ORIGINAL ARTICLE

CORRELATION BETWEEN BODY MASS INDEX AND BLOOD PRESSURE IN ADOLESCENTS

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Background: The obesity and hypertension are the major risk factors of several life threatening diseases. The present study was conducted to study the correlation of Body Mass Index (BMI) the validated index of adiposity with blood pressure in adolescents. Objectives: To determine body mass index (BMI) and blood pressure of the adolescents and to find out the correlation between body mass index (BMI) and blood pressure. To advice about lifestyle modifications like aerobic exercises, diet management, and abstinence from alcohol and smoking. Methods: We obtained data from 300 healthy medical students (112 males and 188 females) and assessed the correlations between BMI and the systolic blood pressure (SBP) and diastolic blood pressure (DBP). In view of gender differences in autonomic regulation, data of male and female subjects were analysed separately. The statistical analysis was done using t-test. Results: There was highly significant ($p<0.001$) positive correlation between BMI with SBP and DBP in both male and female subjects. On further analysis, on the basis of BMI subgroups, it was found that the correlation was significant ($p<0.01$) only in overweight males (BMI $>23$ Kg/m$^2$) compared to overweight females. Conclusion: BP is linearly related to BMI. The observed differences between the BMI subgroups may be possibly due to differences in autonomic function and metabolism.

Keywords: Body Mass Index (BMI), Blood pressure, adolescents.

INTRODUCTION

The obesity is known as one of the most important health problems. The prevalence of overweight and obesity had increased slightly over the past decade in India, but in some urban and high socioeconomic groups it reached relatively high levels. Globally the prevalence of childhood obesity varies from over 30% in USA to less than 2% in sub-Saharan Africa. National representative data for childhood obesity in India is unavailable, however, available studies of Chennai and Delhi has shown that prevalence of 6.2% and 7.4% respectively. Obesity is usually defined in terms of BMI which provides an index of weight relative to height and is generally considered a valid index of adiposity. Obesity is considered as a gateway disease, which can lead to heterogenous diseases such as metabolic syndrome, diabetes different gastrointestinal and respiratory disease, and certain types of cancers and hypertension. As BMI increases, the risk increases for cardiovascular complications including hypertension (high blood pressure).

Hypertension is believed as a significant risk factor of adulthood diseases and unfortunately is getting more prevalent rapidly. Hypertension is associated with the incidence of stroke, coronary heart disease, congestive heart failure and renal insufficiency. It has been shown that high BP in adults can be originated from childhood. The number of adolescents suffering from hypertension is increasing over the years, in no small part because there has been a striking shift in the lifestyle of children and teenagers.

The rise of obesity and the lifestyle has resulted in a whole host of medical problems for youth. The prevalence of hypertension among all adolescents is approximately 3.5%. Blood pressure is regulated by activity in the autonomic nervous system. Obesity is associated with sympathetic activation and is the leading risk factor for development of hypertension. The use of body mass index (BMI) for the production of risk factor in adolescents has clinical utility. This study was designed to see any correlation of BMI with BP in adolescents.

SUBJECTS AND METHODS

This study was conducted in the Department of Physiology, Sri Guru Ram Das Institute of Medical Sciences and Research, Amritsar. Three hundred medical students (112 boys and 188 girls) of age group 17–19 years were included in this study. Ethical clearance was obtained from the Institute Ethical Committee. The students were briefed about the objectives of the study before taking their written consent. Routine history and physical examination was done to rule out any illness that would interfere with the outcome of the study.

Body Mass Index (BMI) was calculated using a Quetelet’s index:

$$\text{BMI} = \frac{\text{weight in (Kg)}}{\text{Height in meters}^2}$$

Subjects were classified into three subgroups based on BMI: underweight (BMI $<18.5$ Kg/m$^2$), normal weight (BMI $18.5-23$ Kg/m$^2$), and overweight (BMI $>23$ Kg/m$^2$).

http://www.pps.org.pk/PJP/12-1/Manjeet.pdf
Standard methodology was used to measure blood pressure. Blood pressure was recorded in sitting position after giving rest for 5–10 minutes. Blood pressure recordings were expressed to the nearest 2 mm Hg. All blood pressure recordings were taken at the same time of the day, i.e., during afternoon hours and recorded by the same person and by the same instrument.

The correlation between BMI and Blood Pressure was assessed by calculating the correlation coefficient \( r \), and the \( p<0.05 \) was taken as significant.

**RESULTS**

Of the total 300 subjects, 112 were boys and 188 were girls. In view of the possibility that there could be gender differences in regulation of cardiovascular autonomic function, data were analysed in males and females separately.

In overall males the correlation coefficient \( r \) of BMI with systolic blood pressure (SBP) and diastolic blood pressure (DBP) was 0.338 and 0.377 respectively \( (p<0.001) \) (Table-1) (Figure-1a, b). On further analysis of 112 males on the basis of BMI subgroups it was found that in underweight \((\text{BMI}<18.5 \text{ Kg/m}^2)\) as well as normal weight \((18.5–23 \text{ Kg/m}^2)\) groups the correlation coefficient \( r \) were not significant. However, in the overweight subjects \((\text{BMI}>23 \text{ Kg/m}^2)\) the correlation coefficient \( r \) with SBP and DBP were 0.007 and 0.004 respectively \( (p<0.01) \) (Table-1).

