Original Article

RELATIONSHIP OF BODY MASS INDEX AND WAIST TO HIP RATIO MEASUREMENT WITH HYPERTENSION IN YOUNG ADULT MEDICAL STUDENTS

Shamail Zafar[1], Israr ul Haque[2], Anjum Rasheed Butt[3], Huda G Mirza[4], Fuad Shafiq[5], Ameed ur Rehman[6], Nusrat Ullah Ch[7]

ABSTRACT

Objectives: To examine the BMI profile and waist to hip ratio measurements of young adult medical students of Lahore medical and dental college and its relationship with hypertension.

Methodology: All the students of Lahore medical & dental college were asked to undergo physical examination. Height, weight, waist circumference, hip circumference, systolic and diastolic blood pressure were recorded. The partial correlation coefficient was used to quantify the association between BMI and waist-to-hip circumference ratio with systolic and diastolic blood pressure. Linear regression analysis was used to assess the influence of body mass index and waist-to-hip circumference ratio on the variance of systolic and diastolic BP.

Results: Mean BMI was 23.24 (SD±4.31). Descriptive analysis revealed that 103(21.3%) of the study population were classified as underweight, 251(52 %) as normal weight, 99 (20.5%) as overweight, and 30 (6.2 %) as obese. Abdominal adiposity, as measured by increased WHR, was present in 56 subjects (11.59 %). Partial correlation controlled for age revealed strong positive correlation between BMI and WHR for males.7.24% had high systolic blood pressure, minimum systolic BP was 90 while maximum being 160mmHg. Same was the value for high diastolic blood pressure i.e. 35 (7.24%), range was from 60 to 100mm Hg. Results of the partial correlation coefficient controlled for age, indicated a significant positive correlation between SBP and DBP. Stepwise linear regression analysis controlled for age revealed that both body mass index and waist-to-hip circumference ratio were independently correlated with both systolic and diastolic blood pressures.

Conclusions: The present results suggest that prevalence of overweight and obesity among the medical students is higher than in general population. Those with either higher BMI or central adiposity distribution are potential candidates of increased risk of hypertension and cardiovascular disease.

KEY WORDS: Body mass index, Hypertension, Overweight, Obesity, Central adiposity.

Pak J Med Sci July - September 2007 Vol. 23 No. 4 574-579

1. Dr. Shamail Zafar, FCPS
2. Dr. Israr ul Haque, FCPS
3. Dr. Anjum Rasheed Butt, FCPS
4. Dr. Huda G Mirza, MRCP

1-4: Assistant Professor of Medicine,

5. Dr. Fuad Shafiq, MRCP Associate Professor of Medicine,
6. Dr. Ameed ur Rehman, Registrar Department of Medicine,
7. Prof. Nusrat Ullah Ch, MBBS MRCP Professor of Medicine,

1-7: Lahore Medical and Dental College, Lahore, Ghurki Trust Teaching Hospital, Lahore – Pakistan.

Correspondence

Dr. Shamail Zafar,
E-mail: shamail@doctor.com

* Received for Publication: December 19, 2006

* Accepted: May 2, 2007

INTRODUCTION

Every individual needs a certain amount of body fat for energy, heat insulation and shock absorption. However, excessive deposition of fat in the body, which is usually referred to as overweight or obesity, is dangerous. Overweight specifically refers to an excess body weight compared to set standards, while obesity is to have an abnormally high proportion of total body fat.[1]

Obesity is a major health hazard all over the world and is becoming a major health threat

in Pakistan.[2] There are a number of health hazards associated with obesity, including diabetes, hypertension, cardiovascular disease, arthritis, anaesthesia risk, respiratory problems, breast cancer, menstrual abnormalities, ovarian dysfunction along with poor social image and rejection.[3] WHO has updated recommendations for action to governments, international agencies and concerned partners in the public and private sectors, as there is a need to assess the burden and determinants of the problem in various populations for effective control measures.[4]

Pakistan is a country facing 'double-burden' of disease. While efforts continue to prevent and control infectious disease such as vaccine-preventable disease (e.g. measles, polio, hepatitis), and those related to water and sanitation (e.g. gastroenteritis), non-communicable diseases (NCDs), such as CVD, hypertension and diabetes, also pose a health burden.[5] Globalization, increasing urbanization, changes in traditional family structures and lifestyles, and a more mechanized workplace directly Affect dietary and physical activity patterns and ultimately increase the risk of such diseases.

