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Experience Report

Analysis of Stress Levels in University Students During Examination Periods

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Abstract: The academic routine, with its responsibilities and commitments, is crucial for professional life but can cause significant stress for students. This study analyzed the stress levels in physiotherapy students at a private college before and after exams. It is an analytical, observational, quantitative, and cross-sectional study conducted with 16 students (10 in the morning shift and 6 in the evening shift) during October 2019. Heart rate variability was measured with a sensor placed on the ear, using the Inner Balance app, before and after the exams. The data were analyzed by Kubius HRV. Additionally, the Lipp's Adult Stress Symptoms Inventory (ISSL) and Whoqol-bref questionnaires were used. The results showed a significant increase in sympathetic nervous system activity after the exams, indicating stress related to the evaluations. 45% of the students exhibited typical symptoms of increased sympathetic activity, corroborating the heart rate variability data. These findings suggest the need for longitudinal studies to understand the duration and effects of academic stress on students' bodies.

Keywords: Stress; Heart rate variability; Evaluation; Autonomic nervous system.

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1. Introduction

The academic routine is very stressful, primarily due to the various activities that occur during the school term, such as assignments, projects, seminars, and bimonthly exams, which often find students more tense and stressed. This is even more relevant in health-related studies, where responsibilities are greater since individuals will deal with the lives, health, and well-being of others [1]. All these activities are important for professional training and require dedication, responsibility, and commitment from university students. However, the pressure and responsibilities, along with academic activities, teacher demands, competition among peers, work commitments, family obligations, and personal issues such as financial problems, debts, and health issues, can cause significant stress [2]. The physiological system enters a state of defense, preparing for fight or flight situations [3].

Stress is a normal mechanism of the human body in the face of danger, challenges, or difficulties, requiring attention to overcome obstacles and achieve better performance in daily life [4]. However, the body and mind have limits; surpassing normal levels can manifest in four distinct domains: physiological, behavioral, subjective experience, and cognitive function, causing a disorganizing effect and compromising physical and mental health [5]. Excessive stress can severely impair a student's academic performance. Consequences such as difficulty concentrating on activities, absorbing important content, memory lapses, and others cause significant harm to the learning process and the student's health [6]. Common initial manifestations of stress exposure include the onset of tachycardia, excessive sweating, muscle tension, dry mouth, and the feeling of being constantly on alert. Endocrinologist Hans Selye defined stress as the body's reactions manifested by the stressor. He observed patients with different types of pathologies but with common nonspecific symptoms that caused them distress and sadness, termed the "General Adaptation Syndrome" (GAS) [6]. Selye believed that the physiological or psychological consequences in response to stress result from stimuli much greater than the organism can withstand [4].

The human body consists of a set of organs, tissues, and diverse functions. To achieve homeostasis, the nervous system plays a crucial role in regulating the biological system and is divided into two main parts: the Central Nervous System (CNS), represented by the brain and spinal cord, and the Peripheral Nervous System (PNS), which consists of other nervous structures. The PNS is subdivided into two parts: the Somatic Nervous System (SNS) or voluntary system, and the Autonomic Nervous System (ANS), responsible for the involuntary functions of the human body's structures. Together with the CNS, the ANS regulates autonomous physiological functions such as heart rate, blood pressure, body temperature, gastrointestinal secretion, and endorphin secretion, among others [7].

In a stressful situation, the ANS increases sympathetic activity, causing alterations in the cardiovascular system [6]. Heart rate variability indicates its functioning state [8]. The ANS is divided into the Sympathetic Nervous System (SNS) and the Parasympathetic Nervous System (PNS). In the SNS, the hormone adrenaline increases heart rate by acting directly on the myocardium during stress. The PNS, whose hormone is acetylcholine, reduces heart rate. The two systems have opposite actions, always trying to maintain homeostasis; thus, when one inhibits, the other excites [9].

Given these circumstances, a study with the INNER Balance device was proposed to evaluate and quantify the stress levels reported by students and to propose a mechanism that correlates these aspects. The study aims to understand how the body reacts to stress concerning heart rate variability and how this autonomic control functions. This study is relevant as it attempts to identify factors that exacerbate stress in the academic routine. The objective is to analyze the stress levels in physiotherapy students at UNIATENEU during evaluations.

