

Correlation Of Blood Pressure With Body Mass Index, Waist Circumference And Waist To Hip Ratio

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Abstract: Obesity, one of the most commonly prevailing conditions is recognized as an important risk factor for the development of hypertension. The purpose of the study was to identify the association between body mass index, waist circumference, waist-hip ratio and blood pressure among students in the University of Peradeniya, Sri Lanka. Although there had been studies that have assessed these parameters and its risk factors for older adults and the elderly, there is a paucity of such data among Sri Lankan young adults. Thorough knowledge of these parameters and predisposing risk factors is vital in the modification of lifestyle and to enhance the quality of life. This was a descriptive cross-sectional study carried out among 646 students of the University of Peradeniya in 2017. Anthropometric measures, blood pressure measures were collected and family history status was assessed using a self-administered questionnaire. Standard equipment and procedures used to measure Body weight, height, waist and hip circumference and blood pressure of the subjects. Prevalence of obesity was 5% and 2.6% among male and female subjects respectively. The prevalence of hypertension among male participants was 3.15% and 1.41% among female participants. BMI had significant positive correlation with systolic blood pressure (SBP) ($r=0.383$) and diastolic blood pressure (DBP) ($r=0.336$) for all subjects ($p<0.01$). Waist to hip ratio had positive correlation with SBP($r=0.273$) and DBP (0.175) for males ($p<0.01$) and positive correlation with SBP($r=0.109$) and DBP (0.118) for females ($p<0.05$). Family history of obesity and hypertension were associated with BMI and Blood pressure values respectively.

Keywords: Body Mass Index, Waist Circumference, Waist to Hip Ratio, Systolic Blood Pressure, Diastolic Blood Pressure

1. Introduction

Overweight and obesity have become a global epidemic. They have important consequences on morbidity, disability, and quality of life. Prevalence rate of obesity is increasing globally and it has more than doubled since 1980 [1]. The prevalence of overweight and obesity among Sri Lankan adults is 34.4% [2]. The fundamental cause behind the prevalence of obesity is an energy imbalance due to the high-calorie intake and low-calorie expenditure. Overweight and obesity are recognized as the major cause for spreading noncommunicable diseases and lifestyle-related diseases, such as coronary heart diseases, diabetes mellitus type-2, hypertension, dyslipidemia, sleep apnoea, gallbladder disease, osteoarthritis, gout, hyperuricaemia, polycystic ovary syndrome and certain cancers such as breast & colon cancers. Many debilitating complications related musculoskeletal system, respiratory system, integumentary system and conditions such as infertility and psychological problems can arise from obesity resulting in reduced quality of life [3]. Body Mass Index (BMI) and other anthropometric measurements have been reported as significantly correlated with hypertension [4]. Researchers have found that hypertension is common in subjects with both extremely low and high BMI levels [5]. BMI and the waist circumference are considered as an indicator for the prediction of hypertension in men and women respectively [6]. According to a Nigerian study, age is associated with hypertension [7]. Hypertension is recognized as a principal symptom of cardiovascular diseases. 80% of the burden of hypertension and its complications are observed in low-income and middle-income countries. More than 25% of Sri Lankans

over 20 years of age are reported to have hypertension and the prevalence of hypertension is doubled among persons with positive family history when compared to persons with negative family history and was independent of weight [8]. The main objectives of this study were (i) to estimate the strength of correlation between Body Mass Index (BMI), Waist Circumference (WC), Waist to Hip Ratio (WHR) measurements and Systolic Blood Pressure (SBP) & Diastolic Blood Pressure (DBP), (ii) assess the prevalence of hypertension and obesity among university students and (iii) to assess the associations of family history of obesity and family history of hypertension.

2. METHODOLOGY

A cross-sectional descriptive study was carried out among the 1st year undergraduate students in the University of Peradeniya, Sri Lanka to assess the relationship between anthropometric measures (BMI, WC, and WHR) and blood pressure (SBP and DBP). Ethical clearance for the study was obtained from the ethics review committee of the Faculty of Allied Health Sciences, University of Peradeniya. Stratified randomized sampling method was used to enroll subjects to the study. 646 volunteer participants were recruited in the study by informed written consent after a verbal explanation of the purposes, procedures, advantages of participating in the study and participants rights to withdraw the study at any time. Physical disabilities, pregnancy, medication usage for hypertension were used as exclusion criteria. Bodyweight was measured by a calibrated weighing scale with light clothes and shoes removed. Height was measured using a stadiometer to the nearest 0.5 cm. BMI was calculated and

categorized according to the Asian BMI cut-off points (Table 1).

