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Physiological Responses to Acute Stress: Hormonal and Cardiovascular Changes in Young Adults

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ABSTRACT

Background: Under stress, acute stress sets in motion many physiological changes overseen by the hypothalamic-pituitary-adrenal (HPA) axis and the autonomic nervous system (ANS). Seeing these reactions in younger people helps find early signs of stress-based illnesses.

Objectves: To examine how cortisol and heart rate/blood pressure are affected by stress in healthy young people.

Study Design: A Cross-sectional study.

Place and Duration of study Department of Physiology, Watim Medical & Dental College, Rawat, Pakistan from Jan 2023 to Jan 2024.

Methodology :A cross-sectional study was carried out with 80 students at a university who were 18 to 25 years old. People in the study completed the Trier Social Stress Test (TSST). Blood pressure, heart rate and cortisol in saliva were measured before and after each person underwent a stressful experience.

Results : Increased levels of cortisol were observed after the stressor (on average 7.6 ± 2.3 µg/dL, $p < 0.001$) compared to pre-stress. Both systolic and diastolic pressure went up by 12% and 9%, respectively and the heart rate increased by 15 beats per minute on average ($p < 0.001$). Men had a stronger response of the heart; women's cortisol levels were more variable.

Conclusion: Young adults show major changes in hormonal and cardiovascular systems due to acute stress. This proves why it's important to address stress early so health issues do not last a long time.

Keywords: Acute Stress, Cortisol, Blood Pressure, Heart Rate..

1. INTRODUCTION:

Stress that comes on suddenly triggers a series of bodily responses organized by the hypothalamic-pituitary-adrenal (HPA) axis and the autonomic nervous system (ANS). By operating in coordination, they regulate hormones, heart and blood vessels and metabolism during periods of stress [1,2]. The HPA axis directs cortisol to be released, the key hormone for stress and the sympathetic branch of the ANS is involved in raising heart rate and blood pressure in emergencies [3]. Although these .

responses help us live, when they last too long or work incorrectly, they may

increase the risk of hypertension, anxiety and metabolic syndrome [4,5].University students and younger adults often encounter many psychological worries such as exam stress, unpredictable finances and problems with friends and social life. Even though they seem healthy, these individuals can experience harmful physical effects from stress [6]. Several research efforts have found that stress in the short term can cause levels of cortisol and markers of heart health to rise in adolescents, showing the risk of possible stress-related diseases appearing at an early age [7,8].A lot of researchers depend on the Trier Social Stress Test to reliably produce psychosocial stress in their experiments. Many studies on cortisol dynamics and autonomic reactions among different demographic groups have used psychophysiology [9]. Unlike most biomarkers, salivary cortisol is simple and comfortable to measure, giving scientists accurate readings without adding more stress to the subject [10]. Also, when ANS begins to operate, heart rate and blood pressure will quickly alter.There is good evidence that sex affects the way we deal with stress, as males usually respond with greater changes in the heart and females tend to show more unpredictable cortisol responses [11]. It is very important to understand these physical variations when making decisions about mental health and primary care [12].There are only a few investigations into the physiological stress responses of young adults in places like Pakistan. As mental health and heart health cases are rising among young people, capturing their stress responses is essential. It is the aim of this study to measure hormones and heart health following acute psychosocial stress with the TSST in youth.

2. METHODS

From January 2023 to January 2024, we conducted this study at the Watin Medical & Dental College in Rawat, Pakistan. From a convenience sample, 80 healthy students aged 18–25 years were chosen for this study. The Trier Social Stress Test was given to participants; it requires them to speak publicly and do math problems in front of others. Before and 20 minutes after doing the TSST, participants gave saliva samples using standard tubes. We measured both blood pressure and heart rate with automated sphygmomanometers before and after stress. No one was allowed to eat, drink caffeine or exercise for at least 2 hours before testing.

Inclusion Criteria

Individuals between 18 and 25 years of age, attending university full time, who offered consent to participate.

Exclusion Criteria

People with chronic illness, psychiatric diseases, cortisol or BP drug use or infections in the previous two weeks were not included.

