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Original Article

Relationship between body mass index and blood pressure in female college students of Paniola, Rawalakot (Azad Jammu and Kashmir)

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Abstract
Obesity and hypertension are both major public health problems of the world. Hypertension remains the most important risk factor identified for the cardiovascular disease of stroke, myocardial infarction, congestive heart failure, coronary artery disease and peripheral vascular disease. It has been observed that body mass index (BMI) is one of the most important risk factor for elevation of blood pressure. To study the relationship between blood pressure with overweight, data were collected from 255 female college students and analyzed. The results revealed that BMI is the main determinant of elevation in both systolic and diastolic blood pressure. The mean systolic (104.26mmHg) and diastolic (70.6mmHg) blood pressure of the underweight female was significantly lower than the normal weight (110.79mmHg and 74.04mmHg respectively). The blood pressure measured of normal weight female (110.79mmHg and 74.04mmHg) was significantly lower than of overweight female (112.05mmHg and 76.77mmHg) respectively while blood pressure of overweight female was not significantly different than obese female.
Key words: Obesity, systolic, diastolic, hilly areas, overweight.

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INTRODUCTION

Obesity refers to an excess of body fat. It is always due to energy intake greater than energy expenditure. It is always defined in terms of co-morbidities and more mortality (Flier and Foster, 1998). The excess food whether fats, carbohydrates or proteins is stored almost entirely as fat in adipose tissue to be used later for energy (Guyton and Hall, 2000). Obese adults are at greater risks of hypertension, stroke, heart disease, diabetes and osteoarthritis (Barlow and Dietz, 1998). The most widely used clinical parameter for the assessment of obesity is the body mass index (BMI) which is an inexpensive and easy to perform method of screening for weight categories (Meiz *et al*., 2002).

In clinical practice, obesity is typically evaluated by measuring BMI, waist circumference and evaluating the presence of risk factors and co-morbidities. The BMI is positively related to the risk of death from cardiovascular disease and cancer (Manson *et al*., 1995). It is the strongest predictor of hypertension and obesity status being related to the presence of hypertension (Bertsias *et al*., 2003). The mean systolic and diastolic blood pressure both gradually increase with an increase in BMI showing obvious linear relationship between BMI and blood pressure and the risk for hypertension increased with BMI elevation (Fang and Nie, 2003).

Blood pressure exceeding normal value is called arterial hypertension. All levels of blood pressure put mechanical stress on the arterial walls. High blood pressure is an established risk factor for cardiovascular disease (Kannel, 1996). The prevalence has increased dramatically over the past several decades both in industrialized and developing world. Hypertension is associated with overweight tendencies and obesity (Marc *et al*., 2001). High pressure increases heart work load and progression of unhealthy tissue growth that develops within the walls of its arteries. The higher the pressure, the more stress that it present and the more atheroma tend to progress and the heart muscles tend to thicken, enlarge and become weaker over time. Persistent hypertension is one of the risk factors for strokes, heart attacks,

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heart failure, arterial ancurysms, and is the second leading cause of chronic renal failure after diabetes mellitus (Whelton, 1994).

Although numerous risk factors for hypertension have been identified, a complete understanding of the cause of hypertension and of the reason for its high prevalence remains elusive. In the past most attention was paid to diastolic pressure; but nows as days it is recognized that both high systolic pressure and high pulse pressure are also risk factors. In some cases it appears that a decrease in excessive diastolic pressure can actually increase risk, probably due to the increased differences between systolic and diastolic pressure (Wolz *et al*., 2000).

It is reported that weight gain in young adult life is potent risk factor for later development of hypertension in youth. The regression analysis showed a linear relative weight-blood pressure relation for both sexes and both systolic and diastolic blood pressure (Gumez-Sandoval *et al.,* 1990). Hypertension is one of the most common obesity related complication, and about 30% of hypertensive individuals can be classified as being obese (Mac-Mahon *et al*., 1987).