Table 1: Asian BMI cut-off points [9]

Body Mass index category	Asian BMI cut-off points (kg/m ²)
Underweight	< 18.5
Normal range	18.5-22.9
Overweight	23.0-27.4
Obese	≥27.5

WC was measured at the approximate mid-point between the lower margin of the last palpable rib and the top of the iliac crest with an anthropometric tape in the expiratory phase. Hip circumference was taken in the erect position and around the widest portion of the buttocks (level of greater trochanter). WHR is defined as the waist circumference divided by the hip circumference. WC and WHR were classified according to the guidelines of Bray et al [10] (Table 2). WC measures recorded higher than reference values were classified as centrally obese subjects.

Table 2: Waist to Hip Ratio (WHR) Norms [10]

Gender	Excellent	Good	Average	At Risk
Male	<0.85	0.85-0.89	0.90-0.95	≥0.95
Female	<0.75	0.75-0.79	0.80-0.86	≥0.86

The mean of the three readings of SBP and DBP taken with the aid of mercury in glass sphygmomanometer calibrated in millimeters (0-300mmHg) and a Littman stethoscope was recorded. Blood pressure measurements were taken within a specific time duration to reduce the temporal variability of measures. Classification of blood pressure was done according to the guidelines of the American Heart Association (Table 3).

Table 3: Classification of Blood pressure for Adults - American Heart Association [11]

	SBP (mmHg)	DBP (mmHg)
Normal	<120	<80
Prehypertension	120-139	80-89
Hypertension Stage I	140-159	90-99
Hypertension Stage II	≥160	≥100
Hypertensive crisis	≥180	≥110

Family history of hypertension and obesity was assessed using a self-administered questionnaire. Mean values of measurements were used to rule out the relationship between variabilities. Pearson coefficient of correlation between chosen dependent and independent variabilities was calculated. Chi-square test was used to assess the association

between family history and obesity. Independent t-test was used for comparisons among male and female subjects. SPSS version 17 was used to analyze collected data.

3. Results

Sample of the study was 424 male subjects (65.6%) and 222 (34.3%) females subjects. The mean age of the female subjects was 21.22 (±0.83) years and the mean age of male subjects was 21.5 (±0.839) years. Mean BMI of the whole sample was 20.19 kg/m². Mean BMI of the male subjects was significantly higher (20.92) than female subjects (19.8) (p=0.01). Prevalence of obesity was significantly higher (p=0.05) among male subjects (5%) than the obesity of female subjects (2.6%). Most of the male and female subjects were classified into the normal weight category. A significant proportion of female (40.6%) subjects were included in the underweight category (Table 4).

Table 4: Distribution of BMI category according to sex

Sex	BMI Category	Frequency	Percentage %
Male (n=222)	under weight	62	27.9
	normal weight	112	50.5
	over weight	37	16.7
	obese	11	5
Female (n=424)	under weight	172	40.6
	normal weight	178	42
	over weight	63	14.9
	obese	11	2.6

Mean SBP and DBP of the whole sample were 108.57mmHg and 69.05mmHg respectively. The mean SBP of males (118.21±10.02 mmHg) was significantly higher (p=0.01) than in females (103.52±9.5 mmHg). The mean DBP of males (72.94±8.03 mmHg) was also significantly higher (p=0.01) than in females (67.01±7.71 mmHg). Prevalence of hypertension was 4.5% among male subjects and 1.4% among female subjects. Mean DBP of all BMI categories were in the normal range, while the mean SBP of obese BMI category was in the prehypertension category (Table 5). Mean SBP and mean DBP showed a graded response with the BMI categories.

Table 5: Mean SBP and DBP according to BMI category

BMI category		Mean	Std. Deviation
underweight	SBP	104.312	10.8071
	DBP	66.308	7.4968
normal weight	SBP	109.994	11.4317
	DBP	70.058	8.2399
overweight	SBP	116.514	11.7540