Excess body weight or obesity, along with hypertension, cigarette smoking and hypercholesterolemia, is an important risk factor for cardiovascular disease (CVD). Arterial hypertension alone is among the most prevalent risk factor of cardio- and cerebrovascular disease and death.[6] The risk increases progressively with every increment in blood pressure, as documented in a meta-analysis of multiple observational studies involving more than 400 000 untreated subjects.[7] The incidence of arterial hypertension, determined by systolic blood pressure greater than 139mmHg or diastolic greater than 89mmHg, continuously increases with age and averages 30% in the fifth decade, 40% in the sixth decade and 50% in the seventh decade.[6]

In recent years, body mass index (BMI) also called Quetelet Index (initially described by Quetelet in 1869), has become the measurement of choice for many obesity researchers and health professionals, to measure overweight and obesity in adults.[8] BMI describes relative weight for height, is not gender specific and is significantly correlated with total body fat content. (Table-I) The evaluation of central adiposity by way of the waist to hip ratio (WHR) has been recognized as a substantial component in the assessment of cardiovascular disease risk factors due to an association between WHR and hypertension.[9]

The childhood roots of adult obesity and (CVD) are widely recognized and associated with calls for heath promotion targeted at youth.[10] Recent studies have indicated the presence of trend in over weight and obesity in children and adolescents of developing countries,[11] but there is very little work done in evaluating relationship of prevalence of obesity among young adults and various modifiable risk factors such as hypertension.

In this study we evaluated a sample of medical students who fall in young adult age group for anthropometric measurements and its relationship with systolic and diastolic blood pressure.

SUBJECTS AND METHODS

Four hundred and eighty three medical college students, belonging to both MBBS and BDS classes aged, 17 to 26 years were recruited to participate in the present study. In order to recruit the subjects, students from all nine classes were randomly selected. Written informed consent was obtained from all subjects prior to their participation.

Anthropometrical Measurements: Anthropometrical measurements were taken using standard apparatus. A digital scale (seca) was used to measure body weight (BW) with an accuracy of +100g. Subjects were weighed without shoes, in light clothing. Standing body height (BH) was measured without shoes to the nearest 0.5cm with the use of a commercial stadiometer with the shoulders in relaxed position and arms hanging freely. Body mass index (BMI) was then calculated as BW in kilograms (kg) divided by square of the BH in meter (m^2). (Table-I).[4] Waist was measured horizontally at the level just above the uppermost border of the iliac crest. The measurement was made at a normal minimal respiration. Hip

was measured as the maximum circumference over the buttocks. Central obesity was also calculated and defined on the basis of WHR. The cut-off value of central obesity was considered ≥0.95 in males while normal value for females was ≥0.80.[4]

Blood pressure measurement: In order to measure blood pressure, subjects were seated in a chair with their back supported and their arms bared and supported at heart level. Measurement was performed with the subject not having ingested coffee or smoked for 30 minutes and after at least five minutes of rest. The appropriate cuff size was used to ensure an accurate measurement. Measurements were taken using a mercury sphygmomanometer applied on the right arm of the participants. First and fifth Korotkoff sounds were recorded for systolic and diastolic readings respectively. Two readings separated by two minutes were averaged. If they differed by more than 5mmHg, one additional reading was obtained and then averaged. Using the recently published "The Seventh Report of Joint National committee on Prevention, Detection, Evaluation and Treatment of High blood Pressure (JNC-VII) criteria"[12] blood pressure was defined accordingly

Normal	Systolic and diastolic < 120/80
Pre- hypertensives:	Systolic 120-139 or diastolic 80-89mm of Hg
Stage-1 hypertensives:	Systolic 140-159 or diastolic 90-99 mm of Hg
Stage-2 hypertensives:	Systolic 160 or diastolic 100mm of Hg

Hypertension was defined as systolic blood pressure (SBP) ≥140 mmHg, and diastolic blood pressure (DBP) ≥90mmHg.