2. Material and Methods

2.1 Research Design

This is an analytical, observational, quantitative, and cross-sectional study based on field research. A bibliographic review was used to develop the theoretical part of the work, based mainly on scientific articles.

3.2 Sample

The total sample consisted of 16 students, with 10 students in the morning shift and 6 in the evening shift, comprising 9 women and 7 men. The study adhered to the bioethical principles outlined in Resolution 466/12 of the National Health Council, ensuring respect for the participants' dignity and autonomy, recognizing their vulnerability, and securing their voluntary participation through the Informed Consent Form (ICF).

3.3 Research Location and Participants

Data collection took place at a private college in Fortaleza, Ceará, in October 2019, involving physiotherapy students who were regularly enrolled in the 2019.2 semester. Students were informed about the study through personal invitations.

3.4 Data Collection and Analysis

Heart rate variability (HRV) was collected using a sensor placed on the earlobe and connected to a smartphone, as shown in Figure 1. Data were collected 5 minutes before and 5 minutes after manipulation or positioning. The Inner Balance app, which is freely available, was used for data collection. The data obtained from the app were transferred to a computer as a text file, and the RR interval signals were processed to calculate HRV using the Kubios HRV Analysis software (MATLAB, version 2 beta, Kuopio, Finland). HRV data were collected using the EmWave system and processed with the Kubios system, evaluating the autonomic nervous system before and after the exam. The variables collected included the parasympathetic nervous system (PNS) index and the sympathetic nervous system (SNS) index.

Figure 1. Heart rate variability measurement sensor.

3.5 The Lipp's Adult Stress Symptoms Inventory (ISSL)

The Lipp's Adult Stress Symptoms Inventory (ISSL), which evaluates the current emotional state, is a stress assessment tool that aims to identify the symptoms perceived by the individual, whether they are of physical or psychological origin, and the phase of stress the individual is in according to the quadriphasic model proposed by Lipp. The ISSL can be applied to individuals over 15 years old and takes about 10 minutes to administer. The ISSL consists of three symptom charts that correspond to the phases of stress: Chart 1 includes symptoms present in the alarm phase, Chart 2 includes symptoms present in the resistance and near-exhaustion phases, and Chart 3 includes symptoms present in the exhaustion phase.

The results of the ISSL were analyzed according to the ISSL manual, confirming the presence of stress, the phase of stress the student is in, and the predominant types of symptoms by verifying the total raw score in each chart for physical and psychological symptoms. A student is considered to be in a state of stress if:

a) 7 or more symptoms are found in Chart 1;

b) 4 or more symptoms are found in Chart 2; or

c) 9 or more symptoms are found in Chart 3.

To determine the stress phase the student is in, the total score of each chart was calculated and converted into a percentage value considering the entire ISSL. The phase with the highest percentage score is the stress phase the student is in. To identify the predominant type of symptom (physical or psychological), the percentages of physical and psychological symptoms were calculated only for the phase the student is in, with the higher percentage indicating the predominant symptom type.

3.6 Whoqol-bref

The Whoqol-bref, used to assess quality of life, consists of 26 questions, with the first two addressing general quality of life. The responses follow a Likert scale from 1 to 5, where a higher score indicates a better quality of life. Besides these two questions, the instrument has 24 facets distributed across four domains: physical, psychological, social relationships, and environment.

Unlike the Whoqol-old, the results of the Whoqol-bref should be presented as averages (from 1 to 5) for each domain and each facet. It is necessary to recode the responses to questions 3, 4, and 26 as follows: 1=5, 2=4, 3=3, 4=2, 5=1.

Questions 1 and 2 should be presented as follows:

Perception of quality of life (average from 1 to 5)
Satisfaction with health (average from 1 to 5)

To calculate the average for each facet, sum the scores of the responses (from 1 to 5) and divide by the number of participants. The resulting average ranges from 1 to 5. Below are the domains and their corresponding facets, each with an identifier number according to the questionnaire.

3.7 Statistical Analysis

The collected data were tabulated in an Excel 2010 spreadsheet and analyzed using descriptive statistics to calculate the mean for comparison. Inferential statistics were applied using Student's t-test for independent samples, with a significance level of $p < 0.05$. The results were presented in tables and figures.

