Original Article

CONICITY INDEX OF ADULT BANGLADESHI POPULATION AND THEIR SOCIO-DEMOGRAPHIC CHARACTERISTICS

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Abstract

In spite of acknowledged importance, no unified definition exists for central obesity. Several anthropometric indexes such as waist circumference, waist-hip ratio, waist-to-height ratio, conicity index etc, are being used. Cindex has been shown to correlate well with various cardiovascular risk factors associated with visceral fat accumulation in some population. Data were collected through interviewing and measuring 22,995 adult males and females of an urban (Mirpur, Dhaka City) and rural area (Kaliganj sub-district) in 2002 and 2003. Overall the mean (SD) conicity index was 1.20 (0.10) and 40.8% of this sample had a high Cindex. Females, increasing age, urban residents, Christians, the better educated, married and farmers were more likely to have higher Cindex than their counterparts. There is a scarcity of data about the conicity index of Bangladeshis and this cross-sectional study is the first large-scale attempt. So it can be used as a baseline data for further research in this field.

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Key words: Conicity index, socio-demography, Bangladeshi

Introduction

Anthropometry is the single most universally applicable, inexpensive, and non-invasive method available to assess the size, proportion, and composition of the human body.[1] It is being increasingly recognised that central obesity, rather than general, is likely to coexist with type 2 diabetes and lead to complications including cardiovascular diseases. If abdominal obesity is more predictive of multiple risk factors, it is necessary to determine a suitable and widely accepted parameter for this kind of obesity as Body Mass Index is for general obesity. But in spite of its acknowledged importance, 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] There is no universally agreed way of measuring adiposity, nor is it known which measure is the best predictor of cardiovascular disease. BMI, WC, WHR, WHtR, Cindex all are found to associate with cardiovascular risk factors.[3] Valdez *et al.* (1993) proposed that 'the conicity index (Cindex) seems to be a viable approach to assess abdominal adiposity and its concomitant health risks in large-scale studies.[4] Cindex has been shown to correlate well with various cardiovascular risk factors associated with visceral fat accumulation in some population.[4,5] Cindex showed the highest correlation with total cholesterol, and low density lipoproteins (LDL) in a study by Yasmin & Mascie-Taylor (2003).[3] There was evidence that the central obesity indices, especially Cindex and WHR, are better at discriminating High Coronary Risk (HCR) than of general obesity (BMI). The largest area under the Receiver Operating Characteristics (ROC) curve

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was found between Cindex and HCR, in males, which was significantly different from other obesity indices. In women, the largest area found under the ROC curve was equally between Cindex, WHR and HCR indices.[6]

A person having a Cindex of 1.25 means s/he has a waist circumference which is 1.25 times larger than the circumference of a cylinder with height and weight of that person. The predicted range of Cindex is between 1.00 (perfect cylinder) and 1.73 (perfect double cone). The best cut-off points for discrimination of high coronary risk in adult men and women of Salvador, Brazil were, respectively 1.25 (73.91% sensitivity and 74.92% specificity) and 1.18 (73.39% sensitivity and 61.15% specificity).[6] Greater conicity in Asian young adults of both sexes, than in Europeans, was observed in the top tertiles of weight and BMI.[7] Cindex is more variable in women than men.[4]

No study, so far, has been conducted to assess the central obesity of Bangladeshi population using conicity index. This study is the first attempt to do so.

Materials and Methods

This was a cross-sectional study. Data were collected through interviewing 22,995 adult males and females of 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 pre-tested structured questionnaire printed in Bangla was used for data collection. Anthropometric measurements were taken using validated equipment based on standard procedures.[8] 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 equipments were 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. Weight was measured using a bathroom scale accurate to 0.5 kg with the subject wearing minimal attire. The scale was placed on a hard flat surface and the subject was requested to step onto it in bare feet without holding onto anything. The weighing scale was set to zero before every 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.

Cindex was constructed using the following formula:

Cindex = Waist Circumference (m)/ [0.109 X√ {Body weight (kg)/ Height (m)}]

where 0.109 is a constant which results from the conversion of units of volume and mass into units of length.[4] For male 1.25 and for females 1.18 cut-offs were used to classify Cindex into normal and high categories.

The analyses were carried out primarily using the Statistical Package for Social Sciences (SPSS) version 14.0. Statistical tests used to determine the association between exposure and outcome variables included χ^2 test and Student t-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.

