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## COMPARATIVE STUDY OF ANXIETY LEVELS IN HYPER-REACTORS AND NORMO-REACTORS IN MEDICAL STUDENTS: A CROSS-SECTIONAL ANALYSIS

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### ABSTRACT

**Background:** Anxiety is a common psychological factor among medical students and may influence cardiovascular reactivity. This study aimed to compare anxiety levels between hyper-reactors and normo-reactors and to evaluate gender-based differences.

**Material and Methods:** A cross-sectional study was conducted among 160 undergraduate medical students. Anxiety was assessed using Sinha's Comprehensive Anxiety Test (SCAT). Cardiovascular reactivity to cold pressor test was evaluated using standard protocol, and participants were categorized as normo-reactors or hyper-reactors. Resting blood pressure was measured and participants were classified into normotensive, prehypertensive, and hypertensive categories.

**Results:** Females had significantly higher SCAT scores compared to males ( $24.28 \pm 15.48$  vs  $17.01 \pm 14.11$ ;  $p = 0.001$ ). The majority of participants were normo-reactors, with 80% females and 86.95% males, while hyper-reactors constituted 20% females and 13.04% males. No significant difference in SCAT scores was observed between hyper-reactors and normo-reactors within females ( $22.71 \pm 13.37$  vs  $24.67 \pm 16.03$ ;  $p = 0.67$ ) or males ( $18.41 \pm 16.12$  vs  $16.80 \pm 13.89$ ;  $p = 0.71$ ). Most participants were normotensive (93.2%), with 6.17% prehypertensive and 0.6% hypertensive, the latter observed only in males.

**Conclusion:** Although females exhibited higher anxiety levels, no significant association was found between anxiety and cardiovascular reactivity. The majority of students were normo-reactors and normotensive.

**Keywords:** Anxiety, SCAT Score, Cardiovascular Reactivity, Hyper-Reactors, Normo-Reactors, Medical Students.

### INTRODUCTION

Anxiety is a prevalent psychological condition characterized by heightened emotional arousal and physiological responses, which can significantly influence both mental and physical health. In recent years, increasing attention has been directed toward the interaction between psychological stressors and cardiovascular regulation, particularly through the concept of cardiovascular reactivity, which reflects the body's hemodynamic response to stress [1]. Evidence suggests that anxiety and stress-related states can modulate autonomic nervous system activity, thereby influencing heart rate and blood pressure responses [1,2].

Medical students represent a vulnerable population with a high burden of psychological stress due to academic demands, competitive environments, and lifestyle changes. Several recent studies have reported a high prevalence of anxiety among medical students, with a substantial proportion experiencing moderate to severe levels [3,4]. These psychological disturbances not only affect academic performance but may also have implications for long-term cardiovascular health [5].

The relationship between anxiety and cardiovascular reactivity is complex and not yet fully understood. While some studies have demonstrated that heightened anxiety is associated with exaggerated cardiovascular responses to stress, others have reported blunted or diminished reactivity in individuals with higher anxiety levels, suggesting variability based on population characteristics and measurement techniques [2,6]. Moreover, emerging evidence indicates that mental stress can influence microvascular and hemodynamic responses,



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potentially contributing to early cardiovascular risk even in young individuals [7].

In addition, anxiety has been shown to affect the integrated functioning of the brain–heart axis, highlighting the interplay between central neural processes and autonomic cardiovascular control [8]. These interactions may manifest differently across individuals, leading to classifications such as hyper-reactors and normo-reactors based on their physiological responses to stress. Understanding these patterns is important, as exaggerated or abnormal cardiovascular reactivity has been linked to the development of hypertension and other cardiovascular disorders later in life [7].

Despite growing interest, limited studies have specifically explored the association between anxiety levels and cardiovascular reactivity among medical students. Furthermore, gender-based differences in anxiety and their relationship with physiological responses remain underexplored in this population. Therefore, the present study was undertaken to compare anxiety levels between hyper-reactors and normo-reactors and to evaluate gender-based variations in medical students.

## MATERIAL AND METHODS

**Study Design and Setting:** This cross-sectional study was conducted among undergraduate medical students at an Indian medical college.

**Study Population and Sampling:** A total of 160 medical students were included using a purposive sampling technique. Participants were selected based on predefined inclusion and exclusion criteria.