Life style especially diet and physical activity are associated with elevation of blood pressure. Unhealthy life style components such as lack of physical activity and imbalanced or higher food intake have been recognized as important risk factors for the development of hypertension. Healthy life style modification plays a significant role in the prevention and management of hypertension (Dickey and Janich, 2001). The present study was conducted to investigate the association of blood pressure with overweight tendency/obesity in female college students of Paniola (Rawalakot). The data collected was analyzed statistically to investigate the relationship of blood pressure with overweight/obese tendency.

MATERIALS AND METHODS

This study was carried out in the colleges of Paniola Valley Rawalakot at the altitude of 5500 feet. The students were 17 to 22 years old. In present study, direct interview was conducted from 255 students and a questionnaire was filled from each student followed by determining the weight and height. Then blood pressure of each student were also measured in day time between 8-11 AM using stethoscope and sphygmomanometer after providing peaceful environment.

Body mass index of each student scaled according to height and weight. The BMI was calculated according to Quetelet, 1871);

$$\text{Body mass index (BMI)} = \frac{\text{Weight (Kg)}}{\text{Height (m}^2\text{)}}$$

The BMI < 18.5 kg/m^2 was considered as the normal while 25-29 kg/m^2 was overweight whereas > 30 kg/m^2 considered as obese.

Statistical analysis:

One way analysis of variance unstacked (ANOVA) was applied using MINITAB software.

RESULTS

A total number of 255 subjects (age 17-22) years mean age 19.5 years randomly participated in this study. Minimum body mass index of students was 14.22 kg/m^2 while maximum body mass index was 32.46 kg/m^2 (Table I). Prevalence of underweight (BMI < 18.5 kg/m^2) and normal weight (18.5-24.9 kg/m^2) status in the studied female population was 12.16% and 71.77% respectively while the prevalence of overweight (BMI 25-<30 kg/m^2) and obese (30 and above kg/m^2) status was 17.73% and 2.36% respectively (Table II). Prevalence of underweight status (BMI<18.5 kg/m^2) was 18.69 kg/m^2 in the age group of 17-18 years, 17.46 kg/m^2 in the age group of 19-20 years, and 17.48 kg/m^2 in the age group of 20-22 years (Table III). Prevalence of normal weight status (BMI 18.5-24.9 kg/m^2) was 20.90 kg/m^2 in age group of 17-18 years, 22.02 kg/m^2 in the age group of 19-20 years, and 21.73 kg/m^2 in the age group of 21-22 years, (Table III). Prevalence of overweight status (BMI 25-29.9 kg/m^2) was 27.04 in the age group of 17-18 years, 27.51 kg/m^2 in the age group of 19-20 and 27.62 kg/m^2 in the age group of 21-22. Prevalence of obesity status (BMI of 30 and above kg/m^2) was 31.32 kg/m^2 in the age group of 17-18 years and 30.34 kg/m^2 in the age group of 19-20 years and 31.48 kg/m^2 in the age group of 21-22 years (Table III). Mean BMI in the studied population was 22.02 kg/m^2 (Table IV); BMI ranges from 14.22 kg/m^2 to 32.46 kg/m^2; all

categories of weight to height ration *i.e.,* body mass index were round in this population which includes underweight normal weight, overweight and obese.

Table I: Comparison of Body Mass Index (BMI) in different age groups of female.

BMI (Kg/m^2)	Age group (years)		
	17-18	19-20	21-22
Minimum	15.00	16.40	14.22
Maximum	31.18	30.51	32.46
Mean	22.05 ±0.40	22.03 ±0.33	22.02± 0.38

Table II: Mean Body Mass Index in female population in percents.

Sr. No.	BMI (kg/m^2) category	Prevalence (%)
1	Under weight BMI < 18.5	12.16
2	Normal weight BMI 18.5-24.9	71.77
3	Over weight BMI 25 to <30	13.73
4	Obese BMI 30 & above	2.36

Table III: Mean Body Mass Index in different age groups (years) in female population.

