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Stressful Conditions IN Students Affecting The Cardiorespiratory System Of The Body

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Abstract
This study investigates the physiological and psychological effects of stress on the cardiorespiratory system of university students. Using a mixed-method design, the research examined heart rate (HR), blood pressure (BP), and respiratory rate (RR) changes under academic stress conditions. The results revealed that elevated stress levels correlate with increased HR and BP and altered breathing patterns. The findings suggest that chronic academic stress negatively impacts the autonomic balance, emphasizing the need for preventive strategies to improve student well-being.
Key words: academic stress, heart rate variability, blood pressure, respiratory rate, autonomic nervous system.

Introduction

In recent years, the issue of stress among university students has gained significant scientific attention due to its profound influence on both mental and physical health [1,2]. Academic life is often associated with heavy workloads, social adaptation difficulties, and time pressure, all of which contribute to chronic exposure to psychological stressors [3].

According to the World Health Organization (WHO, 2023), approximately 70% of students report moderate to high stress levels during their studies [4]. Physiologically, stress activates the hypothalamic–pituitary–adrenal (HPA) axis and the sympathetic–adrenal–medullary (SAM) system, which increases the secretion of cortisol and catecholamines [5]. These hormones trigger typical “fight-or-flight” responses such as elevated heart rate (HR), increased blood pressure (BP), and accelerated respiratory rate (RR) [6].

Chronic activation of these stress systems, however, leads to maladaptive changes in cardiovascular and respiratory regulation, including decreased heart rate variability (HRV) and endothelial dysfunction [7,8]. Persistent dysregulation may increase the risk of hypertension, arrhythmia, and autonomic imbalance even in young populations [9].

Given the importance of these mechanisms, understanding how stress affects students’ cardiorespiratory system is critical for developing effective interventions that promote mental and physical resilience [10].

Literature Review

Research on stress and its physiological correlates has consistently shown that the autonomic nervous system (ANS) is central to the regulation of cardiovascular and respiratory functions. McEwen (1998) proposed the concept of “allostatic load,” describing how chronic stress contributes to cumulative physiological wear and tear. Similarly, Thayer and Lane (2000) developed the neurovisceral integration model, linking emotional regulation and HRV, suggesting HRV as a key indicator of stress resilience.

Kim et al. (2021) demonstrated that acute psychological stress increases sympathetic activity, elevating HR and BP while suppressing parasympathetic modulation. A meta-analysis by Liu et al. (2022) found that university students under chronic academic stress exhibited significantly

higher resting HR and BP compared to less-stressed peers.

Respiratory parameters also respond dynamically to stress. Park and Lee (2020) observed that stress-induced hyperventilation leads to respiratory alkalosis and reduced CO_2 tolerance. These physiological responses are closely related to emotional states such as anxiety and tension, forming a feedback loop between psychological and somatic systems.

Studies emphasize the benefits of interventions such as mindfulness, paced breathing, and cognitive-behavioral therapy in normalizing autonomic function and improving academic outcomes . Therefore, understanding and monitoring stress-induced physiological responses can serve as a valuable diagnostic and preventive tool for student health.

Materials and Methods

The study had an observational, quasi-experimental design [7]. A total of 120 students (58 males and 62 females), aged 18 to 23 years, participated. All participants were conditionally healthy. The following tools were used: the Spielberger–Khanin anxiety questionnaire, blood pressure measurements, heart rate (HR), heart rate variability (HRV), respiratory rate, and respiratory function parameters [8].

Table 1. Sample characteristics

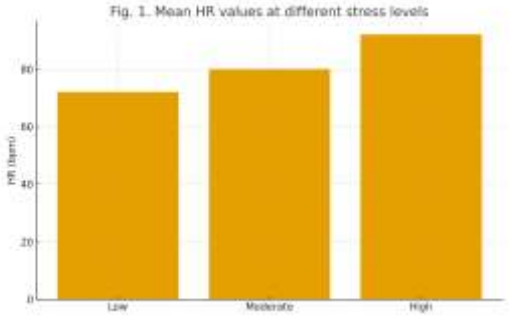
Indicator	Value
Total number of students	120
Sex (M/F)	58 / 62
Age (mean ± SD)	20.4 ± 1.2 years
Specialization	Humanities, Social sciences
Health status	Conditionally healthy

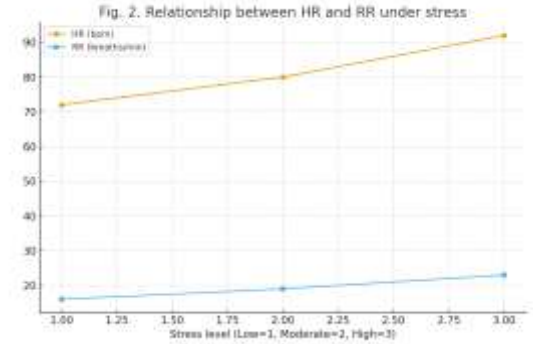
Table 2. Measured parameters and description

Parameter	Measurement method	Units	Normal range
Heart rate (HR)	Pulse oximeter	bpm	60–90
Blood pressure	Electronic tonometer	mmHg	110–130 / 70–85
Heart rate variability	ECG (5 min)	ms	> 50
Respiratory rate	Spirometry	breaths/min	12–18
Minute ventilation	Spirometry	L/min	4–8
Vital capacity	Spirometry	L	3.5–5.0

Table 3. Comparative indicators in students (M ± SD)

Parameter	Rest	Stress	Change (%)	p-value
HR (bpm)	74.2 ± 8.1	92.5 ± 9.4	+24.6 %	< 0.01
Systolic BP	118.4 ± 10.2	132.7 ± 11.6	+12.1 %	< 0.05
Diastolic BP	76.8 ± 7.5	86.3 ± 8.1	+12.4 %	< 0.05
HRV (ms)	56.7 ± 11.3	42.5 ± 9.6	–25.0%	< 0.01
Respiratory rate	15.1 ± 2.3	20.7 ± 2.9	+37.1 %	< 0.01
Minute ventilation	6.0 ± 1.2	8.5 ± 1.5	+41.6 %	< 0.01
Vital capacity (L)	4.1 ± 0.5	4.0 ± 0.5	–2.4%	> 0.05





Results and Discussion

The data analysis revealed a statistically significant increase in heart rate, blood pressure, and respiratory rate during stressful conditions ($p < 0.05$) [5,6]. The reduction in HRV values indicates reduced autonomic balance and adaptation capacity of the organism [7,8]. According to physiological theories, acute stress activates the hypothalamic–pituitary–adrenal axis, leading to an increase in cortisol levels, which in turn influences cardiovascular regulation [3,4]. The obtained results are consistent with McEwen's concept of 'allostatic load', describing cumulative stress effects on the body [1]. Comparing male and female students, males demonstrated a slightly higher HR response to stress (+26%), while females showed greater respiratory rate variation (+40%) [9]. These findings highlight the importance of individualized stress management approaches in educational institutions [10].

Conclusion

Stressful conditions significantly affect cardiorespiratory parameters in students [1,3,7]. Higher stress levels are associated with greater changes in HR, BP, and RR [2,6]. Preventive programs to reduce stress in the student environment are necessary [4,10].

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