upon request subject to the adherence to BSMMU data sharing policy. The request for the data can be sent to farah.sul.lail@gmail.com, the principal investigator of the project.

Ethics approval

Ethical clearance for this study was taken from the Institutional Review Board of the Bangabandhu Sheikh Mujib Medical University (BSMMU) in its 141th meeting held on July 15, 2017, with No. BSMMU/2017/7586.

Consent to Participate and Publication

All study subjects were thoroughly appraised about the nature, purpose and implications of the study as well as the spectrum of benefits and risk of the study. All study subjects were assured of adequate treatment of any risk developed in relation to study purpose and freedom to withdraw themselves from the study any time. Finally written consent of all the study subjects were taken without exploiting any weakness of subjects. Furthermore, all study participants were assured about their confidentiality by ensuring not to disclose their identity when sharing data for publication. With such assurance all the participants have given written permission for publication.

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Author Contributions

FSL and MH designed the study and developed the study protocol. FSL and SA undertook the clinical record of the data with help of technicians in the outpatient department of the BSMMU. FSL analyzed the data, interpreted the results and drafted the paper. MH made critical review and supervised the study. All authors approved the final version of the manuscript.

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