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Original Research Article

A DUAL APPROACH TO STRESS ASSESSMENT: LINKING PSS-10 AND SALIVARY CORTISOL IN MEDICAL STUDENTS

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ABSTRACT

Background: Stress is an integral part of academic life, particularly in rigorous fields such as medicine. Examination periods are known to intensify psychological stress, often affecting students' academic performance and mental health. Understanding the variation in stress levels during different academic phases—especially before and after examinations—can provide valuable insights into the psychological burden. **Aim:** This study aims to assess and compare the stress levels in undergraduate medical students before and after university examinations using validated psychometric tools. **Materials and Methods:** A cross-sectional study was conducted among MBBS students in private medical college between feburary to march 2024. Students were asked to complete self-administered questionnaire following perceived stress scale (PSS) developed by Cohen et al and also samples for salivary cortisol were collected both before and after examination**. Results:** On the basis of pre examination stress score which was calculated on the basis of PSS questionnaire given to the students 2 weeks prior to the university examination, 32 (22.0%) students were in the low stress category while 45 (31.0%) reported high levels of stress. The pre examination salivary cortisol levels showed high levels in 71.0% students while post examination salivary cortisol estimation showed high levels of salivary cortisol in only 24.1% of the students.

INTRODUCTION

Stress is an integral part of academic life, particularly in rigorous fields such as medicine. Undergraduate medical students are frequently exposed to high academic demands, long hours of study, and the pressure of performance, making them particularly vulnerable to stress-related disorders. Examination periods, in particular, are known to intensify psychological stress, often affecting students' academic performance, mental health, and overall well-being.

Extensive course load, lack of time to revise before exams, lack of time management, negative and irrational thinking about exams, more number of classes, continuous examination with least gaps, parental expectation, staying away from parents, poor social support, psychological distress, lack of physical and extracurricular activity, etc., are some of the factors contributing to examination stress and anxiety.[1-3] The magnitude of problematic test anxiety ranges from nil to 52% in undergraduate medical students.[2-4]

While a moderate level of stress may act as a motivator, excessive stress and anxiety can impair cognitive function, concentration, memory, and decision-making—factors that are critical to academic performance. In medical education, where the stakes are high and the academic load is intense, stress-related anxiety can have a particularly detrimental effect.

Understanding the variation in stress levels during different academic phases—especially before and after examinations—can provide valuable insights into the psychological burden experienced by medical students. It can also guide the development of targeted interventions and support systems aimed at stress reduction and resilience building.

This study aims to assess and compare the stress levels in undergraduate medical students before and

after university examinations using validated psychometric tools. By identifying patterns and determinants of stress, the study seeks to contribute to a more supportive educational environment and inform policies for student mental health care in medical institutions.

MATERIALS AND METHODS

A cross-sectional study was conducted among medical undergraduate students in private medical college between Feburary to March 2024. A total of 150 bachelor of medicine and bachelor of surgery (MBBS) students from second year studying in this college were included. Institutional ethical clearance was obtained

The purpose of the study was explained to the participants, and an informed consent was obtained

Study Population

Inclusion Criteria

- Undergraduate second year medical students who provided informed consent.
- Students appearing for scheduled university theory examinations.

Exclusion Criteria

- Students with diagnosed psychiatric disorders.
- Students on medications affecting cortisol levels (e.g., corticosteroids).
- Students with systemic illness or endocrine disorders.

The students who consented to participate in the study were included and were asked to complete self-administered questionnaire consisting of the following sections: (a) sociodemographic profile (b) perceived stress scale (PSS) developed by Cohen et al and also samples for salivary cortisol were collected both before and after examination

Perceived Stress Scale (PSS-10)

The Perceived Stress Scale (PSS-10), developed by Sheldon Cohen in 1983, is a widely used self-report questionnaire designed to measure the degree to which individuals perceive their lives as stressful. It focuses on feelings of unpredictability, lack of control, and overload experienced over the past month.

In our study, the scale consisted of 10 items rated on a 5-point Likert scale ranging from 0 (never) to 4 (very often). Four of the items (questions 4, 5, 7, and 8) were positively worded and required reverse scoring before calculating the total score, which is the sum of all item responses.

The total score helped categorize perceived stress into three levels:

low (0–13), moderate (14–26) and high (27–40)

Salivary Cortisol

Subjects were assessed for salivary cortisol levels as stress parameter at two stages i.e. pre and post written examination. They were monitored to follow the protocol prior to the collection of salivary samples.

Salivary samples for cortisol estimation were collected at two time points: two weeks before the scheduled university examination (pre-examination) and two weeks after the examination (post-examination). To control for diurnal variation, all samples were collected between 8:00 AM and 9:00 AM.

Participants were instructed to avoid eating, drinking (except water), brushing their teeth, smoking, or chewing gum for at least 30 minutes prior to sample collection. They were also asked to rinse their mouths with water 5–10 minutes before providing the sample. Saliva was collected using standard sterile salivary collection tubes, with participants instructed to allow saliva to accumulate in the mouth and then passively drool into the tube until approximately 2–3 mL was obtained.