BMI (kg/m^2) category	Age group (years)		
	17-18	19-20	21-22
Under weight BMI < 18.5 kg/m^2	18.69	17.46	17.48
Normal weight BMI 18.5 to 24.9 kg/m^2	20.90	22.02	21.73
Over weight BMI 25 to < 30 kg/m^2	27.04	27.51	27.62
Obese BMI 30 & above kg/m^2	31.32	30.34	31.48

Mean systolic blood pressure of the studied population was 110.50 mmHg. Mean systolic (104.16 mmHg) of underweight students was significantly lower than that of normal weight (110.79 mmHg) which was significantly lower than overweight (112.05 mmHg) and overweight was also significantly lower from obese (114.0 mmHg). Mean diastolic blood pressure was 74.28 mmHg. Mean diastolic blood pressure (70.58 mmHg) of the underweight students was significantly lower from that of normal weight (74.04 mmHg), normal weight was significantly lower from that over weight (76.77 mmHg) and obese (76.33 mmHg) and that of overweight was same (Table V).. In this age group, mean BMI was 21.65 kg/m^2. BMI was ranged from 15 to 31.81 kg/m^2. Mean systolic blood pressure of the group was 110.06 mmHg. Mean systolic blood pressure of the underweight subjects (100.16mmHg) was significantly lower from that of normal weight (111.75 mmHg) normal weight was significantly lower from overweight (121.38 mmHg) but non significantly lower from obese (Table VI). Mean diastolic blood pressure of the group was 74.63 mmHg. Mean diastolic blood pressure of the underweight students (70.16 mmHg) was significantly lower from that of normal weight (74.34 mmHg) normal weight was significantly lower from that of overweight (80.23 mmHg) but equals to the obese (74.5 mmHg).

Table IV: Mean±SEM of systolic (SBP), diastolic (DBP) blood pressure and body mass index (BMI) in different age groups (years).

Age group (years)	SBP (mmHg)	DBP (mmHg)	BMI (kg/m^2)
17-18	111.64 ±1.58	75.75 ±1.12	22.05 ±0.40
19-20	110.70 ±1.37	73.57 ±0.94	22.03 ±0.33
21-22	109.17 ±1.47	73.54 ±1.03	22.02 ±0.38
Mean	**110.50 ±1.47**	**74.28 ±1.03**	**22.03 ±0.37**

In this age group mean BMI was 21.7 kg/m^2. The range of BMI was from 16.40-30.51 kg/m^2. Mean systolic blood pressure of the group was 109.33 mmHg. Mean systolic blood pressure of the underweight subjects (111.44 mmHg) was non-significantly lower than that of normal weight (111.83 mmHg) and normal weight was non-significantly higher than from overweight (107.77 mmHg) and non-significantly low from obese (113.05 mmHg).

Table V: Correlation of Systolic Blood Pressure (SBP) and Diastolic Blood Pressure (DBP) with Body Mass Index (BMI) in female population.

Category of BMI (kg/m^2)	SBP (mmHg)	DBP (mmHg)
Under weight BMI < 18.5	104.16 ± 2.70	70.58 ±1.72
Normal weight BMI 18.5 to 24.9	110.79 ±0.93	74.04 ±0.66
Over weight BMI 25 to 30	112.05 ±2.50	76.77 ±1.87
Obese BMI 30 & above	114.00 ±6.24	76.33 ±4.61

Mean diastolic blood pressure of the group was 72.63 mmHg (Table VI). Mean diastolic blood pressure of the underweight students (74.55 mmHg) was non-significantly higher than that of normal weight (73.46 mmHg) which was non-significantly high from overweight (72.55 mmHg) but non-significantly low from obese (77.5 mmHg).

In this group mean BMI was 21.64 kg/m^2. The range of BMI was 14.22-32.46 kg/m^2. Mean systolic blood pressure of the group was 107.7 mmHg. Mean systolic blood pressure of the underweight subjects (103.2 mmHg) was significantly lower from that of normal weight (108.73 mmHg). Normal weight was significantly lower from that of the overweight (115.30 mmHg) and also significantly lower from that of the obese (116.05 mmHg). Mean diastolic blood pressure of the group was 72.51mmHg. Mean diastolic blood pressure of the underweight (61.1 mmHg) was significantly low from that of the normal weight (73.8 mmHg), normal weight was non-significantly low from that of the overweight (76.23 mmHg) and obese (77 mmHg).