Statistical Analysis: Statistical analysis was carried out using the statistical program available in SPSS version 10. Descriptive statistics for anthropometric characteristics and SBP and DBP were calculated. Partial correlation coefficient was used to quantify the association between independent variables (BMI and WHR) and dependent variables (SBP and DBP). Linear regression analysis was used to assess the influence of BMI and WHR on the variance of SBP and DBP. All tests for statistical significance were two tailed and significance was selected at P-value <0.05.

RESULTS

There were a total of 483 medical students, 290(60.04%) were female while 193 (39.96%) were male. Ages ranged from 17 to 26 years with a mean age of 20.46 years (SD±1.65). Fig-1 Anthropometric and blood pressure characteristics of the subjects are shown in Table-II, III. Mean BMI according to definition used, was 23.24 (SD±4.31) while descriptive analysis revealed that 103(21.3%) of the study population was classified as underweight, 251(52 %) as normal weight, 99 (20.5%) as overweight and 30 (6.2 %) as obese (Fig-1). The results revealed that at the WHR cut-off point recommended for central obesity (males WHR ≥0.95 cm; females WHR ≥80cm), abdominal adiposity was present in 56 subjects (11.59 %) of which 31 were male while 25 were females. Partial correlation controlled for age revealed strong positive correlation between BMI and WHR for males (r = 0.690, P < 0.0001) and females (r =0.620, P<0.0001). Inspection of the data obtained for the hypertension, indicated that 35 subjects of the study population (7.24%) had systolic high blood pressure, minimum systolic BP was 90 while maximum being 160mmHg. Interestingly the same number of

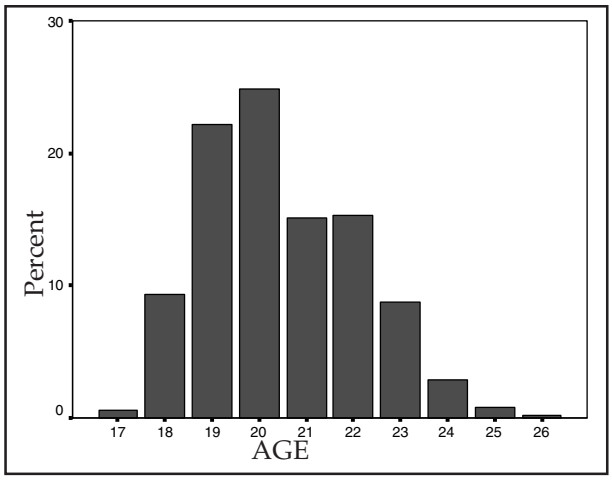

Fig-I: Age Distribution of study population.

Table-I: Categories of BMI to identify, health risk.

BMI	*Weight Categories*	*Risk*
< 18.5	Underweight	Increased Risk
18.5 – 24.9	Normal Weight	Least Risk
25 – 29.9	Overweight	Increased Risk
30 and Over	Obese	
30 – 34.9	Obese Class I	High Risk
35 – 39.9	Obese Class II	Very High Risk
≥ 40	Obese Class III	Extremely High Risk

(Source: WHO guidelines for body weight classification in adults 2003)

subjects had a high diastolic blood pressure i.e. 35 (7.24%), range was from 60 to 100mm Hg. Results of the partial correlation coefficient controlled for age, indicated a significant positive correlation between SBP and DBP (r= 0.590, P<0.0001). Likewise, partial correlation revealed that, there were significant correlation between the independent and dependent variables. BMI was positively correlated with SBP (r = 0.592, P<0.0001) and DBP (r = 0.199, P<0.0001), respectively. Similarly, positive correlation was found between WHR and SBP (Males r = 0.356, P < 0.0001, Females r =0.346) and between WHR and DBP (Males r = 0.396, P < 0.0001, Females r =0.412) in both males and females.