Each sample was immediately labeled with the participant's ID, date, and time of collection. Samples were temporarily stored in an icebox or at 4°C and then transferred to a −20°C or −80°C freezer within two hours for long-term storage. Estimation of salivary cortisol in both pre-test and post-test samples was performed using the Competitive ELISA method (Diagnostic Biochem Canada Inc., CANADA) as described by Dirk (2009).

Data entry was made in excel sheet in codes and analysis was done using SPSS software version 21.0 (Armonk, NY: IBM Corp). Descriptive statistics were used to describe the sociodemographic characteristics, perceived stress, and sources of stress

RESULTS

Of 150 students enrolled in the second year MBBS 145 completed and returned the questionnaire and agreed to participate in the study giving an overall response rate of 96.7 (%).

Out of a total of 145 undergraduate medical students who participated in the study there were 57 males (39.3%) and 88 females (60.7%).

The majority of participants (98.2%) were aged over 20 years, with a mean age of 20.8 ± 1.2 years. Most students had received their schooling from private institutions where English was the medium of instruction. Only a small proportion (4%) had studied in non-English medium schools, indicating a predominantly English-educated cohort.

Day scholars (55%) were more than hostellers (45%).

Pre and Post examination stress score

On the basis of pre examination stress score which was calculated on the basis of PSS questionnaire given to the students 2 weeks prior to the university examination, 32 (22.0%) students were in the low stress category while 45 (31.0%) reported high levels of stress .

On the post examination stress score assessment most of the students showed low levels of stress and only 13.7% and 3.4% students showed moderate and high levels of stress respectively.

The mean PSS score pre examination in the study was 32.2+1.5 and the mean PSS score Post examination was 9.5+_ 2.6. [Table 1]

The most common coping mechanism used by the students was active coping which included active efforts to tackle the problem rather than r avoiding it and consisted of creating a study schedule to prepare for exams and discussing academic difficulties with a teacher or mentor.

Table 1: Perceived Stress Scores and Coping Mechanisms

Variable	Mean ± SD	Median	Min–Max
PSS Score (Pre-exam)	32.2+_ 1.5	22	6-36
PSS Score (Post-exam)	9.5 + 2.6	15	4-28
Most Common Coping Mechanism	Active Coping		

In the study group the pre examination salivary cortisol levels showed high levels in 71.0% students while post examination salivary cortisol estimation showed high levels of salivary cortisol in only 24.1% of the students The mean salivary cortisol in the pre examination group was 42+_2. [Table 2]

Table 2: Pre and Post Examination Salivary cortisol levels

Variable	Mean ± SD	Median	Min–Max
Salivary Cortisol (Pre-exam) (µg/dL)	42+ 2	30	15-46
Salivary Cortisol (Post-exam) (µg/dL)	20+ 3	12	10-38

Coping mechanisms play a critical role in managing academic stress, Various coping strategies were reported by the participants, with some individuals selecting more than one method. Active coping emerged as the most commonly employed strategy, reported by 89 students (61.3%), indicating a proactive approach to managing stress. Acceptance was the second most frequent mechanism, adopted by 55 students (37.9%), followed by seeking emotional support, chosen by 24 students (16.5%). Denial was noted in 20 participants (13.7%), while self-distraction and religion/spirituality were utilized by 9 (6.2%) and 12 (8.2%) students, respectively. Substance use was the least reported coping strategy, mentioned by only 4 students (2.7%). As participants were allowed to choose multiple coping strategies, the percentages do not total 100%. [Table 3]

Table 3: Distribution of Coping Mechanisms Among Participants

Coping Mechanism	Number of students (%)
Active Coping	89 (61.3)
Seeking Emotional Support	24 (16.5)
Acceptance	55 (37.9)
Denial	20 (13.7)
Self-Distraction	09 (6.2)
Religion/Spirituality	12 (8.2)
Substance Use	4 (2.7)

Note: Participants could select more than one coping strategy; therefore, percentages do not sum to 100%.

Table 4: Comparison of Pre- and Post-Examination Stress Scores and Salivary Cortisol Levels

Variable	Pre-Exam Mean ± SD	Post-Exam Mean ± SD	p-value (Paired t-test)
Perceived Stress Score (PSS-10)	32.2+ 1.5	9.5 + 2.6	0.0009
Salivary Cortisol (µg/dL)	42+ 2	20+ 3	< 0.00001

