RESEARCH ARTICLE

Response of cardiovascular system to exercise using bicycle ergometer among first year medical students

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ABSTRACT

Background: Hypertension is becoming more common in young adults because of sedentary lifestyle and lack of exercise in this digital world. The literature regarding the prevalence of hypertension among medical students in South India is limited. This study was done to find out the cardiovascular response in response to bicycle ergometric exercises.

Aim and Objectives: This study aims to find the response of short time effect of exercise on cardiovascular system by using bicycle ergometer among medical students and to determine the prevalence of prehypertension and hypertension in them.

Materials and Methods: A cross-sectional study was conducted among 100 medical students to assess their cardiovascular response to bicycle ergometer exercise. The subject was instructed to pedal the cycle for 5 min with 50–60 revolutions per minute. Pulse rate and blood pressure (BP) were recorded in resting state, during exercise (at 3 min), after exercise (at 5 min), and after recovery (10 min). Statistical analysis was performed using repeated measure ANOVA test and Pearson’s correlation co-efficient.

Results: About 24% students had increased systolic and 15% had increased diastolic BPs at rest. There was a significant increase in both during exercise. Ten minutes after exercise, the systolic BP was in prehypertensive range in 25% and Stage 1 hypertension in 2% students. Body mass index correlated with BP positively.

Conclusion: The prevalence of prehypertension among asymptomatic healthy medical students is high. Medical students need orientation to improve their knowledge, attitude, and lifestyle practices early in life for prevention and treatment of hypertension.

KEY WORDS: Exercise; Bicycle Ergometer; Prehypertension; Cardiovascular Response

INTRODUCTION

Hypertension is one of the important treatable risk factors for cardiovascular and cerebrovascular diseases. Its prevalence is on the rise in India. However, its awareness among public and its control is low. Only 25% rural and 38% of urban Indians with hypertension are aware and being treated for it. Global Burden of Diseases study reported that in India, there is 108% increase in deaths due to hypertension, averaging 1.63 million deaths in 2016 compared to 0.78 million in 1990. The disease burden measured by disability adjusted life years (DALYs) showed an 89% increase in this period.[1]

The term prehypertension was introduced by Joint National Commission 7 in their report on Prevention, Detection, Evaluation, and Treatment in May 2003 for persons with a systolic blood pressure (SBP) of 120–139 or diastolic pressure of 80–89.[2] This was intended to suggest lifestyle changes for those with abnormal level of pressure but not quantifying...
enough as hypertension. People with prehypertension are at higher risk for development of hypertension as suggested by the national heart, lung, and blood institute.

The presence of hypertension and prehypertension among medical students is on the rise, resulting from a sedentary lifestyle and stress from their clinical overload. These young adults aged 18–24 years are prone for development of its resultant complications.[3] Measurement of BP can assess the risk and help in treatment.

Early detection of hypertension and its effective management can prevent complications as end organ damage can be seen even in patients in early stages of hypertension. One of the useful indicators for the development of hypertension in future is an exaggeration of BP response to exercise.[4] Intervention in the form of assessing their disease progression and lifestyle modification reduced the risk of coronary heart disease.[5] Hence, this study was conducted among 1st year medical undergraduates to assess the risk of cardiovascular diseases and its impact on health.

Objectives
This study was done to assess the prevalence of prehypertension and hypertension among medical students. This study was aimed to study the short-term response of exercise on cardiovascular system using bicycle ergometer among medical students by analyzing BP and pulse rate in resting state, during exercise (3 min), after exercise (5 min), and after recovery (10 min). The relationship of gender and body mass index (BMI) with their cardiovascular response to exercises was also studied.

MATERIALS AND METHODS
The study was conducted in the Department of Physiology, SRM Medical College Hospital and Research Centre, Kattankulathur, Tamil Nadu. Institutional Ethical Committee Clearance (301/IEC/2019) was obtained. Informed written consent was obtained from the study participants and the parent of the study participants. First year MBBS undergraduate students attending the department were included in the study. Their age, height, weight, and BMI were recorded.

Subjects were instructed to have light breakfast 3 h before the test. The test was performed between 11 am and 12.30 pm in a good illuminated and ventilated room. The subject was given rest for 10 min. BP at rest in the sitting posture was recorded using Omron automated machine. The seat of bicycle ergometer was adjusted according to their height. BP cuff was tied around their right arm. Subject was instructed to pedal the cycle for 5 min with 50–60 revolutions/min. Heart rate and pulse rate were monitored within 130–150 beats/min by pulse oximetry. BP was recorded at 3rd min during exercise and at the end of cessation of exercise (5 min). After 10 min of exercise again, BP and pulse rate were recorded.

First year MBBS Students in the age group 17–21 years were included in the study. Students with pre-existing hypertension, diabetes mellitus, cardiovascular diseases, and respiratory diseases and who have undergone major surgeries were excluded from the study.

Statistical analysis was analyzed by SPSS software 25. The data were expressed in percentage, mean, and standard deviation. Repeated measure ANOVA test was used to determine the response of BP. \( P \leq 0.05 \) was considered as statistically significant.