Stepwise linear regression models were fitted for each SBP and DBP as the dependent variable and BMI and WHR as the independent variables controlled for age to determine the influence of BMI & WHR on the variance of SBP and DBP. In this study BMI correlated similarly with SBP (beta 0.30, SE 0.21, P< 0001) as with DBP (beta 0.29, SE 0.20, P<0.0001). While stronger correlation existed between results for WHR as an independent positive correlate to SBP (beta 0.16, SE 11.90, P< 0.04) than to DBP (beta 0.11, SE 9.25, P< 0.041).

Table-II: Descriptive analysis for anthropometrics and blood pressure characteristics

Variables	*Mean*	*S.D.*
Age (Y)	20.46	± 1.0
Height (Cm)	165	± 9.8
Weight (Kg)	63.1	± 12
Waist (Cm)	75.6	± 8.2
Hip (Cm)	90	± 6.5
WHR	0.78	± 7.6
BMI (Kg/m^2)	23.24	± 4.3
SBP mm/Hg	122.0	± 10
DBP mm/Hg	71.2	± 8.4

DISCUSSION

The purpose of this study was to provide data on the prevalence of overweight and obesity and their associations with hypertension among young adult medical college students. BMI and WHR were used in the present study for two reasons. First, due to simplicity and reproducibility of height, weight, hip and waist circumference measurements, second because both have been recognized as important indicators for estimating cardiovascular disease risk factors, in particular their association with hypertension.[8-11] The results of the present study demonstrated that the overall prevalence of overweight and obesity were 20.5% and 6.2%, respectively, while 21.3% were underweight. In addition, according to the present results, 11.59% of the participants had waist-to-hip circumference ratio ≥0.92. When we compare it with National Health Survey of Pakistan 1990-94[2] the prevalence of BMI and overweight among our study group came out to be little higher. In NHSP-the first comprehensive national health examination survey, the prevalence of overweight was reported as 13.5% for males and 19.6% for females, while under-

Table-III: Comparison of anthropometric characteristics (mean and standard deviation) of university students reported in different countries[16]

Country	*N*	*Age (y)*	*Weight (kg)*	*Height(cm)*	*BMI (kg/m2)*
England	303	20.0±2.0	69.0±10.4	178.0±6.7	21.8±2.6
France	289	21.1±2.3	68.0±9.3	178.0±7.2	21.6±2.2
Greece	310	20.9±1.9	75.0±9.5	179.0±5.9	23.5±2.4
Iceland	393	21.2±2.9	76.0±10.0	182.0±5.9	23.0±2.7
Spain	369	21.2±2.6	72.0±10.0	176.0±6.6	23.1±2.7
Iran	537	21.7±2.4	65.7±11.1	176.4±6.1	21.6±3.4
Current study	483	20.4±1.6	63.1±12.1	165.0±9.8	23.2±4.3

weight population was declared as 25% which is higher than our study group. Mean BMI according to NHSP was 20.9kg/m^2 for males and 21.7kg/m^2 for females. In another large scale study done on Pakistani population[5] the prevalence of overweight and obesity was around 14% and 2.2% respectively. In this very same study the prevalence of underweight population was around 11% which was less than not only our study but also from National Health survey of Pakistan. The very reason for this difference of values may be the rapid change of lifestyle and eating behavior amongst the youth in the past decade. It thus necessitates the need of large-scale data collection at national level.