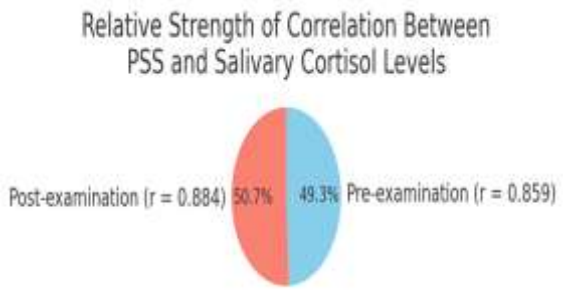
The comparison of pre- and post-examination stress scores and salivary cortisol levels revealed a statistically significant reduction in both psychological and physiological stress markers following the examination. The mean Perceived Stress Score (PSS-10) decreased from 32.2 ± 1.5 before the exam to 9.5 ± 2.6 after the exam, with a p-value of 0.0009, indicating a highly significant reduction in self-reported stress

Similarly, salivary cortisol levels, a biochemical indicator of stress, showed a significant decline from a pre-exam mean of 42 ± 2 µg/dL to a post-exam mean of 20 ± 3 µg/dL, with a p-value of <0.00001.

These results demonstrate that both perceived and physiological stress were markedly elevated before the examination and substantially decreased afterward, suggesting a direct association between examination-related stress and elevated cortisol levels.

Table 5: Correlation Between Perceived Stress Score and Salivary Cortisol Levels

Time line	Pearson Correlation (r)	p-value
Pre-examination	0.859	0.0001
Post-examination	0.884	0.00001



The pie chart below illustrates the relative strength of correlation between Perceived Stress Score (PSS) and Salivary Cortisol levels measured pre- and post-examination. Both correlations are strong, with the post-examination value slightly higher.

The analysis revealed a strong and statistically significant positive correlation between perceived stress scores and salivary cortisol levels at both time points. During the pre-examination period, the Pearson correlation coefficient (r) was 0.859 with a p-value of 0.0001, indicating that higher perceived stress was strongly associated with elevated cortisol levels.

This relationship remained consistent in the post-examination period, where the correlation further strengthened to r = 0.884 with a p-value of 0.00001. These findings suggest a robust link between psychological stress and physiological stress response, supporting the role of salivary cortisol as a reliable biomarker for perceived stress among the participants.

DISCUSSION

In this study, on the perceived stress among medical students, the potential stressors such as academic, psychosocial, and environmental stressors and association of perceived stress with sociodemographic characteristics and stressors were assessed. The mean perceived stress score in this study was 32.2 +_1.5 with a median of 22. Mean PSS score in a study conducted in Mangalore,[5] was 27.53 ± 7.01

The mean PSS score was higher among female students than male students which was also shown in a similar study by shan et al.[6] The school where the students pursued their education, medium of education and age had no influence on stress in the present study

Determinants of Stress

The study identified several significant academic, psychosocial, and environmental stressors among participants. The vastness of the academic curriculum, fear of failure, loneliness, family problems, lack of recreation, and living away from home were all found to be significantly associated with higher stress levels ($p < 0.01$). Previous studies have also reported that academic curriculum, frequency of examinations, performance in examinations, competition with peers were common sources of stress among medical students.[7,8]

The study shows that The students generally used active coping strategies and alcohol/drug was a least used coping strategy. The coping strategies commonly used by students in our institution were positive reframing, planning, acceptance, active coping, self-distraction and emotional supports

Active coping was found to be a a positive and adaptive strategy, associated with better mental health outcomes and improved academic performance, especially in high-stress environments like medical school university examinations

Key Features of Active Coping commonly encountered among the students were

- Planning and executing solutions to deal with stress.
- Seeking information or assistance to resolve the issue.
- Taking responsibility for actions that help control the stressor.
- Maintaining goal-directed behavior despite adversity

Concurent with PSS assessment the study also correlated levels of stress with measurement of morning salivary cortisol.

In our study morning salivary cortisol concentrations correlated strongly with reported stress levels and showed good r predictive power for high-stress levels

Many studies have focused on comparing salivary levels of stress markers during exam periods . kho sm et al,[12] found significant psychological changes in students before the exam (increased anxiety and life stress and decreased well-being), reflected in biochemical changes in saliva. Salivary morning cortisol levels increased significantly in participants during the examination time

Moreover, Ng et al,[9] determined differences in experienced stress and levels of salivary markers (such as cortisol, IgA, and chromogranin A) immediately before and after the exam test. Before the test, students reported higher levels of perceived stress, which resulted in a significant increase in cortisol and a slight decrease in the secretion of IgA and chromogranin A

Limitations of our preliminary study may include a relatively small sample size;. In addition, the level of perceived academic stress was rated by students It was impossible to rule out the interference of the stress level by other various stressors in private life.

Among the advantages, saliva collection as diagnostic material is stress-free in contrast to serum

CONCLUSION

This study highlights the utility of salivary cortisol as a non-invasive, objective biomarker for assessing physiological stress, complementing the subjective evaluation provided by the Perceived Stress Scale (PSS). The correlation between elevated PSS scores and increased salivary cortisol levels, particularly during pre-examination periods, underscores the biological impact of psychological stress. Salivary

cortisol thus serves as a valuable tool in stress research, offering insights into the body's hormonal response and reinforcing the need for timely stress management interventions among students

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