### Inclusion Criteria:

- Undergraduate medical students who provided written informed consent

### Exclusion Criteria:

- History of cardiovascular disease
- Known hypertension
- Known diabetes mellitus
- History of neurological illness
- Use of medications within the preceding 7 days
- Female participants during menstruation
- Individuals unwilling to participate

**Ethical Considerations:** The study protocol was approved by the Institutional Scientific Committee and Institutional Ethics Committee prior to initiation. Written informed consent was obtained from all participants after explaining the study objectives and procedures.

**Data Collection Procedure:** All participants underwent detailed history taking, general physical examination, and baseline assessment. Anthropometric parameters, blood pressure measurements, cardiovascular reactivity to cold pressor test, and anxiety levels were recorded using standardized protocols.

**Assessment of Anxiety:** Anxiety levels were evaluated using Sinha's Comprehensive Anxiety

Test. The SCAT consists of 90 dichotomous items requiring “Yes” or “No” responses. Each “Yes” response was assigned a score of 1, while “No” responses were scored as 0. The total score ranged from 0 to 90, with higher scores indicating greater levels of anxiety.

**Blood Pressure Classification:** Resting blood pressure was measured after 15 minutes of rest using a mercury sphygmomanometer. Three readings were taken at 2-minute intervals, and the average was considered for analysis. Participants were categorized as normotensive (SBP <120 mmHg & DBP <80 mmHg), prehypertensive (SBP 120 - 139 mmHg &/or DBP 80 – 89 mmHg), or hypertensive (SBP ≥140 mmHg &/or DBP ≥90 mmHg) based on standard blood pressure classification criteria.

### Assessment of Cardiovascular Reactivity:

Cardiovascular reactivity was assessed using cold pressor test. Blood pressure responses were measured in right arm every 30 seconds during the procedure while left hand and forearm was immersed into ice- cold water (4-5° C) for 90 seconds. Based on the response, participants were categorized as normo-reactors (SBP rise by 15-20 mmHg and DBP rise by 10 mmHg) or hyper-reactors (SBP rise by >20 mmHg and DBP rise by >10 mmHg). Hyper-reactivity was defined by exaggerated cardiovascular responses to physiological stressors, whereas individuals with responses within normal limits were classified as normo-reactors.

**Anthropometric Measurements:** Height and weight were measured using a stadiometer and calibrated weighing scale, respectively. Body mass index (BMI) was calculated using the formula:  $BMI = \text{Height (m)}^2 / \text{Weight (kg)}$

**Statistical Analysis:** Data were expressed as mean ± standard deviation for continuous variables and as proportions for categorical variables. Comparisons between groups were performed using appropriate statistical tests, and a p-value <0.05 was considered statistically significant.

## RESULTS

The comparison of anxiety levels revealed that females had a significantly higher mean SCAT score ( $24.28 \pm 15.48$ ) compared to males ( $17.01 \pm 14.11$ ), and this difference was statistically significant ( $p = 0.001$ ) (Table 1).

With respect to cardiovascular reactivity, the majority of participants in both genders were classified as normo-reactors. Among females, 56 (80%) were normo-reactors and 14 (20%) were hyper-reactors, whereas among males, 80 (86.95%) were normo-reactors and 12 (13.04%) were hyper-reactors (Table 2). Thus, a slightly higher proportion of hyper-reactors was observed in females compared to males.

Further analysis comparing SCAT scores between hyper-reactors and normo-reactors within each

gender demonstrated no statistically significant differences. In females, the mean SCAT score was  $22.71 \pm 13.37$  in hyper-reactors and  $24.67 \pm 16.03$  in normo-reactors ( $p = 0.67$ ). Similarly, in males, hyper-reactors had a mean SCAT score of  $18.41 \pm 16.12$  compared to  $16.80 \pm 13.89$  in normo-reactors ( $p = 0.71$ ) (Table 3).

Assessment of blood pressure categories showed that the majority of participants were normotensive.

Among females, 69 (98%) were normotensive and 1 (2%) was prehypertensive, with no cases of hypertension. Among males, 82 (89%) were normotensive, 9 (10%) were prehypertensive, and 1 (1%) was hypertensive. Overall, 93.2% of participants were normotensive, 6.17% were prehypertensive, and 0.6% were hypertensive (Table 4).