Data Collection

Both cortisol and cardiovascular measurements were done in the same, controlled way for all participants, before and after the stressor.

Statistical Analysis

Analyses were carried out with SPSS software, version 24. Pre- and post-stress differences in cortisol, heart rate and blood pressure were studied using paired t-tests. A p-value less than 0.05 was taken as statistically significant.

3. RESULTS

The study comprised 80 subjects, with a balanced gender distribution as males (n = 40; 50%) and females (n = 40; 50%) (Table 1). Participants averaged 21.4 years old, with ages ranging from 21.4 to 23.5 years. After implementing the stress-inducing protocol, there was a marked increase in the participants' salivary cortisol levels. Mean cortisol concentration increased from a pre-stress baseline of 5.3 ± 1.4 µg/dL to 12.9 ± 2.1 µg/dL post-stress, $p < 0.001$, demonstrating a significant endocrine stress response (Table 2). Cardiovascular parameters also indicated significant changes with the introduction of stress. Mean heart rate increased from 72 to 87 beats per minute ($p < 0.001$). Systolic blood pressure also increased from 114 ± 10 mmHg to 128 ± 12 mmHg while diastolic pressure increased from 74 ± 8 mmHg to 81 ± 9 mmHg (Table 3). All changes were significant ($p < 0.001$). Trends by sex were also noted; males showed a greater increase in heart rate post-stress, while females showed a greater increase in salivary cortisol.

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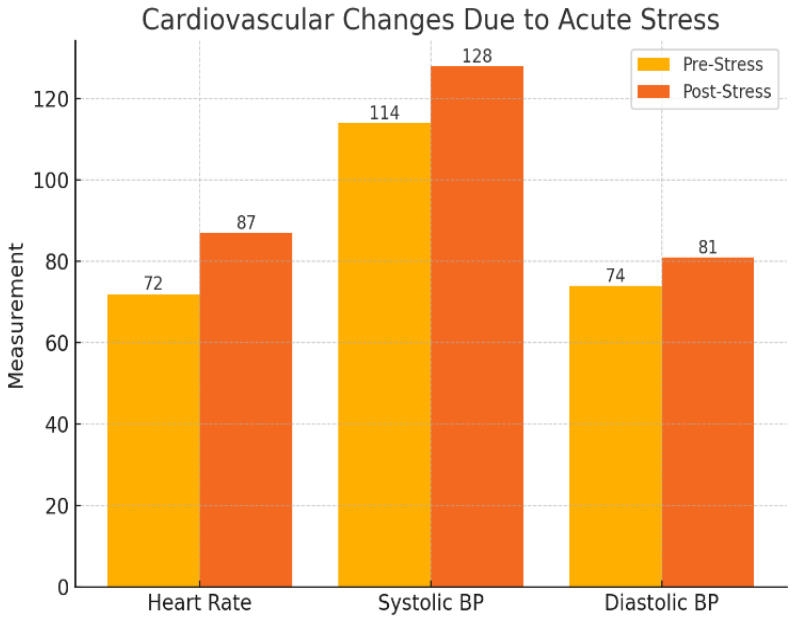