	DBP	73.790	8.0845
obese	SBP	125.905	16.4336
	DBP	78.333	8.7369

Mean WC was significantly higher among males (76.15cm) than female subjects (72.23cm). 79 (24.8%) female subjects had WC measures more than 80cm and 14 (3.5%) male participants had WC more than 90cm. However, according to the cut-off values for South Asians, a higher percentage of female subjects (18.6%) were at risk than male subjects (6.3%). Mean WHR was 0.848 in male subjects and 0.812 in female subjects. According to WHR, 92 female subjects and 2 male subjects were in “at-risk” category. Positive family history of obesity was 10.7%, while the positive family history of hypertension was 37.9%. Mean BMI (21.81 Kg/m²), WC (77.47cm) and WHR (0.8397) were higher in subjects with a positive family history of obesity. Mean BMI (20.54 Kg/m²) and WC (74.39cm) were higher in subjects with a positive family history of hypertension. However, mean SBP and DBP were not significantly different between the subjects with a positive and negative family history of hypertension. Family history of hypertension was significantly associated with family history of obesity (Pearson Chi-Square=32.849). As per the current study, BMI, WC, and WHR were significantly and positively correlated with both SBP and DBP for male and female subjects. Highest correlation coefficient recorded for both the SBP and DBP was WC for males and BMI for females (Tables 6 & 7).

Table 6: Correlation between BMI, WC, and WHR with SBP and DBP among male subjects

Male subjects		BMI	WC	WHR
SBP	Pearson Correlation	0.379**	0.398**	0.273**
DBP	Pearson Correlation	0.292**	0.323**	0.175**

Table 7: Correlation between BMI, WC, and WHR with SBP and DBP among female subjects

Female subjects		BMI	WC	WHR
SBP	Pearson Correlation	0.359**	0.298**	0.109*
DBP	Pearson Correlation	0.313**	0.258**	0.118*

4. Discussion

Association of age with hypertension, BMI and WHR has been reported in literature. Accordingly, BMI and WHR tend to increase proportionately with advancing age [12]. Since the sample of the present study consisted of subjects of a narrow age range of 20-23 years, the variations due age were assumed to be minimal and hence not analyzed in depth. Majority of the subjects were included in the normal BMI range, although a significant proportion of female participants were the included in the underweight category.

A national survey conducted in 2012 to assess the prevalence and association of overweight among adult women in Sri Lanka has estimated the prevalence of underweight among females in the age category of 20-29 as 22.5%. However, according to the same survey, prevalence of underweight among females in the age category of 15-19 years was 40.5 % [13]. Although the findings of the present study on the prevalence of obesity among males were comparable with other relevant studies, obesity among females was found to be far less than what has been previously reported. For instance, a study on the prevalence of overweight and obesity in Sri Lankan adults has estimated that the prevalence of obesity among males and females of 20-29 year age category as 4.4% and 5.3% respectively [14]. According to a previous study, higher level of education, being a female, urban living, physical inactivity, and being in the middle age were associated with the prevalence of obesity [14]. The same study has reported the prevalence of central obesity of male and female subjects of 20-29 years of age as 7.5% and 23.1% respectively [14]. Similarly, the prevalence of abdominal obesity was higher among female subjects of the present study as well, while the figures for male subjects were even lesser compared to the previous study. According to the current study, the prevalence of hypertension was higher among male participants. Similar findings have been reported regarding Sri Lankan young adults following a population based survey. However, the prevalence of hypertension was lesser in female subjects compared to the findings of the said survey [15]. As per the findings of this study, Family history of hypertension is significantly associated with hypertension. A study, carried out in 7 of 9 provinces in Sri Lanka has identified that the hypertension was common in adults with a positive family history compared to adults with negative history [8]. It is possible that deviations from other relevant studies are contributed by the effects of the level of education and narrow age range of the current study group. An increased prevalence of hypertension with higher levels of education has been demonstrated in a recent Sri Lankan study [2]. The mean SBP of obese BMI category is already in the prehypertensive range. This indicates that higher BMI categories have an increased risk of developing hypertension and related cardiovascular diseases. BMI was the better predictor of hypertension for males as demonstrated by a previous study [6]. However, blood pressure of male subjects in this population showed a stronger correlation with WC than BMI. Correlation coefficients of anthropometric measure with SBP for males were stronger than the findings of related previous studies [2]. According to a previous study, the anthropometric measure with the highest correlation to hypertension was WC in females while it was BMI for males [6]. WHR has a weaker correlation in females while a comparatively stronger correlation was observed in males.

5. Conclusion

Correlation of WC with SBP and DBP was stronger in the male subjects while correlation of BMI with SBP and DBP was stronger in female subjects. Prevalence of both Hypertension and obesity was comparatively higher in male population while the prevalence central obesity was higher among female subjects.

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Author Profile



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