Table 1: Comparison of SCAT Score between Males and Females

Parameter	Females (N=70)	Males (N=92)	Significance
SCAT Score (out of 90)	$24.28 \pm 15.48$	$17.01 \pm 14.11$	0.001

Table 2: Percent of Normo-reactors and Hyper-reactors in Males and Females

Category	Females	Males
Normo-reactors (N, %)	56 (80%)	80 (86.95%)
Hyper-reactors (N, %)	14 (20%)	12 (13.04%)
Total N	70 (100%)	92 (100%)

Table 3: Comparison of SCAT Score in Hyper-reactor and Normo-reactor Males and Females

Gender	Hyper-reactors	Normo-reactors	Significance
Females	$22.71 \pm 13.37$	$24.67 \pm 16.03$	0.67
Males	$18.41 \pm 16.12$	$16.80 \pm 13.89$	0.71

Table 4: Percent of Pre-hypertensives and Hypertensives among Participants

Category	Normotensive N (%)	Prehypertensive N (%)	Hypertensive N (%)	Total N (%)
Females	69 (98%)	1 (2%)	0	70 (100%)
Males	82 (89%)	9 (10%)	1 (1%)	92 (100%)
Total	151 (93.2%)	10 (6.17%)	1 (0.006%)	162 (100%)

## DISCUSSION

The present study examined the relationship between anxiety levels and cardiovascular reactivity among medical students and demonstrated that although females had significantly higher anxiety scores, no significant association was observed between anxiety levels and reactor status. These findings contribute to the ongoing debate regarding the complex interaction between psychological factors and autonomic cardiovascular responses.

In the current study, females exhibited significantly higher anxiety scores compared to males. This observation is consistent with recent literature indicating a higher prevalence of anxiety and stress-related symptoms among female medical students, possibly due to differences in coping mechanisms, hormonal influences, and psychosocial stressors [9]. Increased academic pressure and emotional demands in medical training have also been shown to contribute to elevated anxiety levels in this population [10].

Despite higher anxiety levels, no significant difference in SCAT scores was observed between hyper-reactors and normo-reactors within either gender group. This finding aligns with emerging evidence suggesting that the relationship between anxiety and cardiovascular reactivity is not always linear. Recent studies have demonstrated that

individuals with higher anxiety or psychological distress may exhibit either exaggerated or blunted cardiovascular responses to stress, depending on underlying physiological and neural mechanisms [11]. In particular, diminished cardiovascular reactivity has been associated with anxiety and stress in otherwise healthy individuals, indicating a possible adaptive or dysregulated autonomic response [12].

The distribution of hyper-reactors and normo-reactors in the present study showed that the majority of participants were normo-reactors, with a slightly higher proportion of hyper-reactors among females. However, this difference was not substantial, suggesting that anxiety alone may not be a primary determinant of cardiovascular reactivity in young healthy individuals. Previous research has highlighted that cardiovascular reactivity is influenced by multiple factors, including genetic predisposition, vascular responsiveness, and neuroendocrine regulation, rather than psychological factors alone [7].

Furthermore, the majority of participants in this study were normotensive, with only a small proportion classified as prehypertensive or hypertensive, predominantly among males. This is in agreement with studies indicating that abnormal cardiovascular reactivity and its clinical

consequences, such as hypertension, may develop over time and are less evident in younger populations without established risk factors [13]. The relatively healthy status of the study cohort may have contributed to the lack of significant association between anxiety and cardiovascular responses.

The findings of this study support the concept of a complex “mind–heart” interaction, wherein psychological states such as anxiety influence cardiovascular physiology, but not always in a predictable manner. Recent evidence suggests that mental stress can affect microvascular and hemodynamic responses, potentially contributing to long-term cardiovascular risk even in the absence of overt clinical abnormalities [7, 13]. However, such effects may not be readily detectable using conventional autonomic function tests in young individuals.

### CONCLUSION

In conclusion, the present study demonstrates that anxiety levels are significantly higher among female medical students compared to males; however, this difference does not translate into a corresponding variation in cardiovascular reactivity. The proportion of hyper-reactors was slightly higher in females, though the majority of participants in both groups were normo-reactors. Furthermore, no significant association was observed between anxiety scores and reactor status within either gender. Most participants were normotensive, with a small proportion exhibiting prehypertension, particularly among males. These findings suggest that while gender differences exist in perceived anxiety, cardiovascular reactivity may be influenced by additional physiological or environmental factors, warranting further investigation.

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