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PERFIL AUTONÔMICO, NÍVEL DE ATIVIDADE FÍSICA, ANSIEDADE E PERCEPÇÕES PSICOSSOCIAIS EM ESTUDANTES UNIVERSITÁRIOS: UM ESTUDO TRANSVERSAL

AUTONOMIC PROFILE, PHYSICAL ACTIVITY LEVEL, ANXIETY, AND PSYCHOSOCIAL PERCEPTIONS AMONG UNIVERSITY STUDENTS: A CROSS-SECTIONAL STUDY

PERFIL AUTONÓMICO, NIVEL DE ACTIVIDAD FÍSICA, ANSIEDAD Y PERCEPCIONES PSICOSOCIALES EN ESTUDIANTES UNIVERSITARIOS: UN ESTUDIO TRANSVERSAL

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Resumo

Este estudo objetivou descrever indicadores de modulação autonômica cardíaca em repouso, atividade física habitual, ansiedade e percepções psicossociais de universitários, comparando os resultados por sexo e por agrupamentos exploratórios de atividade física. Estudo observacional transversal com 243 estudantes (140 homens e 103 mulheres). Foram obtidos dados sociodemográficos, antropométricos, respostas a itens psicossociais, Inventário de Ansiedade Traço-Estado (IDATE), Questionário Internacional de Atividade Física (IPAQ, versão curta) e índices de variabilidade da frequência cardíaca (VFC) em repouso. As comparações não ajustadas utilizaram teste t de Welch, qui-quadrado ou Fisher e ANOVA de Welch, conforme a natureza das variáveis. As categorias brasileiras do IPAQ foram reunidas, para análise exploratória, em sedentários, irregularmente ativos e ativos/muito ativos, sem pressupor equivalência com as três categorias do protocolo internacional. Mulheres relataram maior frequência de aparência/comportamento ansioso e maiores escores de desgaste psicoacadêmico contextual. Não foram detectadas diferenças estatisticamente significativas entre sexos nos escores de ansiedade-estado e ansiedade-traço. Na comparação por sexo, mulheres apresentaram maiores valores de RMSSD, pNN50, HF e SD1, além de menor razão LF/HF. Não foram detectadas diferenças estatisticamente significativas entre os três agrupamentos de atividade física nos desfechos de ansiedade, tempo sentado ou índices de VFC avaliados. Os achados descrevem padrões distintos entre autorrelatos contextuais, escores globais de ansiedade e índices cardíacos de repouso. Não permitem inferir equivalência entre grupos, associação individual ausente ou propriedades diagnósticas das medidas exploratórias.
Palavras-chave: Frequência Cardíaca; Sistema Nervoso Autônomo; Exercício Físico; Ansiedade; Estudantes.

Abstract

This observational, cross-sectional study described resting cardiac autonomic modulation indices, habitual physical activity, anxiety, and psychosocial perceptions among university students, with unadjusted comparisons by sex and exploratory physical activity groupings. The sample comprised 243 students (140 men and 103 women). Sociodemographic and anthropometric characteristics, author-developed psychosocial items, the State–Trait Anxiety Inventory (STAI), the short International Physical Activity Questionnaire (IPAQ), and resting heart rate variability (HRV) indices were assessed. Welch's t-test, chi-square or Fisher's exact test, and Welch's ANOVA were used as appropriate. The five Brazilian IPAQ categories were analytically pooled as sedentary, irregularly active, and active/very active; this grouping was not considered equivalent to the international three-level IPAQ scoring algorithm. Women more frequently endorsed anxious behavior or appearance and reported greater context-specific psycho-academic strain. State- and trait-anxiety scores did not differ significantly by sex. Women had higher RMSSD, pNN50, HF, and SD1 values and a lower LF/HF ratio in resting recordings. No statistically significant differences were detected across the exploratory physical activity groupings for sitting time, anxiety, or the examined HRV indices. These results indicate distinct group-level patterns across contextual perceptions, overall anxiety scores, and resting cardiac indices, without establishing individual-level associations, equivalence, or diagnostic utility.
Keywords: Heart Rate; Autonomic Nervous System; Physical Exercise; Anxiety; Students.

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Resumen

Este estudio transversal describió los índices de modulación autonómica cardíaca en reposo, la actividad física habitual, la ansiedad y las percepciones psicosociales de estudiantes universitarios, mediante comparaciones no ajustadas por sexo y por agrupaciones exploratorias de actividad física. Participaron 243 estudiantes (140 hombres y 103 mujeres). Se evaluaron variables sociodemográficas y antropométricas, ítems psicosociales desarrollados por los autores, el Inventario de Ansiedad Estado-Rasgo, el Cuestionario Internacional de Actividad Física (IPAQ, versión corta) y los índices de variabilidad de la frecuencia cardíaca en reposo. Se utilizaron la prueba t de Welch, chi-cuadrado o prueba exacta de Fisher y ANOVA de Welch, según correspondiera. Las cinco categorías brasileñas del IPAQ se agruparon analíticamente como sedentarios, irregularmente activos y activos/muy activos, sin suponer equivalencia con las tres categorías del protocolo internacional. Las mujeres informaron con mayor frecuencia comportamientos o apariencia ansiosos y mayor desgaste psicoacadémico contextual. No se detectaron diferencias estadísticamente significativas entre sexos en ansiedad-estado ni ansiedad-rasgo. Las mujeres presentaron valores más altos de RMSSD, pNN50, HF y SD1, además de una menor razón LF/HF en reposo. Tampoco se detectaron diferencias estadísticamente significativas entre las agrupaciones de actividad física en tiempo sentado, ansiedad o índices cardíacos evaluados. Estos hallazgos describen patrones grupales diferentes entre las percepciones contextuales, los puntajes globales de ansiedad y los índices cardíacos en reposo, sin demostrar asociaciones individuales, equivalencia o utilidad diagnóstica.
Palabras clave: Frecuencia Cardíaca; Sistema Nervioso Autónomo; Ejercicio Físico; Ansiedad; Estudiantes.

1. Introduction

University life imposes academic, social, and emotional demands on students that may negatively affect mental health, health-related behaviors, and the physiological mechanisms involved in stress adaptation. In this context, anxiety has emerged as a prevalent problem within this population, with high prevalence rates reported across different university settings, particularly among women. Concurrently, factors such as lower levels of physical activity and higher sedentary behavior have been associated with poorer mental health and unfavorable academic outcomes, highlighting the need for integrative approaches capable of simultaneously addressing psychological, behavioral, and physiological dimensions (Ahmed et al., 2023; