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Correlation between body mass index and blood pressure indices in under weight, normal weight and over weight adolescents.

KEYWORDS: body mass index, blood pressure indices, adolescents.

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ABSTRACT *Background*

Overweight and obesity are disorders of energy balance affecting wide range of people belonging to diverse ethnic groups, age and socio–economic status. The present study is an endeavor to study the nutritional status in relation to the cardiovascular status of medical students joining the medical college.

AIM OF THE STUDY

To study the correlation between body mass index and blood pressure indices, in underweight, normal weight and overweight adolescents.

MATERIALS AND METHODS

The present study for a period of one year from August 2007 to August 2008 was done in the department of physiology.149 subjects were taken up as sample in the study after they were informed of the nature of the study and then getting consent from them for inclusion in the study.The data is analyzed by the relevant statistical methods

TOOLS USED:

1. *Descriptive measures – Mean, Standard Deviation.*
2. *One-way ANOVA (Analysis of Variance).*
3. *Tukey-Kramer's Multiple comparison test.*
4. *Karl Pearson's Correlation Coefficient.*

RESULTS: Among 149 students 88 (59%) are male and 61 (41%) are female students.

According to the BMI, the subjects were made into three groups – underweight, normal weight and overweight.

56 males (63%) and 32 females (52%) are of normal weight.

12 males (14%) and 17 females (28%) are of underweight.

20 males (23%) and 12 females (20%) are of overweight. The BMI, the Systolic Blood Pressure and Diastolic Blood Pressure are normal in the normal weight subjects, where as low in underweight and high in over height and obese subjects in both males and females.

CONCLUSION:Thus the problem of underweight, overweight and hypertension was observed amongst students joining the Medical College of Kurnool. These need to be addressed to prevent its sequelae.Advised exercise, modification of life style and dietary habits in overweight and obese students.Underweight students are advised to improve nutritional status by encouraging to take balanced food. Also advised regular health checkups to exclude iron deficiency and some of the chronic diseases like parasitic infestations etc.

INTRODUCTION

Hypertension, Diabetes mellitus (DM) and coronary heart diseases (CHD) are constituent members of non-communicable diseases. Increased prevalence of the diseases has been reported among overweight and obese persons as a consequence of unhealthy lifestyle.

The prevalence of obesity in India is 7-9%; though it is less than that in America or other countries but the situation is alarming when computed against huge population in India.[3]

Early detection of obesity and its intervention with treatment could avert the long-term consequences like the development of cardiovascular diseases.

Blood pressure is regulated by activity in autonomic nervous system. Obesity is associated with sympathetic activation and is the leading risk factor for the development of hypertension.[14]

The use of body mass index (BMI) for the prediction of risk factor clustering among children and adolescents has significant clinical utility. In a large cross sectional study of adolescents, BMI has been shown to be a better index of body fatness compared to waist-hip ratio.[13]

In the present study we tested the hypothesis that there is a correlation between Body Mass Index and Blood pressure indices viz. systolic blood pressure, diastolic blood pressure, pulse pressure, mean pressure, heart rate and

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rate-pressure product in apparently healthy adolescents. The age group from 18 to 21 years is important physically mentally and emotionally. This is the period of transition when individuals are entering adulthood. Medical Students joining Medical Colleges represent this group.

AIM OF STUDY: To study the correlation between body mass index and blood pressure indices, in underweight, normal weight and overweight adolescents.

MATERIALS AND METHODS

The present study for a period of one year from August 2007 to August 2008 was done in the department of physiology. During the above period the First year Medicos were taken up in the study. 149 subjects were taken up as sample in the study after they were informed of the nature of the study and then getting consent from them for inclusion in the study. The study was started after clearance of the ethical committee. This study was performed between 10AM and 11AM, 2-3 Hrs after a light breakfast.

The data regarding their identity, dietary habits, lifestyle, Family History of Diabetes mellitus, Hypertension and Obesity, height, weight and Blood pressure indices were collected in a proforma. Students belonging to mixed socioeconomic status were taken. The age of each individual was recorded in completed years.

The height was measured to the nearest of 0.1cm with the help of a steel tape and the weight was measured to the nearest of 0.1kg with the help of a weighing machine. The instruments were tested for accuracy and the weighing machine was adjusted to '0' level each time before actual measurement. The body mass index was calculated by the formula weight (in kg) / height (in metre^2).

The study population was divided into 3 groups of underweight, normal weight and overweight sub groups taking the cut-off point of BMI as 18.49 kg/metre^2 for underweight and 22.99 kg/metre^2 for overweight, from 18.5 to 22.99 kg/meter^2 for normal weight according to International Obesity Task Force Standards for Asia.

Both overweight and obese subjects were clubbed together.

Recording of Blood Pressure:

After a rest period of 5 minutes, systolic and diastolic pressures were recorded with mercury sphygmomanometer (Diamond) and the stethoscope, by both palpatory & auscultatory methods. In the palpatory method the radial pulse was used as it was more convenient.Two readings were taken at an interval of 5 minutes and average of two readings used for analysis.Blood pressure was measured in the seated position with the right arm supported at heart level.

Blood pressure was measured and classified as per the Seventh Report of the Joint National Committee on prevention, detection, evaluation and treatment of high blood pressure (JNC 7).

Classification of blood pressure for adults aged 18 and older:[6]

Category	systolic, mmHg	diastolic, mmHg
Hypotension	<90	or <60
Normal	90–119	and 60–79
Prehypertension	120–139	or 80–89
Stage 1 Hypertension	140–159	or 90–99
Stage 2 Hypertension	≥160	or ≥100

Heart rate (**HR**) was recorded by counting the pulse rate by palpation of the radial artery.

Pulse pressure (PP), the difference between systolic blood pressure and diastolic blood pressure was recorded.

Mean Arterial pressure (MAP) was calculated as **Diastolic pressure + 1/3 pulse pressure.**

Rate pressure product (RPP) was calculated as **Systolic pressure X Heart rate X 10-2.**

The data is analyzed by the relevant statistical methods**.**

RESULTS:

The present study investigated the correlation between body mass index (BMI) and blood pressure indices in apparently healthy subjects aged 17-20 years. The data was obtained from 149 students (88 males and 61 females). All first year MBBS students were monitored age wise and sex wise.

According to BMI, among 88 **Males**, 56 (63%) are of normal weight, 12 (14%) are of underweight and 20 (23%) are of overweight.

According to BMI, among 61 **Females**, 32 (52%) are of normal weight, 17 (28%) are of underweight and 12 (20%) are of overweight

All data are expressed as mean **±** standard deviation.

The difference between under weight, normal weight and over weight groups were tested by using ANOVA, followed by Tukey-Kramer's Comparison test for both males and females subjects.

Correlation between Body Mass index (BMI) and all other parameters were assessed by calculating Karl Pearson's Correlation Coefficient.

A two-tail 'p' value less than 0.05 (<0.05) is considered statistically significant.

Results are tabulated in tables I, II and III.

All the parameters under study are expressed as mean **±** standard deviation, are given in **table I for males** and in **table II for females**.The correlation coefficient between BMI and various parameters are presented in **table III.**

In view of the possibility that there could be gender differences, the data was analyzed in males and females separately.

Males:In the three groups, that is under weight, normal weight and over weight, there is a significant difference between the groups in terms of BMI ($P < 0.0001$).

SBP, DBP and MAP are lowest in under weight and highest in over weight ($P < 0.05$ in both the subjects).

It was observed that HR, PP and RPP are similar in all the three groups ($P > 0.1$ and also $P > 0.001$ for each).

Females:There is a significant difference between the three groups in terms of BMI ($P < 0.001$) in females also. There is a significant difference between the three groups in terms of DBP and MAP ($P < 0.05$). They are highest in

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over weight and lowest in underweight subjects.

Though SBP was highest in over weight subjects, the difference could not reach statistical significance as P = 0.22.

In both males and females, it was found that SBP and DBP are highest (maximum) in over weight subjects and least (minimum) in underweight subjects, intermediate in normal weight subjects.

PP and HR are similar in both males and females in all the three groups.

