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Obesity and Blood Pressure Variations among the Bengali Kayastha Population of North Bengal, India

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ABSTRACT Obesity is defined either by increased waist circumference (WC), waist-height ratio (WHtR), conicity index (CI) waist-hip ratio (WHR) and/or body mass index (BMI). As individuals from the developing countries consume more quantities of high-energy food and have less physical activity, the number of overweight and obese individuals increase. Obesity has a detrimental effect on blood pressure and increases cardiovascular events. One important issue that is currently assuming relevance in studies involving blood pressure and anthropometric parameters is the mean arterial pressure (MAP). There exists limited data on such issues among different Indian population and caste groups. This cross sectional study was carried out during the period October-December 2007 in four localities of Alipurduar town (Alipurduar sub-division, Jalpaiguri district, West Bengal, India). A total of 150 individuals (75 males and 75 females) agreed to take part in the same. Blood pressure (SBP and DBP) was measured on left arm by auscultatory method using a mercury sphygmomanometer. The anthropometric measurements have been recorded using standard procedures. The male individuals show higher means with respect to the anthropometric measurements and the blood pressure values, as compared to the females. The prevalence of hypertension was almost 50.00%. Obesity accounted for 80.00% of the individuals. Using step-wise regression analysis, it has been observed that all the anthropometric parameters play a role in blood pressure. It can be observed that the Bengali Kayastha population of Alipurduar town has a high prevalence of obesity. Moreover, BMI, WC and WHtR have strong correlations with DBP and MAP.

INTRODUCTION

Obesity is defined either by increased waist circumference (WC), waist-height ratio (WHtR), conicity index (CI) waist-hip ratio (WHR) and/or body mass index (BMI). For estimating regional fat distribution, either waist-hip circumference ratio or sub-scapular skin fold has been found to be most useful. Obesity results from an interaction of genes and lifestyle. As individuals from both developed and developing countries consume more and more quantities of high-energy food and have less physical activity, the number of overweight and obese individuals increases to epidemic proportions (WHO 2002). Obesity has a potential detrimental effect on blood pressure and increases cardiovascular events. Hyper-insulinemia and leptin released from adipose tissue play an important role in the development of hypertension in obese individuals. Insulin and leptin increase sympathetic tone, which results in sodium retention and hyper-responsiveness of blood vessels. As leptin has also a direct vasodilative and diuretic action, its effect on blood pressure is bidirectional. Moreover, abdominal obesity plays a key role in the patho-physiology of metabolic disorders, and is associated with insulin resistance, and predicts the development of type 2 diabetes and subsequent coronary artery disease. Body mass index has been traditionally promulgated by the World Health Organization (WHO) as a useful epidemiological measure of obesity. Numerous studies have now established the relationship between obesity, overweight and underweight (Matusik et al. 2007). A number of cut-off points to differentiate between obese, overweight and underweight individuals have also been proposed. However, WHO goes on to state that BMI is a crude index that does not take into account the distribution of body fat, resulting in variability among different individuals and populations (WHO 2002). In another word of caution, Mascie-Taylor and Goto (2007) have observed that the use of BMI as a surrogate for body fat percentage is debatable and universal BMI cut-off points do not seem appropriate. Moreover, they opined that lower cut-off points

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than currently recommended by WHO should be used in some populations, especially in Asia. It is also been argued that rather than excess general fatness (assessed by BMI), more specifically it is excess abdominal fatness, quantified by WC measurement, which is a better measure of risk for these metabolic abnormalities.

Blood Pressure and Hypertension

The term 'Blood Pressure' refers to the mean systemic arterial blood pressure in the largest arteries near the heart. The normal blood pressure is defined as <120 mm Hg systolic blood pressure (SBP) and <80 mm Hg diastolic blood pressure (DBP). Hypertension was defined by blood pressure equal or higher than 140/90 mm Hg (Fuchs et al. 2005). An individual is considered to be hypertensive if he/she possesses a SBP of >140 mm Hg and/or DBP of >90 mm Hg (Stranges et al. 2004). Chronic hypertension is a 'silent killer' causing changes in blood vessels and retina, abnormal thickening of heart muscles, kidney failure and brain damage. Hypertension is caused by numerous factors such as genes, age, alcohol intake, excessive intake of salt, overweight, obesity and a sedentary lifestyle. It has been observed that overweight could be a major factor in determining the increasing rates of coronary heart disease by its influence on blood pressure (Reddy et al. 2002).