Result

Overall, the mean (SD) conicity index was 1.20 (0.10) but there was considerable heterogeneity in relation to socio-demographic status. Age and sex adjustments were made before taking into account each of the other socio-demographic variables (Table-1). Except for religion all other socio-demographic variables were found to associate with Cindex. Urban residents, Christians, widows/divorcees, less educated and the non-paid had, on average, a higher Cindex than their counterparts.

Table-1: *Conicity Index in Relation to the Socio-demographic Variables*

Variables	N	Mean	SD	F	p-value	Adjusted for Other Socio-demographic Variables		
						B	F-change	p-value
Sex								
Male*	10456	1.18	0.09					
Female	12539	1.21	0.11	-17.9^{a} $567.7^{\wedge}$	<0.001 <0.001	.034	257.6	<0.001
Total	22995	1.20	0.10					
Age in Years								
<20*	2507	1.15	0.09					
20-29	7356	1.18	0.10			.018		
30-39	4949	1.20	0.09			.044		
40-49	3720	1.22	0.09			.060		
50-59	2249	1.23	0.10	$1007.7^{\dagger}$	<0.001	.074	180.6	<0.001
60-69	1397	1.24	0.11			.091		
70 & above	817	1.23	0.10			.089		
Total	22995	1.20	0.10					
Area								
Rural*	11789	1.19	0.09					
Urban	11206	1.20	0.11	172.1^{v}	<0.001	.015	106.1	<0.001
Total	22995	1.20	0.10					
Religion								
Islam*	21445	1.20	0.10					
Hinduism	1215	1.20	0.09					
Christianity	333	1.21	0.10	2.8^{v}	ns	.015	5.6	0.004
Total	22993	1.20	0.10					
Marital Status								
Married*	17885	1.20	0.10					
Unmarried	4078	1.15	0.08	36.7^{v}	<0.001	-.014	25.3	<0.001
Widow/ Divorced	1031	1.22	0.12			-.012		
Total	22994	1.20	0.10					
Educational Status								
No Schooling*	6477	1.20	0.10					
1-5 yrs of Schooling	5044	1.20	0.10			.009		
6-10 yrs of Schooling	8067	1.19	0.10	84.5^{v}	<0.001	.017	54.6	<0.001
Higher Secondary +	3402	1.19	0.10			.031		
Total	22990	1.20	0.10					
Occupation								
Non-paid*	11042	1.21	0.11					
Students	1597	1.15	0.08			-.022		
Manual Labourer	575	1.16	0.07			-.014		
Farmer	2660	1.20	0.08			.011		
Skilled Labourer	886	1.17	0.08	12.2^{v}	<0.001	-.010	15.7	<0.001
Business	2526	1.19	0.09			.002		
Service/ Professionals	3575	1.19	0.10			-.006		
Total	22861	1.20	0.10					

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

Sequential multiple regression analyses were also undertaken to determine the effect of each socio-demographic variable after correcting for all the other socio-demographic variables. The full model was significant (F = 133.3; p<0.001) but only explained 10.8% of the variance in Cindex. After adjustment

Table-2: *Conicity Index Categories in Relation to the Socio-demographic Variables*

Variables	Conicity Index*				Total		χ^2	p-value
	Normal		High					
	n	%	n	%	n	%		
Area								
Rural	7359	62.4	4430	37.6	11789	51.3		
Urban	6262	55.9	4944	44.1	11206	48.7	101.8	<0.001
Total	13621	59.2	9374	40.8	22995	100.0		
Sex								
Male	8188	78.3	2268	21.7	10456	45.5		
Female	5433	43.3	7106	56.7	12539	54.5	2889.2	<0.001
Total	13621	59.2	9374	40.8	22995	100.0		
Age in years								
<20	1900	75.8	607	24.2	2507	10.9		
20-29	4753	64.6	2603	35.4	7356	32.0		
30-39	2939	59.4	2010	40.6	4949	21.5		
40-49	1841	49.5	1879	50.5	3720	16.2	721.9	<0.001
50-59	1082	48.1	1167	51.9	2249	9.8		
60-69	665	47.6	732	52.4	1397	6.1		
70 & above	441	54.0	376	46.0	817	3.6		
Total	13621	59.2	9374	40.8	22995	100.0		
Geometric Mean±SD	31.05±14.68		35.66±15.24		32.85±15.10		-26.0^	<0.001
Religion								
Islam	12680	59.1	8765	40.9	21445	93.3		
Hinduism	756	62.2	459	37.8	1215	5.3	6.8	ns°
Christianity	184	55.3	149	44.7	333	1.4		
Total	13620	59.2	9373	40.8	22993	100.0		
Marital Status								
Married	9975	55.8	7910	44.2	17885	77.8		
Unmarried	3252	79.7	826	20.3	4078	17.7	989.6	<0.001
Widow/ Divorced	393	38.1	638	61.9	1031	4.5		
Total	13620	59.2	9374	40.8	22994	100.0		
Educational Status								
No Schooling	3616	55.8	2861	44.2	6477	28.2		
1-5 yrs of Schooling	2965	58.8	2079	41.2	5044	21.9		
6-10 yrs of Schooling	4880	60.5	3187	39.5	8067	35.1	60.6	<0.001
Higher Secondary +	2155	63.3	1247	36.7	3402	14.8		
Total	13616	59.2	9374	40.8	22990	100.0		
Occupation								
Non-paid	4810	43.6	6232	56.4	11042	48.3		
Students	1248	78.1	349	21.9	1597	7.0		
Manual Labourer	514	89.4	61	10.6	575	2.5	2294.0	<0.001
Farmer	2054	77.2	606	22.8	2660	11.6		
Skilled Labourer	670	75.6	216	24.4	886	3.9		
Business	1799	71.2	727	28.8	2526	11.0		
Service/ Professionals	2431	68.0	1144	32.0	3575	15.6		
Total	13526	59.2	9335	40.8	22861	100.0		