But when we examine the prevalence of overweight and obesity among students then these values are almost similar. In a study done on Greek medical students[13] the mean BMI was 39.5% in males while 22.3% in female students, while 27.6% were overweight and 4.3%were obese. In a survey at Louisiana state university 37% of males and 9% of females were found to be overweight.[14]A study conducted among 154 medical students in south Africa reported rates of overweight and obesity that were19.7% and 4.6% for black students. Overweight and obesity among black female medical and nursing students was fond to be 30.6%.[15] A comparison of anthropometric characteristics of students of various countries is shown in Table-III.[16] By looking at all these studies it is apparent that results of BMI and height and weight are quite similar in students of around same age groups.

Central adiposity levels among medical students vary widely according to anthropometric index used. A common problem found in similar surveys, as no consensus about the appropriateness of the different obesity indices or cut-off points have been reached. We adopted waist to hip ratio cut-offs proposed by Dobbelsteyn et al.[17] Abdominal adiposity was present in 56 subjects (11.59%) with males more obese than females. Almost similar findings were there in a study from Iran which showed prevalence to be around 11.4%. In a European study on medical students[13] 33.4% of men and 21.7% of women were declared to have central adiposity, which means that in our area this parameter does show lower prevalence. Other parameters like waist circumference and waist to height ratio should also be considered before relying on a single parameter as no consensus is still present which can prove superiority of one over other.

A striking finding of our study was the high prevalence of elevated systolic and diastolic blood pressure (7.24%) as compared to other studies. A study done among black and Indian medical students in South Africa,[15] disclosed rates of high blood pressure of 2.5% and 4.2% respectively. New Jersey medical students reported high DBP (4.2%) & SBP (3.5%).[18] A survey conducted at Louisiana State University reported rates of high SBP of 4% of both sexes while DBP of 11% in females while 4% for males. In a study from Iran 4.8% of college students had high SBP while 4% had high DBP.[16] Significant positive association between either BMI or WHR and SBP and DBP was found in the present study. The independent association between BMI and either SBP or DBP is in line with previous findings.[9 13 16]

Similarly, the results of this study that described the independent relationship between WHR and either SBP or DBP are consistent with previous reports.[13 16]

Surprisingly, however, contrasting results have been found in a number of studies.[19 20] Borona et al,[19] reported that BMI was an independent predictor for diastolic blood pressure and not for systolic blood pressure. However, they reported that WHR was not an independent predictor for either systolic or diastolic blood pressures. They argued that failure to find an independent association between WHR and blood pressure might have been due to the fact that most of the study populations were nonobese. This argument is based on the evidence that showed regional fat distribution has an impairment effect on metabolic and haemodynamic measures, only when the overall body fat is larger than a certain quantity. Our results are also in contrast to Bogalusa Heart Study where none of the WC, WHpR, WHtR measurements predicted the blood

pressure levels of young adults in multivariate models.[21] Nonetheless there are many studies with different conclusions.[13 17 21]

An important result of the present study is a considerably high prevalence of underweight (20.5%) among young adult medical students. This has been observed to be more common among girls. A possible explanation for the tendency toward being underweight among students may be that, since majority of the students that enrolled in LMDC lived far from their family in the hostels or independently, they may be mal- or undernourished. In order to indicate whether the BMI's of those living at home and those far from home are different , independent samples T-test was used and a statistically significant ($P<0.01$) difference between the two groups was found. Similar results were also found in other studies[16] but separate work should be done to evaluate predictors of this result.

Limitations of the study: International Diabetes Federation (IDF) has proposed new cut off value of BMI for Asian population. If they were taken into account as against WHO proposed criteria, the prevalence of obesity would have been much higher.

CONCLUSIONS

The main findings of this study are summarized as follows: a) a substantial proportion of young medical students were overweight or obese, b) obese students had higher levels of major CVD risk factor variables, namely blood pressure. c) BMI was found to be a useful index for the prediction of high blood pressure. WHP ratio also correlates well with SBP and DBP.