Relationship between Obesity and Blood Pressure

It has been very recently observed by Kotchen et al. (2008) that blood pressure levels and the prevalence of hypertension are related to adiposity, and the main components of adiposity are BMI, waist/hip ratio, waist/height ratio (WHtR) and percent body fat. Another very convenient measure of abdominal adipose tissue is WC (Bouguerra et al. 2007) Studies have shown that WC has a significant role to play in the prevalence of hypertension (da Silva and Rosa 2006; Sung et al. 2007). Some studies have also focused on sex differences in the prevalence of blood pressure (Turconi et al. 2006). Studies also documented association of hypertension with WHtR and considered it as the best indicator of hypertension and estimation body fat (Nagai et al. 2008; Zhou et al. 2008).

One important issue that is currently assuming relevance in studies involving blood pressure and anthropometric parameters is the mean arterial pressure or MAP (Sadhukhan et al. 2007). As aortic pressure fluctuates up and down with each heartbeat, the important pressure to consider here is MAP. Mean arterial pressure is the pressure that propels the blood to the tissues. Since diastole usually lasts longer than systole, MAP is not simply the value halfway between systolic and diastolic pressures. Instead it is roughly equal to the diastolic pressure plus one third of the pulse pressure. Pulse pressure is the difference between the systolic and diastolic pressure. Both MAP and pulse pressure decline with increasing distance from the heart. The MAP loses ground to the never-ending friction between the blood and the vessel walls and the pulse pressure is gradually phased out in the less elastic muscular arteries, where elastic rebound of the vessels ceases to occur. At the end of the arterial tree, blood flow is steady and the pulse pressure has disappeared.

Studies Done in Obesity and Blood Pressure in India

It is a well-recognized fact that overweight, obesity and hypertension are some of the major public health concerns in India. Although there have been steady increases in the prevalence of these parameters among the Indian population (Gupta 2004; Gupta et al., 2008) there exists limited data on such issues among different Indian populations and caste groups (Deshmukh et al. 2006; Gupta et al. 2007). Very few studies have also been done among the Bengali caste groups and here the studies of Ghosh and Bandyopadhyay (2007), Bose et al. (2003) and Bose and Das Chaudhuri (2001) bear prominence. The northern part of the state of West Bengal, India, is popularly known as North Bengal and is constituted by the districts of Malda, Uttar Dinajpur, Dakshin Dinajpur, Darjeeling, Cooch Behar and Jalpaiguri and is the home to many indigenous and caste groups. There is also an absence of scientific literature in different peer-reviewed journals on these issues among different populations and caste groups of North Bengal.

Taking the above issues into consideration, the present study on the association of different anthropometric parameters of obesity and blood pressure was designed among the Bengali Kayastha population of Alipurduar town of North

Bengal. The following anthropometric measurements have been taken to estimate obesity:

1 Height vertex
2 Weight
3 WC
4 Hip Circumference (HC)

From these measurements, BMI, WHtR, CI and WHR have been calculated.

Objectives of the Present Study

The present study has the following objectives:-

1 To estimate the prevalence of hypertension among Bengali Kayasthas
2 To determine sex differences in some anthropokmetric variables (BMI, WC, WHtR, CI and WHR) and blood pressure among Bengali Kayasthas.
3 Observe the relationship between these parameters and blood pressure among Bengali Kayasthas.

MATERIAL AND METHODS

Study Design and Setting

This cross sectional study was carried out during the period October-December 2007 in four localities of Alipurduar town (Alipurduar subdivision, Jalpaiguri district). The four localities are 'Suryanagar', 'Santinagar', 'Udayanbitan' and 'Bidhanpally'. Alipurduar town is located around 250 km from Siliguri. House-to-house visits have been utilized for collecting the data for the present study.