4. Results and Discussion

It is known that the activity of the parasympathetic nervous system (PNS) (vagal stimulation) decreases heart rate (HR) and increases heart rate variability (HRV). Conversely, the activity of the sympathetic nervous system (SNS) has the opposite effect on heart rate and heart rate variability, i.e., it increases HR and decreases HRV. Therefore, HR is lower and HRV is higher in a resting and fully recovered state. During stressful situations, when sympathetic nerve activity increases, resting heart rate is elevated, and heart rate variability decreases [10].

The PNS index in the Kubios HRV software is related to cardiac vagal activity, increasing the average RR interval (i.e., decreasing HR); thus, the average RR interval is a natural choice for calculating the PNS index. Besides the average heart rate, cardiac vagal activity affects heart rate variability by regulating the magnitude of the respiratory sinus arrhythmia (RSA) component [11]. The SNS index in the Kubios HRV software is calculated based on the average HR (bpm) and Baevsky's stress index. The average HR is an evident choice as increased HR is known to be linked to increased cardiac sympathetic activation. Baevsky's stress index is a widely used indicator of cardiovascular stress and is strongly linked to sympathetic nerve activity [12].

During exercise, the withdrawal of cardiac vagal activity followed by an increase in sympathetic activation occurs, causing an increase in HR proportional to the exercise intensity. A curvilinear decrease in heart rate variability is observed, shown in the time-domain and frequency-domain variables during exercise, with the minimum variability level normally reached at moderate to high intensity [13].

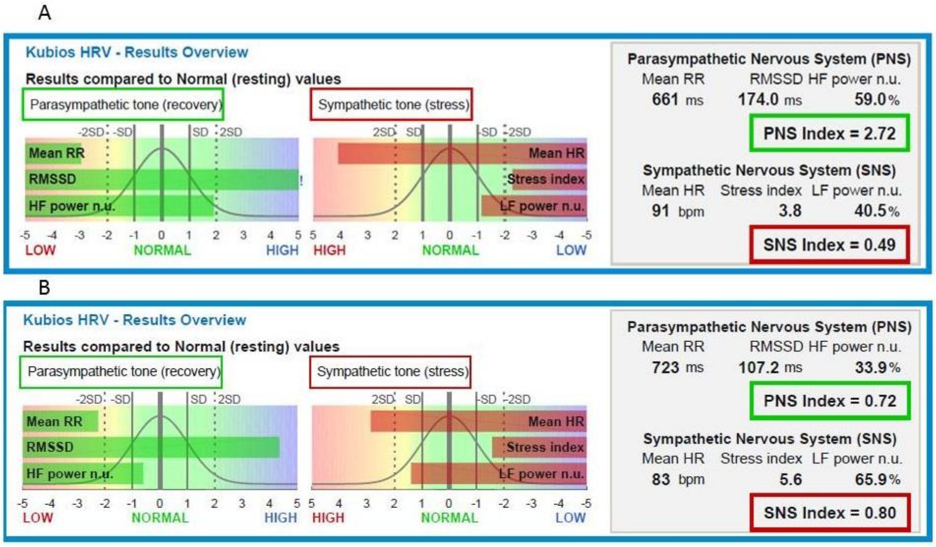
The interpretation of PNS and SNS indices is straightforward. A PNS (or SNS) index value of zero means that the parameters reflecting parasympathetic (or sympathetic) activity are, on average, equal to the normal population average. Correspondingly, PNS index values different from zero describe how much and in what direction these values vary compared to the rest of the population. However, during stress or high-intensity exercise, very low PNS indices and much higher SNS values can be observed [14].

Table 1. Results of the Kubios HRV Analysis on the Sympathetic and Parasympathetic Systems Before and After the Exam.

	Index		Percentual	
	PNS	**SNS**	**PNS**	**SNS**
Before the Exam	5.94	-0.23	54.05	45.63
After the Exam	3.98	0.12	49.52	50.13

According to Table 1, it can be seen that the parasympathetic system index values decreased, leading to the conclusion that there was a reduction in stress recovery (recovery) after statistical analysis using Student's t-test. In percentage terms, the same response was observed, showing that the students were a bit more stressed after the exam than before. This stress was also evident in the sympathetic index and percentage values. There was a statistically significant increase, indicating a real increase in stress levels in these students after the exam. Figure 2 shows the index and percentage values before (A) and after (B) the exam.

Figure 2. Image of the graph generated by Kubios HRV showing index and percentage values for the sympathetic and parasympathetic systems. A) before the exam B) after the exam.