**Table-1: Correlation of BMI with SBP and DBP in males**

<table>
<thead>
<tr>
<th>Parameters ( \text{BMI}&lt;18.5 \text{ Kg/m}^2 ) ( (n=5) ) Underweight</th>
<th>( r )</th>
<th>( p )</th>
</tr>
</thead>
<tbody>
<tr>
<td>SBP</td>
<td>0.202</td>
<td>0.745</td>
</tr>
<tr>
<td>DBP</td>
<td>0.489</td>
<td>0.403</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Parameters ( \text{BMI} 18.5–23 \text{ Kg/m}^2 ) ( (n=40) ) Normal weight</th>
<th>( r )</th>
<th>( p )</th>
</tr>
</thead>
<tbody>
<tr>
<td>SBP</td>
<td>0.173</td>
<td>0.287</td>
</tr>
<tr>
<td>DBP</td>
<td>0.238</td>
<td>0.138</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Parameters ( \text{BMI}&gt;23 \text{ Kg/m}^2 ) ( (n=67) ) Overweight</th>
<th>( r )</th>
<th>( p )</th>
</tr>
</thead>
<tbody>
<tr>
<td>SBP</td>
<td>0.325</td>
<td>0.007*</td>
</tr>
<tr>
<td>DBP</td>
<td>0.348</td>
<td>0.004*</td>
</tr>
</tbody>
</table>

\* \( p<0.05 \)=Significant, \** p<0.001=Highly significant

In total girls (188) the correlation coefficient \( r \) of BMI with the SBP and DBP were 0.297 and 0.263 respectively \( (p<0.001) \) (Table-2) (Figure-2a, b). There was no significant correlation of SBP and DBP in the underweight, normal and overweight girls (Table-2).

**Table-2: Correlation of BMI with SBP and DBP in females**

<table>
<thead>
<tr>
<th>Parameters ( \text{BMI}&lt;18.5 \text{ Kg/m}^2 ) ( (n=34) ) Underweight</th>
<th>( r )</th>
<th>( p )</th>
</tr>
</thead>
<tbody>
<tr>
<td>SBP</td>
<td>0.181</td>
<td>0.307</td>
</tr>
<tr>
<td>DBP</td>
<td>0.154</td>
<td>0.385</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Parameters ( \text{BMI} 18.5–23 \text{ Kg/m}^2 ) ( (n=100) ) Normal weight</th>
<th>( r )</th>
<th>( p )</th>
</tr>
</thead>
<tbody>
<tr>
<td>SBP</td>
<td>0.175</td>
<td>0.081</td>
</tr>
<tr>
<td>DBP</td>
<td>0.050</td>
<td>0.623</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Parameters ( \text{BMI}&gt;23 \text{ Kg/m}^2 ) ( (n=54) ) Overweight</th>
<th>( r )</th>
<th>( p )</th>
</tr>
</thead>
<tbody>
<tr>
<td>SBP</td>
<td>0.207</td>
<td>0.133</td>
</tr>
<tr>
<td>DBP</td>
<td>0.248</td>
<td>0.070</td>
</tr>
</tbody>
</table>

\** p<0.001=Highly significant
DISCUSSION
Hypertension is the most common universal contributor to cardiovascular mortality. Elevated blood pressure, labile or fixed, systolic or diastolic, at any age, in either sex is a contributor to all forms of cardiovascular diseases. Studies on hypertension in adolescents have the important advantage that they may help in the control and possibly prevention of high blood pressure before its harmful sequel can occur.

The present study was carried out on 300 adolescent medical students between the age group of 17–19 years, to correlate between body mass index and blood pressure. In our study groups, both males (112) and females (188) were found to have significant positive correlation between BMI and blood pressure (SBP and DBP). This was possibly due to differences in sympathetic tone between underweight and overweight subjects. Analysing further on the basis of BMI subgroups, it was found that SBP and DBP were highest in overweight subject, which was statistically significant in males but not in female subjects. Thus, there were also gender differences in correlation between BMI and BP. Similar results were also observed by other Researchers where the above correlation was more significant in the males. The association of BMI with BP is also significant in children. Other studies suggested key predictors of high BP among adolescents are BMI followed by sedentary lifestyle.

Our results indicate that there was a positive correlation between BMI and BP, which was highly significant in both male and female subjects. Further dividing them into various subgroups there was statistically significant correlation between overweight male and BP indices which were not significant in overweight female subjects. Thus the correlation was at best modest and it was likely that several factors besides BMI influence BP indices. Indeed, there has been evidence that genetic factors account significantly for the correlation observed between BMI and BP.

One of the causes of hypertension is abnormal sodium and fluid balance. In obesity and hypertension, abnormal kidney function initially is due to increased tubular sodium reabsorption, which causes sodium retention and expansion of extracellular and blood volumes. Thus the obese individual requires higher levels of BP to maintain sodium fluid homeostasis. There are several potential mechanisms that could mediate the sodium retention and hypertension associated with obesity, including sympathetic nervous system activation, rennin-angiotensin-aldosterone system activation, and compression of the kidney.

Weight gain is almost invariably associated with an increase in BP. Thus, prevention of weight gain should be a primary target for reducing the problem of hypertension. Regular physical activity and reduced dietary fat intake could be achieved by small life style changes for prevention of obesity-associated hypertension.

CONCLUSION
BP is linearly related to BMI. The observed differences between the BMI subgroups may possibly be due to differences in autonomic function and metabolism.

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