Sampling Design

A two-stage sampling method was utilized. In the first stage, the households of individuals belonging to the Bengali Kayastha population were identified. The Kayastha is a general Hindu caste, also believed to be the fifth 'varna' of the Hindu caste system. They are of an Indo-Caucasoid origin. In the history of India, since pre-Mughal times, representatives of this caste were highly educated and engaged in administrative posts The Bengali Kayasthas form one of the regional Kayastha communities residing in West Bengal and are also known as the 'writing caste' due to their good education, intellect and success in administrative occupations. Presently, they are involved in miscellaneous professions. In course of this study, individuals belonging to the Kayastha population have been identified by their surnames and subsequent interviews.

In the second stage, purposive sampling has been utilized. Male and female individuals belonging to the Bengali Kayastha population in the age group 30-50 years were identified. Older individuals were not considered as it has been shown that blood pressure increases among the elderly population (Rurik et al. 2004; Jani and Rajkumar 2006). For more precision, only those individuals who were not taking medication or were on erratic medication for hypertension have been included in the present study. A total of 155 individuals (78 males and 77 females) were approached for taking part in the study. The objectives of the study and the methods were explained to them and finally 150 individuals (75 males and 75 females) agreed to take part in the same.

Measurement of Blood Pressure

After obtaining verbal consent, blood pressure (SBP and DBP) was measured on left arm by auscultatory method using a mercury sphygmo-manometer (Diamond Deluxe B.P. Apparatus 1202004120583, Pune, India). The individual was made comfortable and seated at least for five minutes in the chair before measurement. The mean arterial pressure was also calculated.

Anthropometric Measurements Recorded

Body weight was recorded to the nearest 0.5 kg with the subject standing motionless on a bathroom weighing scale. Height was measured to the nearest 0.1 cm with the subject standing in the erect position with the head in the ear-eye plane, with the help of an anthropometer. Waist circumference was measured at the level halfway between the iliac crest and the coastal margin in the mid-axillary line after exhaling with the subject in the standing position. Hip circumference was measured at the level of the greater trochanters with the subject in a standing position with two feet together. Two consecutive readings were recorded for WC and HC to the nearest 0.1 cm using a non-stretchable measuring tape without compression of skin. The mean of the two values

has been used. The waist and hip measurements have been determined following the method of WHO (1998).

The values for BMI and WHR have been calculated. The BMI cut-offs for overweight and obesity was >23.0 and >25.0 kg/m^2 respectively (WHO 2000). Waist circumference cut-offs were taken as >90 for males and >80 for females to define overweight (WHO 2000). The cut-offs used for WHR were >0.9 for males and >0.8 for females (Webb 2002). For WHtR, the cut-offs used was 0.5 for both sexes (Hsieh and Muto 2004).

Statistical Analysis

The data was statistically analyzed using SPSS 15.0. Statistical constants have been utilized to document the population characteristics, anthropometric indicators, SBP, DBP and MAP. Means were compared between sexes using paired t-test. Correlations were utilized to determine the association between the anthropometric indicators and blood pressure indicators. Stepwise regression analysis was used to assess the influence of BMI, WC, WHtR, CI and WHR on SBP, DBP and MAP. One-way analysis of variance (ANOVA) was used to assess the differences between the normotensive and hypertensive group. The level of significance was taken as $p<0.05$.