**Conicity Index Cut-off: 1.25 for male and 1.18 for females; ^t-test; °Bonferroni Corrected*

Table-3: *Socio-demographic Predictors of Conicity Index Categories: 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*	196.0	<0.001		
Urban			1.667	1.551 - 1.792
Sex				
Male*	1477.2	<0.001		
Female			7.542	6.760 - 8.415
Age in Years				
<20 *	893.5	<0.001		
20-29			1.326	1.171 - 1.502
30-39			2.444	2.121 - 2.817
40-49			3.553	3.065 - 4.117
50-59			4.601	3.913 - 5.410
60-69			6.277	5.221 - 7.547
70 & above			7.068	5.714 - 8.742
Religion				
Islam*	7.2	ns°		
Hinduism			0.988	0.863 - 1.131
Christianity			1.414	1.096 - 1.825
Marital Status				
Married*	56.6	<0.001		
Unmarried			0.673	0.593 - 0.765
Widow/ Divorced			0.727	0.628 - 0.842
Educational Status				
No Schooling*	157.9	<0.001		
1-5 yrs of Schooling			1.185	1.085 - 1.295
6-10 yrs of Schooling			1.527	1.400 - 1.665
Higher Secondary +			1.999	1.775 - 2.252
Occupation				
Non-paid*	105.2	<0.001		
Students			0.613	0.510 - 0.737
Manual Labourer			0.401	0.297 - 0.542
Farmer			1.195	1.034 - 1.380
Skilled Labourer			0.862	0.715 - 1.039
Business			1.198	1.048 - 1.369
Service/ Professionals			1.065	0.949 - 1.195

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

for the other socio-demographic variables it was found that females, increasing age, urban residents, Christians, the better educated, married and farmers were more likely to have a higher Cindex than their counterparts.

Cindex was categorised into 'normal' and 'high' using cut-offs of 1.25 for males and 1.18 for females.[6] Although considerable variation was found in relation to socio-demographic variables (Table-2), overall 40.8% of this sample had a high Cindex. Except for religion all socio-demographic variables were associated with Cindex categories. High Cindex was more common in urban residents, females, and older age groups while it was less common in the unmarried, the better educated and manual labourers.

Sequential binary logistic regression models were used to test the effect of individual socio-demographic variables, after adjusting for the other variables.

Table-3 shows that the likelihood of high Cindex increased with age and better education. Gender was strongly associated with Cindex; females were 7.5 times more likely to have high Cindex than males. High Cindex was more often found in urban residents, married, farmers and business persons. When all the socio-demographic variables were entered into the model they significantly predicted Cindex (χ^2=4974.2; $p<0.001$; Nagelkerke R^2 = .264) and overall 69.9% and 76.5% of normal Cindex, and 60.4% of high Cindex, were correctly predicted. The forward binary logistic regression revealed sex and age group as the best predictors of Cindex categories. When the analyses were repeated for each sex separately, age was the best predictor of Cindex categories in both sexes, followed by occupation in males and locality in females.