RESULTS
The mean age of the participant was 17.94 ± 0.77 years, the minimum age being 17 years and maximum being 21 years. Hundred students participated in the study. About 51% participants were male and 49% participants were female. The mean BMI of the study was 23.56 ± 3.94, the minimum BMI being 15.62, the maximum BMI being 39.47 [Figure 1]. According to BMI, five students were underweight, 69 students were normal, 18 students were overweight, seven students were pre-obese Class I, and one student were pre-obese class II.

A repeated measures ANOVA with a Greenhouse-Geisser correction determined that mean SBP differed significantly between time points \( (F[1.88, 186.60] = 355.87, P < 0.0005) \). Post hoc tests using the LSD correction revealed that exercise training elicited a significant increase in SBP from resting to 3 min after exercise 113.32 ± 10.25 mm of Hg vs. 141.12 ± 9.99 mm of Hg, respectively. However, after recovery (10 min) SBP had been reduced to 114.88 ± 10.57 mm of Hg as in Table 1 and Figure 2.

Similar increase in diastolic BP (DBP) from resting to 3 min after exercise (73.86 ± 0.82 mm of Hg vs. 83.88 ± 1.26 mm of Hg, respectively), which was statistically significant.

![Figure 1: Body mass index](image-url)
(P ≤ 0.001) was noted. However, there was no significant difference between after exercise DBP and after recovery DBP (75.20 ± 0.79 mm of Hg vs. 74.86 ± 0.79 mm of Hg, respectively) (P = 0.05) as shown in Table 1 and Figure 3.

In Table 2 the resting state BP values were lower in females compared to males. The increase in SBP and DBPs after exercise was more marked in females than males. It increased from 108.37 to 139.38 in females compared to an increase from 118.08 to 142.78 mm Hg in males. The fall in BP after exercise and after recovery was also more in females than males.

In Table 3, BP is associated with BMI by Pearson correlation. There was positive Pearson correlation for resting BP, after exercise BP and 10 min after recovery and it was statistically significant. Figure 4 depicts the positive correlation with resting SBP and BMI with r = 0.254 and statistically significant P = 0.01. Figure 5 depicts the positive correlation with resting DBP and BMI with r = 0.253 and statistically significant P = 0.01.

Table 4 depicts the prevalence of BP among the study participants. The mean frequency distribution of BP showed

![Image](https://example.com/image1)

**Figure 2:** The mean of systolic blood pressure at rest, during exercise, resting after exercise, and recovery after exercise

![Image](https://example.com/image2)

**Figure 3:** The mean of diastolic blood pressure at rest, during exercise, resting after exercise, and recovery after exercise

![Image](https://example.com/image3)

**Figure 4:** Resting systolic blood pressure versus body mass index

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**Table 1:** Association of BP and exercise (n=100)

<table>
<thead>
<tr>
<th>Exercise</th>
<th>Mean SBP (in mm of Hg)</th>
<th>Mean DBP (in mm of Hg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resting state</td>
<td>113.32±10.25</td>
<td>73.86±0.82</td>
</tr>
<tr>
<td>During exercise (3 min)</td>
<td>141.12±9.99</td>
<td>83.88±1.26</td>
</tr>
<tr>
<td>After exercise (5 min)</td>
<td>122.14±8.30</td>
<td>75.20±0.79</td>
</tr>
<tr>
<td>After recovery (10 min)</td>
<td>114.88±10.57</td>
<td>74.86±0.79</td>
</tr>
</tbody>
</table>

BP: Blood pressure, SBP: Systolic blood pressure, DBP: Diastolic blood pressure

**Table 2:** Association of gender with BP (n=100)

<table>
<thead>
<tr>
<th>Exercise</th>
<th>Male SBP ± SE</th>
<th>Male DBP ± SE</th>
<th>Female SBP ± SE</th>
<th>Female DBP ± SE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resting</td>
<td>118.08±1.37</td>
<td>75.72±1.13</td>
<td>108.37±1.17</td>
<td>71.92±1.12</td>
</tr>
<tr>
<td>During exercise</td>
<td>142.78±1.26</td>
<td>85.06±1.63</td>
<td>139.38±1.54</td>
<td>82.65±1.19</td>
</tr>
<tr>
<td>After exercise</td>
<td>126.04±1.07</td>
<td>77.49±1.04</td>
<td>118.08±0.99</td>
<td>72.82±1.10</td>
</tr>
<tr>
<td>After recovery</td>
<td>120.11±1.34</td>
<td>78.31±1.24</td>
<td>109.43±0.99</td>
<td>71.26±1.07</td>
</tr>
</tbody>
</table>

BP: Blood pressure, SBP: Systolic blood pressure, DBP: Diastolic blood pressure

**Table 3:** Association of BMI with BP (n=100)

<table>
<thead>
<tr>
<th>Exercise</th>
<th>SBP</th>
<th>DBP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resting</td>
<td>r=0.254, P=0.01</td>
<td>r=0.253, P=0.01</td>
</tr>
<tr>
<td>During exercise (3 min)</td>
<td>r=0.063, P=0.53</td>
<td>r=0.062, P=0.53</td>
</tr>
<tr>
<td>After exercise (5 min)</td>
<td>r=0.235, P=0.02</td>
<td>r=0.278, P=0.01</td>
</tr>
<tr>
<td>After recovery (10 min)</td>
<td>r=0.273, P=0.01</td>
<td>r=0.192, P=0.06</td>
</tr>
</tbody>
</table>

BMI: Body mass index, BP: Blood pressure, SBP: Systolic blood pressure, DBP: Diastolic blood pressure
76% had normal resting SBP and 81% had normal resting DBP. Immediately after 5 min of exercise, 46% had normal SBP and 79% had normal DBP. BP recorded 10 min after recovery showed that 74% had normal SBP and 78% had normal DBP.