RESULTS

The Baseline Characteristics of the Study Population

The present study has included 150 individuals (75 male and 75 female), the nature of which has been discussed in the previous section. The mean age of the male Bengali Kayastha individuals were 40.72 (±6.09) years and that of the females were 38.01 (±5.46) years. The mean and standard deviations of the anthropometric measurements and blood pressures observed in the present study is shown in Table 1. The mean height was 164.79 (±4.99) cm and 153.63 (±3.59) cm among males and females respectively. The mean weight was 69.37 (±5.10) kg and 61.63 (±5.33) kg among males and females respectively. Similarly, BMI was higher in females than in males (26.11 kg/m^2 and 25.76 kg/m^2 respectively). Waist circumference is also higher in males (108 cm) than in females (98.81 cm). Males also have a higher mean WHR (0.66 ±0.06) than the women (0.64 ±0.58). Waist-hip ratio is seen to be marginally higher in males than in females (0.97 and 0.96 respectively). Males have a higher mean SBP 143.12 (±11.31) mm/Hg than their female counterparts (131.07 ±14.14 mm/Hg). Similarly, DBP also show a higher mean in case of male individuals (85.88 ±4.73 mm/Hg) than in female individuals (83.59 ±4.74). The mean arterial blood pressure also shows a sex difference, with the males having a higher mean (104.72 ±6.69 mm/Hg) than the females (99.47 ±6.73). The mean values of CI also higher among the male (1.54 ±0.13) Kayastha individuals than the females (1.42 ±0.12).

When the data was sub-divided into hypertensive and normotensive (Table 2), it was observed that the prevalence of hypertension among the 150 individuals was 46.67% (70 individuals). Hence, 80 individuals were normotensive (55.33%). In the hypertensive category, the mean SBP was 148.17±8.06 mm/Hg, DBP was 88.41±3.03 mm/Hg and MAP was

Table 1: Baseline characteristics of the Kayastha population

Characteristics	*Men*	*Women*
No. of Subjects	75	75
Age (years)	40.72 ± 6.09	38.01 ± 5.46
Height (cm)	164.79 ± 4.99	153.63 ± 3.59
Weight (kg)	69.37 ± 5.10	61.63 ± 5.33
BMI (kg/m2)	25.76 ± 1.53	26.11± 1.71
Waist-hip ratio	0.97 ± 0.01	0.96 ± 0.33
Waist circumference	108.65 ±11.00	98.81 ± 9.43
Hip circumference	111.87 ±11.24	101.89 ± 9.80
Systolic blood pressure (mm/Hg)	143.12 ±11.31	131.07 ±14.14
Diastolic blood pressure (mm/Hg)	85.88 ± 4.73	83.59 ± 4.74
Mean arterial pressure (mm/Hg)	104.72 ± 6.69	99.47. ± 6.73
Waist- Height ratio	0.66 ± 0.06	0.64 ± 0.58
Conicity index	1.54 ± 0.13	1.42± 0.12

± s.d.

Table 2: Baseline characteristics of hypertensive and normotensive population

Characteristics	*Hypertensive*	*Normotensive*
No. of Subjects	70	80
Age (years)	42.70 ±5.33	36.45 ±4.97
Height (cm)	162.17 ±6.78	156.63 ±6.32
Weight (kg)	69.89 ±4.99	61.66 ±5.08
BMI (kg/m2)	26.74 ±1.18	25.23 ±1.64
Waist-hip ratio	0.97 ±0.03	0.96 ±0.01
Waist circumference	111.46 ±8.77	96.97 ±8.74
Hip circumference	114.91 ±8.71	99.84 ±9.05
Systolic blood pressure (mm/Hg)	148.71 ±8.06	128.64 ±7.74
Diastolic blood pressure (mm/Hg)	88.41 ±3.03	81.51 ±3.74
Mean arterial pressure (mm/Hg)	108.03 ±4.26	96.00 ±4.80
Waist- Height ratio	0.69 ±0.04	0.62 ±0.05
Conicity index	1.56 ±0.11	1.42 ±0.11

± s.d.

108.03±4.26 mm/Hg. In the normotensive category, the corresponding values were 128.64±7.74 mm/Hg, 81.51±3.74 mm/Hg and 96.90±4.80 mm/Hg. When the obesity parameters were considered, the hypertensive group had a mean BMI of 26.74±1.18 kg/m^2, mean WC of 111.46±8.76 cm, mean WHtR 0.69 ±0.04, mean CI of 1.56 ±0.11 and mean WHR of 0.97±0.03. The normotensive group had a mean BMI of 25.22±1.64 kg/m^2, mean WC of 96.97±8.74 cm, mean WHtR of 0.62 ±0.05, mean CI of 1.42 ±0.11 and mean WHR of 0.0.96±0.01.