The results of the application of the Lipp Adult Stress Symptoms Inventory questionnaire showed that 45% of the students reported experiencing muscle tension, tachycardia, and sudden enthusiasm in the last 24 hours before the evaluation. These symptoms are characteristic of increased sympathetic activity. 20% reported memory problems, forgetfulness, a sense of exhaustion, and constant thoughts over the last month. 10% expressed a desire to escape everything and excessive fatigue over the last three months, while the remaining 25% reported no symptoms. In the second questionnaire, Whoqol-bref, regarding quality of life, 68% of the students responded with "more or less" or "neither bad nor good" for question 3. The other 28% of the students responded with "good," "very good," or "quite satisfied," while the remaining percentage was divided among other options.

5. Conclusion

The results reveal that stress is present in most students. The academic routine directly influences this, highlighting the importance of evaluating the mental health of students in health-related fields and identifying the groups most vulnerable to excessive stress in the academic environment. This study aimed to measure stress levels during evaluation periods through questionnaires and heart rate variability measurement, a time when students typically report more pre-exam tension. Heart rate variability data indicate that stress increased after the exam. Almost all students showed increased sympathetic activity, which could be due to pre-exam tension or the anticipation of a negative result. A longitudinal study is needed to determine how long this stress persists and its effects on the body. The questionnaire showed that 45% of the students exhibited typical symptoms of increased sympathetic activity, corroborating the data obtained from heart rate variability changes.

This study may contribute to future interventions aimed at reducing stress levels and improving student performance during exams, whether academic or otherwise.

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References

1. Lacerda AND. Indícios de estresse, ansiedade e depressão em estudantes universitários. [monograph]. Brasília: Universidade de Brasília; 2015.
2. Ferreira HA, Vidor E, Soares JC. Efeito de um programa de terapia manual sobre a variabilidade da frequência cardíaca e indicadores de estresse em vestibulandos. [thesis]. Campinas: Universidade Estadual de Campinas; 2014.
3. Macedo BF. Associação entre a dor cervical e no ombro em relação ao estresse emocional em alunos de Graduação dos Cursos de Saúde da Universidade de Brasília-UnB. [dissertation]. Brasília: Universidade de Brasília; 2017.
4. José FEM. Estresse e desempenho em concursos públicos. [dissertation]. Porto Alegre: Universidade Católica do Rio Grande do Sul; 2012.
5. Ferreira HA. Intervenção fisioterapêutica reduz o índice de estresse em vestibulandos. [dissertation]. Campinas: Universidade Estadual de Campinas; 2009.
6. Costa LBS. Avaliação do estresse e do rendimento acadêmico em estudantes da área da saúde da Universidade de Brasília. [dissertation]. Brasília: Universidade de Brasília; 2018.
7. Silva AM. Relação entre estresse e variabilidade da frequência cardíaca em profissionais das unidades de terapia intensiva de um hospital do centro oeste de Minas Gerais. [undergraduate thesis]. Formiga: Centro Universitário de Formiga; 2016.
8. Rosário NSA. Associação da variabilidade da frequência cardíaca com parâmetros antropométricos e fisiológicos em professores da Universidade Federal de Ouro Preto. [dissertation]. Ouro Preto: Universidade Federal de Ouro Preto; 2018.
9. Lopes PFF, Silva AG, Fernandes T, Carvalho LT. Aplicabilidade Clínica da Variabilidade da Frequência Cardíaca. Rev Neurosci. 2013;21(4):600-3.
10. Laitio T, Jalonen J, Kuusela T, Scheinin H. The role of heart rate variability in risk stratification for adverse postoperative cardiac events. Anesth Analg. 2007;105(6):1548-60.
11. Acharya UR, Joseph KP, Kannathal N, Lim CM, Suri JS. Heart rate variability: a review. Med Biol Eng Comput. 2006;44:1031-51.
12. Baevsky RM. Methodical recommendations use kardivar system for determination of the stress level and estimation of the body adaptability standards of measurements and physiological interpretation. 2009.
13. Bragge T, Tarvainen TP, Ranta-Aho PO, Karjalainen PA. High-resolution QRS fiducial point corrections in sparsely sampled ECG recordings. Physiol Meas. 2005;26(5):743-51.
14. Lipponen JA, Tarvainen MP. A robust algorithm for heart rate variability time series artefact correction using novel beat classification. J Med Eng Technol. 2019;43(3):173-81.