Correlation: For a sample of 149 of the three types of subjects (over weight, normal weight and under weight), correlation is assessed between BMI, and HR, SBP, DBP, PP, MAP and RPP. 't' test is used for correlation coefficient.

important Correlations: A significant correlation between BMI and all the BP indices, namely SBP, DBP, PP and MAP (P < 0.05) except HR and RPP is observed in underweight males.No significant correlations are observed between BMI and BP indices in underweight female subjects.

In underweight males, the correlation between BMI and DBP is highest (r = 0.821), where as in over weight subjects, the correlation between BMI and MAP is highest (r = 0.703). **In overweight females**, the correlation between BMI and SBP is highest (r = 0.670). The correlation between BMI and DBP is observed to be closer (nearer to each other) in underweight and overweight female subjects.

Table I: Parameters of the study are expressed as mean ± Standard Deviation
Males

	Under Weight n = 12	Normal Weight n = 56	Over Weight n = 20	P value
Age	18.5 ± 0.674	18.339 ± 0.228	18.9 ± 0.75	0.41
Height	1.710 ± 0.041	1.687 ± 0.003	1.697 ± 0.078	0.09
Weight	52 ± 3.643	57.919 ± 5.025	71.8 ±8.135	0.0001
BMI	17.754 ± 0.833	20.328 ± 1.318	24.893 ± 1.727	0.0001
HR	77 ± 2.296	77.44 ± 2.433	77.1 ± 3.567	0.98
SBP	103.5± 7.038	110.214 ± 4.066	118.8 ± 5.247	0.001
DBP	66.667 ± 4.924	70.607 ± 2.051	78.5 ± 3.776	0.0001
PP	36.833 ± 3.010	39.607 ± 2.708	40.25 ± 2.788	0.88
MAP	78.925± 5.541	83.804 ± 2.589	91.96 ± 4.132	0.0001
RPP	79.792 ± 7.073	85.409 ± 5.146	91.7 ±7.501	0.19

Table II: Parameters of the study are expressed as mean ± Standard Deviation – Females

	Under Weight n = 17	Normal Weight n = 32	Over Weight n = 12	P value
Age	18.352 ± 0.702	18.312 ± 0.592	18.2 ± 0.39	0.12
Height	1.615 ± 0.040	1.5889 ± 0.062	1.580 ± 0.045	0.33
Weight	46.058 ± 2.766	51.593 ± 5.02	62.833 ± 6.057	0.0001
BMI	17.641 ± 0.522	20.416 ± 1.239	25.107 ±1.677	0.001
HR	78 ± 1.802	77.062 ± 1.865	78.166 ± 1.642	0.81
SBP	98.823 ± 5.918	108.5 ± 4.977	115.166 ± 4.706	0.22
DBP	64.588 ± 4.988	73.812 ± 3.880	78 ± 2.828	0.049
PP	34.235± 2.818	34.687 ± 4.051	37.166 ± 4.706	0.76
MAP	76.005 ± 5.136	85.368 ± 3.830	90.383 ± 2.779	0.0445
RPP	77.064 ± 4.534	83.662 ± 5.246	90.051 ± 4.572	0.93

Table III: Correlation between BMI and Various parameters

Group list	N	HR	SBP	DBP	PP	MP	RPP
UNDER WEIGHT (Males)	12	0.654	0.777*	0.821*	0.474*	0.817*	0.797
OVER WEIGHT (Males)	20	0.492	0.664	0.690	0.316	0.703	0.639
NORMAL WEIGHT (Males)	56	0.55	0.58	0.411	0.56	0.52	0.64
UNDER WEIGHT (Females)	17	-0.023	-0.066	0.067	-0.259	0.017	-0.080
OVER WEIGHT (Females)	12	-0.079	0.670	0.062	0.632	0.417	0.505
NORMAL WEIGHT (Females)	32	0.521	0.429	0.223	0.314	0.338	0.518

*t-test for correlation show P<0.001

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DISCUSSION

The World Health Organization (WHO) describes overweight and obesity as one of the today's most important public health problems in developed and in developing countries, and countries under going economic transition. The prevalence of overweight and obesity among children and adolescents has significantly increased in developed and developing countries during the past two decades.[16]

Studies carried out during the last decade indicated that India has entered the era of dual nutrition burden; under and over nutrition both coexist in all segments of the population.

Adolescence is a period of transition from childhood to adulthood. It occupies a crucial position in the human life cycle, characterized by an exceptionally rapid rate of growth.