Prevalence of Obesity

The prevalence of obesity among the Bengali Kayastha individuals in the present study is depicted in Table 3. Based on BMI cut-offs, a majority of the individuals are obese (120 individuals; 80.00%), 21 individuals suffer from overweight (14.00%) while only 9 individuals are normal (6.00%). Among male individuals, 61 (81.33%) are obese, 11 are overweight (18.67%) and only 3 are normal (4.00%). Among female individuals, 59 (78.67%) are obese, 10 (13.33) suffer from overweight and 6 (8.00%) are normal. When cut-offs for WC is considered, a total of 144 individuals (96.00%) are obese and the remaining 6 are normal (4.00%). Among male individuals, 72 (96.00%) are obese, while 3 (4.00%) are normal. Among females also, 72 (96.00%) are obese, while 3 (4.00%) are normal. While WHtR cut-offs determines 98.67% males and females were obese in both cases. However, when the cut-offs for WHR are considered, all the individuals are obese.

Sex Differences in Blood Pressure and Anthropometric Variables

Using paired t-test, it is observed that there are significant statistical differences between male and female Bengali Kayastha individuals in WC (t=5.75, d.f.: 74), WHR (t = 4.48, d.f.: 74), CI (t =

Table 3: Prevalence of obesity among all the individuals.

Obesity parameters	*Men (N=75)*	*Women (N=75)*	*Total (N=150)*
BMI			
<23	03 (4.00)	06 (8.00)	09 (6.00)
>23-24.99	11 (18.67)	10 (13.33)	21 (14.00)
>25	61 (81.33)	59 (78.67)	120 (80.00)
Waist Circumference			
Normal	03 (4.00)	03 (4.00)	06 (4.00)
Obese	72 (96.00)	72 (96.00)	144 (96.00)
Waist- hip ratio			
Normal	0 (0.00)	0 (0.00)	0 (0.00)
Obese	75 (100.00)	75 (100.00)	150 (100.00)
Waist-Height ratio			
<.50	01 (1.33)	01 (1.33)	02 (1.33)
≥.50	74 (98.67)	74 (98.67)	148 (98.67)

Figures in parenthesis indicates percentages

5.88 d.f.: 74) SBP (t = 5.45, d.f.: 74), DBP (t = 2.92, d.f.: 74) and MAP (t = 4.57, d.f.: 74). In case of BMI (t = 1.32, d.f.: 74) and WHtR (t = 1.58, d.f.: 74) the differences are statistically not significant.

Correlations between BMI, WC, CI, WHR, WHtR and Blood Pressure

Positive correlations have been obtained between BMI and SBP (r=0.51) and BMI and DBP (r=0.67). When the data set is subdivided into males and females, the respective r-values are 0.54 and 0.68 for BMI and SBP, and 0.65 and 0.78 for BMI and DBP. Significant correlation was obtained in case of SBP and WHtR (r=0.64) and DBP and WHtR (r=0.78). In case of males, significant correlation was found r=0.61for SBP and WHtR and r=0.75 for DBP and WHtR while in female is 0.63 for SBP and WHtR and is 0.81 for DBP and WHtR. Significant positive correlation was also been observed in case of CI with blood pressure indicators. Almost negligible yet positive correlations have been obtained between WHR (r=0.07) and SBP, and WHR and DBP (r=0.06). In case of males, the correlation coefficient is 0.15 for WHR and SBP, and 0.17 for WHR and DBP and CI (r=0.65) and SDP. For females, the respective correlation coefficients are also negligible, but negative (-0.14 and -0.07). In case of BMI and MAP, the r-value is 0.63 (for males it is 0.63 and for females it is 0.79). The correlation coefficient for WC and SBP is 0.74 (for males it is 0.66 and for females it is 0.73). The correlation coefficient for WC and DBP is 0.81 (for males it is 0.78 and for females it is 0.84). The r-value between WC and MAP is 0.83 (0.74 in case of males and 0.86 in case of females). In case of WC versus MAP, the r-value is 0.83 (in case of males it is 0.74 and for females it is 0.86). When correlation between WHR and MAP was performed, the r-value is 0.06 (for males it is 0.15 and for females it is -014). The correlation coefficient was found also significant between MAP and WHtR (for males r=0.72 and for female r=0.83) and MAP and CI (for males r=0.63 and for female r=0.60).