Discussion

Because of epidemiological transitions, Bangladesh is facing a double burden of health problems; on the one hand the country is not free of communicable diseases and emergence of new infectious diseases, while on the other hand the occurrence of non-communicable diseases is also increasing. Linked to this epidemiological transition, Bangladesh is also facing a 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%[9]. Many countries in this region are going through the so-called "nutrition transition" but collection of good quality national data on obesity as well as under-nutrition are needed. While in some Asian countries the prevalence of obesity is lower than that in Europe, the health risks associated with obesity occur at a lower BMI.[10] Central obesity is likely to coexist with type 2 diabetes and lead to complications including cardiovascular diseases and it is measured by several anthropometric indexes such as WC, WHR, WHtR, Cindex etc.[2] Both Cindex and WHR are equivalent as health indicators. Valdez *et al.* (1993) claimed some advantages of Cindex over WHR: (i) it has a theoretical (expected) range; (ii) it includes a built-in adjustment of waist circumference for height and weight, allowing direct comparisons of abdominal adiposity between individuals or even between populations; and (iii) it does not require the hip circumference to measure fat distribution.[4] On the contrary, Bose & Mascie-Taylor (1998) did not find any advantage of Cindex over WHR, as a surrogate for abdominal adiposity[11]. Data from the Charleston Heart Study cohort indicated that while Cindex has a built-in correction for relative weight, it might not adequately control for relative weight where the relationship is quadratic.[12] A study in India recommended further studies to explore the importance of Cindex in South Asian populations.[13] Yasmin & Mascie-Taylor (2000) also suggested more detailed studies should be undertaken before Cindex is used as a surrogate for WHR of abdominal adiposity in both men and women in different population groups.[3]

There is a dearth of adult anthropometric data in Bangladesh other than weight and BMI and most nutrition research has focused on under-nutrition, particularly among women and children. To meet the scarcity of data in regard to Cindex of Bangladeshi population, this study was an attempt to measure the level of Cindex and magnitude of central obesity as classified by the Cindex. The study also observed the variation in Cindex statistically with differences in the socio-demographic status of the Bangladeshi population. This could work as a baseline data for further studies. Given the large sample size of this study, particular care was taken when interpreting 'significant' results and 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 K is the number of tests used) was used to reduce Type I errors. The combination of more stringent p value and correction for the number of test undertaken, lowered the cut-off p value for significance to <0.0014 and most of the p-values were <0.001. The magnitude of the difference for statistically significant results was also considered. For example, with a quantitative (continuous) variable a small difference in means might be significant because the standard errors will be small given these sample sizes. However, for a qualitative variable, much larger differences would be required in a chi-square test because the denominator is the expected value, which would be large. Even so, the primary aim of inferential statistics is to generalize from a sample to a population and so the large sample size used here will more closely approximate to the adult Bangladesh population and the 95% confidence intervals will be small. However, this was a cross-sectional study and is the simplest form of epidemiological study and so the associations discussed later do not indicate causality.[14]

The overall mean Cindex in the current study was 1.20 and were higher in urban residents. Females had, on average, higher Cindex (1.21 ± 0.11) than males (1.18 ± 0.09). The gender difference in mean Cindex could not be compared with any study because of non-availability. An Indian study[15] showed that average Cindex of Bengali Adult Hindu male was 1.22 ± 0.07 which is higher than that of Bangladeshi adult male. But this difference probably is not due to difference in their religion as the current study could not detect any influence of religion on Cindex.

A survey on medical students of United Kingdom showed that females of South Asian descent had a significantly higher conicity index than females of European descent irrespective of how the groups were compared. This difference in conicity was not significant in the male group as a whole, or when ethnic pairs were matched for body weight or body mass index. Male students of South Asian origin in the top tertile for body weight or body mass index had a significantly greater conicity index than European males in these top tertiles. However, the trend towards higher conicity (i.e. abdominal obesity) in young Asians may help explain the higher incidence of diabetes and cardiovascular disease seen in elderly Asians living in the United Kingdom.[7]

Overall 40.8% of this sample had a high Cindex. Conicity index was categorised into 'normal' and 'high' using cut-offs of 1.25 for males and 1.18 for females. The best cut-off points for discrimination of high coronary risk in adult men and women of Salvador, Brazil were, respectively 1.25 (73.91% sensitivity and 74.92% specificity) and 1.18 (73.39% sensitivity and 61.15% specificity[6]. Except for religion all socio-demographic variables were associated with the Cindex categories in this study. Cindex is more variable in women than men.[4] High Cindex increased with age and better education. Gender was strongly associated with Cindex; females were 7.5 times more likely to have high Cindex than males. High Cindex was more often found in urban residents, married, farmers and business persons. The forward binary logistic regression revealed sex and age group as the best predictors of Cindex categories. When the analyses were repeated for each sex separately age was the best predictor of Cindex categories in both sexes, followed by occupation in males and locality in females. For a national cut-off point the socio-demographic differentials need to be considered.

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