Our results highlight the necessity to institute effective prevention and health promotion programs targeting younger age groups. In view of the fact that medical students are not representative of the general population, studies should be extended to the young adult population and investigate the presence of obesity and major CVD risk factors and their trends over time.

REFERENCES

1. Afridi AK, Khan A. Prevelance and etiology of obesity-An overview. Pak J Nutr 2004;3(1):14-25.
2. National Health Survey of Pakistan 1990-1994: Pakistan Medical Research Council,1998.
3. Akhter MN, Pappas G. Health, Pakistan, and globalization. Am J Public Health 2001;91:13-4.
4. WHO. Obesity: Preventing and managing the global epidemic. Report of WHO consultation on obesity, June5-7 1997.Geneva: World Health Organization 1998.
5. Shah SM, Nannan D, Rahbar MH. Assessing obesity and overweight in a high mountain Pakistani population. Trop Med Int Health 2004;9(4):526-32.
6. Seidell JC, Cigolini M, Charzewska J. Fat distribution in European women: A comparison of anthropometric measurements in relation to cardiovascular disease risk factors. Int J Epidemiol 1990;19:303-8.
7. Filipovsky J, Ducimetiere P, Darne B. Abdominal body mass distribution and elevated blood pressure are associated with increased risk of death from cardiovascular diseases and cancer in middle-aged men. The results of a 15- to 20-year follow-up in the Paris prospective study. Int J Obes 1993;17:197-203.
8. Brown CD, Higgins M, Donato KA. Body mass index and the prevalence of hypertension and dyslipidemia. Obes Res 2000;8:605-19.
9. McKeigue PM, Shah B, Marmot MG. Relation of central obesity and insulin resistance with high diabetes prevalence and cardiovascular risk in South Asians. *Lancet* 1991;337:382-6.
10. Whitaker R, Wright J, Pepe M. Predicting obesity in young adulthood from childhood and parental obesity. N Eng J Med1997;337:869-73.
11. Serdula M, Ivery D, Coates R. Do obese children become obese adults? A review of the literature. Prev Med 1993.22:167-77.
12. Chobanion AV, Bakris GL, Black HR. The seventh report of the joint national committee on prevention, detection, evaluation and treatment of high blood pressure-the JNC 7 report. JAMA 2003;289:2560-72.
13. Bertsias G, Mammas I, Linardakis M. Overweight and obesity in relation to cardiovascular disease risk factors among medical students in Crete, Greece. BMC public health 2003;3:3.
14. Farris R, Strada R, Wolf T. Nurient intake and cardiovascular risk factors of first year medical Students J Vasc Med Biol 1994,5:138-43.
15. Morar N, Seedat YK, Naido DP. Ambulatory blood pressure and risk factors for Coronary heart disease in black and Indian medical students. J Cardiovasc Risk 1998,5:313-8.
16. Shahbazpour N. Prevalence of Overweight and Obesity and Their Relation to Hypertension in Adult Male University Students in Kerman, Iran. Int J Endocrinol Metab 2003; 2:55-60.
17. Dobbelsteyn C. A comparative evaluation of waist circumference, wasit –to-hip ratio and BMI as indicators of cardiovascular risk factors. The Canadian heart health surveys. Int J Obes Relat Metab Disord 2001,25:652-61.
18. Najem GR, Passannante MR, Foster JD. Health risk factors and health promoting behavior of medical, dental and nursing students. J Clin Epiemiol 1995,48:841-9
19. Bonora E, Targher G, Branzi P. Cardiovascular risk profile in 38-year and 18-year-old men. Contribution of body fat content and regional fat distribution. Int J Obes Relat Metab Disord 1996;20:28-36.
20. Folsom AR, Burke GL, Ballew C. Relation of body fatness and its distribution to cardiovascular risk factors in young blacks and whites. The role of insulin. Am J Epidemiol 1989;130:911-24.
21. Gustat J. Relation of abdominal height to cardiovascular risk factors in young adults. The Bogalusa Heart Study. Am J Epidemiol 2000,151:885-91.