Influence of BMI, WC, WHtR, CI and WHR on SBP, DBP and MAP

The pronounced influences of the above anthropometric predictors on the blood pressure variables (SBP, DBP and MAP) were observed by using step-wise regression analysis. The

Table 4: Prevalence of obesity between the hypertensive and normotensive individuals

Obesity parameters	*Hypertensive (N=70)*	*Normotensive (N=80)*	*Total (N=150)*
BMI			
<23	0 (0.00)	9 (11.25)	9 (6.00)
>23-24.99	4 (5.71)	17 (21.25)	21 (14.00)
>25	66 (94.29)	54 (67.50)	120 (80.00)
Waist Circumference			
Normal	0 (0.00)	06 (7.50)	06 (4.00)
Obese	70 (100.00)	74 (92.50)	144 (96.00)
Waist-hip ratio			
Normal	0 (0.00)	0 (0.00)	0 (0.00)
Obese	70 (100.00)	80 (100.00)	150 (100.00)
Waist-Height ratio			
<.50	0 (0.00)	2 (2.50)	2 (1.33)
≥.50	70 (100.00)	78 (97.50)	148 (98.67)

Figure in parenthesis indicates the percentages

Table 5: Results of stepwise regression analysis of anthropometric predictors on blood pressure variables

Predictors	*Systolic blood pressure*			*Diastolic blood pressure*			*Mean arterial pressure*		
	Total	*Male*	*Female*	*Total*	*Male*	*Female*	*Total*	*Male*	*Female*
WC	54.7	28.5	52.9	65.1	60.4	70.4	68.4	54.8	74.1
WC + BMI	55.9	47.1	53.8	71.8	68.4	71.6	72.3	63.0	75.2
WC + BMI + WHR	55.7	46.4	54.6	71.7	68.0	71.4	72.5	62.0	76.1
WC + BMI + WHR + WHtR	61.0	50.0	55.0	72.0	70.4	70.0	74.5	64.8	75.8
WC + BMI + WHR + WHtR + CI	60.7	49.7	54.4	72.2	70.0	71.1	74.7	64.6	75.5

Figures indicate percentages of variance

results are depicted in Table 5.

Differences in obesity parameters and blood pressure between normotensive and hypertensive groups

The prevalence of obesity between the hypertensive and normotensive individuals are shown in Table 4. The prevalence of obesity is much higher in case of hypertensive individuals than in case of normotensive individuals.

Using ANOVA, it has been observed that significant differences in BMI (F=41.03, d.f.: 1,148), WC (F=102.35, d.f.: 1,148), CI (F=66.26, d.f.: 1,148) and WHtR (F=70.59, d.f.: 1,148) between the normotensive and hypertensive groups. However, differences in WHR are not statistically significant between these two categories (F=0.16, d.f.: 1,148).

DISCUSSION

A lot of published literature exists on the relationship between blood pressure and obesity measures. Studies have been done among women (Atallah et al. 2007), children (Sung et al. 2007), adolescents (Turconi et al. 2006), urban subjects (Feldstein et al. 2005) and the elderly population (Rurik et al. 2004). Although there are cut-offs for obesity measures such as BMI and WC recommended by WHO, studies have also been initiated to obtain optimal cut-offs for these measures for specific populations (Misra et al. 2006; Bouguerra et al. 2007). Some studies have also been done on Indian populations (Singh et al. 1998; Bose and Chaudhuri 2001; Ghosh and Bandyopadhyay 2007). The positive relation of BMI, WC, WHtR and WHR with blood pressure has also been recognized. This relation bears great significance, given the fact that the all these parameters have a prime role to play in the estimation of cardiovascular risk.