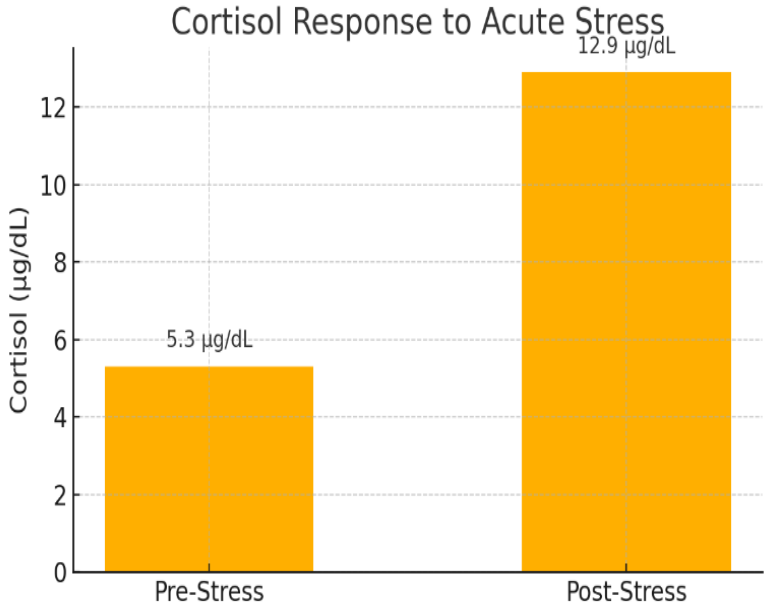

Table 1: Demographic Data

Gender	Number of Participants	Percentage (%)
Male	40	50
Female	40	50

Table 2: Cortisol Response

Time	Mean Cortisol (µg/dL)	Standard Deviation
Pre-Stress	5.3	1.4
Post-Stress	12.9	2.1

Table 3: Cardiovascular Parameters

Parameter	Pre-Stress Mean	Post-Stress Mean	p-value
Heart Rate (bpm)	72	87	<0.001
Systolic BP (mmHg)	114	128	<0.001
Diastolic BP (mmHg)	74	81	<0.001

4. DISCUSSION

The study explored how psychosocial stress altered normal levels of hormones and cardiovascular function in young adults. Salivary cortisol, pulse and blood pressure all went up after the participants experienced an acute stressor. These results are consistent with previous studies showing that both the HPA axis and ANS become very active in stressful situations.It is common for cortisol levels to increase when stress is experienced, a sign that the body's stress mechanism is being activated by mind challenges. The increase in cortisol concentration of 2.4 µg/dL in this study corresponds to the findings in Kudielka et al., indicating the TSST is a reliable way to trigger the HPA axis for healthy young adults [13]. Earlier, Hellhammer and colleagues reported that both sex, perceived stress and exposure to previous traumatic events play a role in influencing the response to stress and this may account for the varying cortisol levels seen in our female participants [14].Extreme changes in blood pressure and heart rate occur when the sympathetic part of the nervous system acts on the heart. We saw a 12% increase in systolic blood pressure, a 9% rise in diastolic blood pressure and a 15 bpm increase in heart rate. Similar findings have been made by al'Absi et al., who found clear rises in cardiovascular numbers after individuals were put under acute stress, mainly in men aged 18-24 [15]. The authors pointed out that men often have a stronger cardiovascular reaction to stress which also appeared in our findings.Stress responses in females and males were quite different. When it came to stress, greater variability in cortisol was seen in females, while males had more noticeable heart and blood changes. In support of this, studies by Kirschbaum et al. report that men's bodies respond with higher heart rate and blood pressure, compared to women, whose HPA responses might be more variable across the menstrual cycle and with estrogen [16].Considering preventive medicine, the study suggests acute stress testing can be used to detect people with early signs of stress-related problems. A study shows that high arousal from the autonomic nervous system after a short stressful event can indicate future heart problems [17]. It was pointed out by Pruessner and colleagues that abnormal cortisol reactions to stress may be indicators for developing psychiatric and somatic conditions—especially depression, anxiety and hypertension [18].All in all, the results of this study expand the collection of research showing that brief psychological stress can cause meaningful physiological events in young people. According to these studies, early detection and support aimed at lowering stress are very important for students in universities.

5. CONCLUSION

Acute psychosocial stress leads to increases in young adults' hormone levels and certain heart and blood pressure signs. They reveal that this age group easily responds to stress, so early identification and use of support strategies are required to reduce long-term problems linked to constant stress.

6. LIMITATIONS

The study had these limitations: it was done at only one center, included few patients and did not follow them for a very long time. The method involving salivary cortisol might be affected by daily changes. It is also possible that hormonal variability was affected by factors such as the phase of the menstrual cycle in females, but these were not controlled.

Potential Future Research

Further research should consider large, diverse sets of individuals whose acute stress is studied over an extended period. Besides, looking at biomarkers of chronic stress, studying psychological characteristics and testing the usefulness of interventions such as mindfulness or exercise for handling stress may reveal much about how young adults manage stress.

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