Adolescents are becoming more overweight and obese than in the past, possibly because of decrease in physical activity & sedentary life styles and change in dietary habits. Therefore estimating overweight and obesity among adolescents is of paramount importance to avert morbidity and mortality associated with the problem of overweight and obesity. This is particularly important for the future health guards of the people, that is medicos who pursue a prolonged rigorous academic training with lot of mental stress to excel in the examination leaving little scope for outdoor games or physical exercise.

The present study has highlighted that overweight and obesity is an emerging health problem.

Both systolic and diastolic blood pressure increase with increase of BMI. Overweight and obese individuals are at higher risk of developing hypertension than lean individuals.

Ravi Sankar P et al.[15] in their study obtained data from 145 (105 males and 40 females). According to BMI 65 males and 9 females were of underweight, 27 males and 20 females were of normal weight and 13 males and 11 females were of overweight.

In contrast in the present study data was obtained from149 students. According to BMI, 12 males and 17 females are of underweight, 56 males and 32 females are of normal weight and 20 males and 12 females are of overweight.

In the present study only two subjects have fallen in the obese category. Hence they were clubbed in the overweight group only.

On analyzing the correlation between body mass index and blood pressure indices in underweight, normal weight and overweight adolescents, in the present study, it is found that in both males and females systolic blood pressure and diastolic blood pressure were highest in overweight subjects, intermediate in normal weight subjects and least in underweight subjects. This study correlated with the study of Ravi Sankar P. et al.[15]

In the present study heart rate and pulse pressure were similar in the three groups in both males and females, correlated with Ravi Sankar P. et al[15] who documented similar findings. It could possibly be due to insignificant difference in cardiac output, arterial compliance and stroke volume in all the three groups.

Ravisankar P et al study revealed significant correlations between BMI and BP indices in underweight males. In marked contrast, no significant correlations were observed between BMI and BP indices in underweight female subjects.[15] Similar findings are observed in the present study. Thus there are gender differences in correlation between BMI and BP indices.

The observed differences between the three groups and gender differences in correlation between BMI and BP indices may be due to differences in autonomic function and or energy metabolism.[15]

Jiang He et al stated that both systolic and diastolic blood pressure were positively related to the body mass index.[10] The association of body mass index and blood pressure was greater in men than in women. In the present study similar observations are made.

Jiang X et al study found positive correlation between BMI and hyperdynamic circulation that is increased PP and HR[11]. Present study revealed statistically insignificant correlation.

Gupta et al, Chadha SL documented the significant increase of blood pressure with increasing age groups[7,4]. In the present study the overweight subjects ranging from 19–20 years showed elevated blood pressure when compared to 17–18 years age group. These observations correlated with the above studies.

Mario Vaz et al stated that heart rate was similar in the lean and obese subjects. Diastolic blood pressure was significantly higher in obese compared with the lean subjects.[12] Similar findings are noted in the present study.

Jawed Aziz et al in their study found significant difference in mean systolic and mean diastolic blood pressure in three BMI blood groups (underweight, normal and overweight)[9]. Similar findings are observed in the present study.

Israeli E et al in his study documented that pre hypertension was common in adolescents. He also observed BMI is greater than normal. In the present study the prehypertension and greater BMI was observed in adolescents[8]. Hence this study is correlated with above findings.

I.Banerjee et al documented that the adolescents from middle income families have lower BMI.[1] In the present study same observations are made.

M. Behjati et al, documented that elevated BMI was strongly associated with elevated blood pressure.[2] Present study correlated with the above observations.

P.Chhabra et al observed that students with BMI more than 25 were more likely to have elevated blood pressure.[5] Similar observations are made in the present study.

CONCLUSION:

The BMI, the Systolic Blood Pressure and Diastolic Blood Pressure are normal in the normal weight subjects, where as low in underweight and high in over height and obese subjects in both males and females.

The results of the present study provide some insights to support to encourage physical activity during adolescence and also for attempts aimed at modifying the food habits. The role of physical activity, participation in games and

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sports are to be emphasized in adolescence. Promotion of better food, life style practices and regulated TV viewing could go a long way in preventing development of obesity and overweight.

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