Table VI: Correlation of Systolic Blood Pressure (SBP) and Diastolic Blood Pressure (DBP) with Body Mass Index (BMI) in different age groups of female population

Age (Years)	Category according to BMI	SBP (mmHg) (Mean ± SEM)	DBP (mmHg) (Mean ± SEM)
17-18	Under weight BMI < 18.5 kg/m^2	100.16±4.28	70.16±3.01
	Normal weight BMI 18.5 to 24.9 kg/m^2	111.75±1.61	74.34±1.26
	Over weight BMI 25 to < 30 kg/m^2	121.38±4.85	80.23±3.36
	Obese BMI 30 & above kg/m^2	112.0±10.00	74.50±8.50
19-20	Under weight BMI < 18.5 kg/m^2	111.44±4.69	74.55±2.76
	Normal weight BMI 18.5 to 24.9 kg/m^2	111.83±1.61	73.46±1.11
	Over weight BMI 25 to < 30 kg/m^2	107.77±2.85	72.55±3.25
	Obese BMI 30 & above kg/m^2	113.05±11.50	77.50±8.50
21-22	Under weight BMI < 18.5 kg/m^2	103.20±4.83	61.10±3.22
	Normal weight BMI 18.5 to 24.9 kg/m^2	108.73±1.63	73.80±1.13
	Over weight BMI 25 to < 30 kg/m^2	115.30±3.78	76.23±2.89
	Obese BMI 30 & above kg/m^2	116.50±18.50	77.00±13.00

DISCUSSION

Hypertension is a common problem in elder population. It remains the most important risk factor identified for the cardiovascular disease of stroke, myocardial infarction, congestive heart failure, coronary artery disease and peripheral vascular disease (Verdecchia *et al*., 2012). A key predictor of blood pressure in many populations is age (Nayak *et al*., 2012). High blood pressure is an established risk factor for cardiovascular disease (CVD) (Kováčová and Kiňová, 2012). Raised blood pressure tracks relatively well from youth to adulthood making blood pressure in youth, a useful predictor of essential hypertension in adulthood (Bao *et al*., 1995). Patterns of risk factors in populations such as raised blood pressure, are not static over time, and predict subsequent changes in patterns of cardiovascular disease (Thom, 1989). Evidence from United States and World Wide showed that the mean blood pressure of adults has decreased over the past two decades (Kucllasma *et al*., 2000).

Age significantly modifies the relationship of body mass index with mean diastolic blood pressure in both sexes and with prevalence of high blood pressure in females (Ortiz-Galeano *et al*., 2012). All the four categories of BMI were found in this population. 71.77% students were normal weight; overweight category comes after normal weight. Overweight category is (13.73%). Underweight students were (12.16%) and obese student were only (2.36%). It is clear from above results that the prevalence of overweight / obese tendency is low in this population. After summing up both overweight and obese it reaches to 16.09%. In female of United Arab Emirates, overweight subjects were 19% and obese were 9.8% (Musaiger *et al*., 2012). A survey of university students in Europe showed that a very few subjects were overweight (8%) and less than 1% were obese (Phillips, 2012).

Statistical analysis showed that BMI was more or less significantly correlated with systolic and diastolic blood pressure (Table V-VI). Analysis of data after considering various age groups also showed the same results. Body mass index was found to be important predictor of blood pressure. A low physical fitness level and high BMI was independently associated with a high B.P and risk of having hypertension in girls, BMI was strong predictor of hypertension especially in girls. (Nielsen and Andersen, 2003). The present study showed that increase in body mass index is the most important predictor of elevated blood pressure in this population. The reason for high blood pressure may be high lipid dietary intake, less physical activity and changed life style. Normalization of blood pressure cannot occur without reaching ideal body weight. The change in life style including increase of physical activity and reduction in fat intake is the best method to prevent elevation in blood pressure, which is a risk factor for further hypertension and cardiovascular ailments.

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