The mean frequency distribution of prehypertension states showing 24% had increased SBP and 15% had increased DBP at rest. Immediately after 5 min of exercise nearly 52% had increased SBP and 19% had increased DBP in prehypertensive state. BP recorded after 10 min of recovery of exercise shows that 25% had increased SBP and 18% had increased DBP.

The mean frequency distribution of hypertension Stage 1 showing 2% had increased SBP and 5% had increased DBP immediately after 5 min of exercise.

**DISCUSSION**

In the present study, 26% of students had abnormal BMI, with 8% being classified in obesity range. There was positive correlation between BP and BMI. Both SBP and DBPs increased during exercise and decreased after 10 min in 74% students. It remained increased in prehypertension and hypertension levels in 25% and 2% of students, respectively. The rise of BP with exercise and fall during recovery was more marked in females than males, even though the former had lower resting values of both pressures.

The exaggerated rise in BP during and after exercise was demonstrated in Framingham Heart Study to be a predictor of onset of hypertension in men. The increase in DBP was related positively to newer onset hypertension in female.\[^6\] The BP at 4 min after exercise was associated with a higher risk for hypertension, independent of their resting BPs according to a study done using Master’s double two-step exercise test.\[^7\]

The prevalence of prehypertension among general population varies from 20% to 80%.\[^8,9\] Studies among medical students in India have shown a prevalence of 64%, 52%, and 58.75% in Davengere, Wardha, and Dehradun, respectively.\[^10-12\] In our study, 24% students were found to have prehypertension which is lower than western and northern parts of India. Bhavani et al., found 15.9% of students were prehypertensive and more males were prehypertensive than females like the results of our study.\[^13\] In a study among medical students in North India by Kumar et al., 13.5% students were obese.\[^12\] Amruth et al. found that students with a family history of cardiovascular diseases had a higher BMI and 21.3% were found to be overweight.\[^14\] In the current study, 26% students had higher BMI than normal. The association of obesity, glucose intolerance, and dyslipidemia with prehypertension was found in many studies. In our study also, there was a positive correlation between BMI and BP.

Meta-analysis of multiple prospective studies involving people with prehypertension showed that the risk of cardiovascular diseases increases by a relative risk ratio of 1.55, coronary heart disease by 1.5, and stroke by 1.71.\[^15\] This signifies the importance of identification of these people in younger adulthood and make lifestyle changes. More than 10% of cardiovascular diseases can be prevented by controlling prehypertension. Family history of hypertension, heavy workload in their academic activities, mental stress, and sedentary lifestyle all are attributed as factors which promote hypertension among medical students. Less than 25% of Indian medical students do physical activities regularly.

The limitation of the current study is limited number of sample size. We have studied the cardiovascular response to exercise induced stress. We have not taken the anthropometric measurements, lipid profile, and glycemic status of these students into consideration.

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**Table 4:** Distribution of BP among the study participants (n=100)

<table>
<thead>
<tr>
<th>Category</th>
<th>Resting (SBP/DBP)</th>
<th>3rd min (SBP/DBP)</th>
<th>Resting after ex (SBP/DBP)</th>
<th>Resting after recovery (SBP/DBP)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>76%/81%</td>
<td>2%/52%</td>
<td>46%/79%</td>
<td>74%/78%</td>
</tr>
<tr>
<td>Pre hypertension</td>
<td>24%/15%</td>
<td>41%/10%</td>
<td>52%/19%</td>
<td>25%/18%</td>
</tr>
<tr>
<td>Stage -1</td>
<td>0%/4%</td>
<td>54%/25%</td>
<td>2%/5%</td>
<td>1%/3%</td>
</tr>
<tr>
<td>Stage -2</td>
<td>0%</td>
<td>3%/13%</td>
<td>0%</td>
<td>0%/1%</td>
</tr>
</tbody>
</table>

BP: Blood pressure, SBP: Systolic blood pressure, DBP: Diastolic blood pressure

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Figure 5: Resting DBP versus body mass index

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"Response of cardiovascular system to exercise using bicycle ergometer"

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CONCLUSION

A sedentary lifestyle among medical students increases the risk for cardiovascular diseases in them. Awareness programs for medical students about cardiovascular risk factors and to educate them for adopting a healthy dietary behavior should be initiated. Preventing obesity and living an active lifestyle should be a health priority. The medical students should be motivated to do regular exercise to reduce the risk. These lifestyle modifications can reduce the mortality risk.

REFERENCES


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