The present study has shown that a high percentage of the individuals in the present study are obese. Based on BMI, it can be concluded that general obesity is quite prevalent. However, prevalence of central obesity, as observed by WC and WHR, is higher than general obesity among this population. This has also been reported in the very recent study of Atallah et al. (2007). This can probably partly be related to the nature of the diet and sedentary lifestyle of the individuals, although studies need to be initiated on these two parameters to confirm the observation. However, nutritional intervention in the form of diet education and weight monitoring need to be introduced to reduce obesity.

The results of the present study indicate that male Kayastha individuals have higher WC, WHtR, WHR, SBP, DBP and MAP than their female counterparts, except in BMI where the female are higher than the male counterparts. The results agree with other reported studies worldwide (Cox et al. 1997; Kroke et al. 1998; Bouguerra et al. 2007). The results are also in agreement with Indian studies (Gupta et al. 2003; Das et al. 2008). However, no sex differences in these parameters were observed by Mukhopadhyay and Mukhopadhyay (2001).

The results of the present study further indicate that unlike DBP, both SBP and MAP are strongly correlated with BMI and WC. High correlations between SBP and BMI have also been reported in other studies (Fuchs et al. 2005; da Silva and Rosa 2005; Turconi et al. 2006; Gupta et al. 2007). Similar results have been obtained when WC is considered in place of BMI. The results are in agreement with the studies of Bose and Chaudhuri (2001) and Gupta et al. (2007). The study of Ghosh and Bandyopadhyay (2007).has also reported that such obesity measures are positively correlated with blood pressure. The present study further indicates that WHR has a very low correlation with the obesity indicators. It may be concluded that both BMI and WC seems to have a positive effect on blood pressure, mainly on MAP and DBP. Apparently, it would be worthwhile to consider MAP in subsequent investigations. Waist-hip ratio does not seem to be a positive indicator in the scale of BMI and WC, even though some recent studies have mentioned its importance (Gupta et al. 2007; Kotchen et al. 2008).

The results of the present study have shown that there are significant differences between hypertensive and normotensive individuals with regards to BMI, WC and WHR. Many studies have reported such differences between hypertensive and normotensive individuals (Bose and Chaudhuri 2001; Shanthirani et al. 2003; Kotchen et al. 2008).

Using step-wise regression analysis, the present investigation has shown that all the anthropometric measures have pronounced influences on SBP, DBP and MAP. Hence, an increase of such measures forms a risk factor to hypertension and allied major coronary risk factors such as diabetes and metabolic syndrome.

Moreover, it can also be concluded that blood pressure levels are related to adiposity (both general and abdominal). Such inferences have also been drawn up in other similar studies both in Indian and abroad (Deshmukh et al. 2006; Ghosh and Bandyopadhyay 2007; Gupta et al. 2007; Kotchen et al. 2008). Analysis of variance (ANOVA) has shown statistically significant differences between normotensives and hypertensive in BMI and WC in the present study. It has been observed by Shanthirani et al. (2003) that BMI and WHR differ significantly between normotensives and hypertensives. Bose and Chaudhuri (2001) have also reported significant differences in WHR between such groups. It may be hypothesized here that blood pressure-adiposity relationship in hypertensives is modulated by a combination of environmental and genetic factors. However, the strength of the association of risk factors with hypertension depends on how the variables are analyzed. Acknowledging these differential effects and assigning differential risks by age could be useful in intervention programs.

To summarize, the Bengali Kayastha population of Alipurduar town has a high prevalence of obesity. Body mass index, WC and WHtR have strong correlations with DBP and MAP. Both these anthropometric measures ratio have strong influences on blood pressure and hypertension. In subsequent studies involving obesity measures and blood pressure, MAP should also been included.

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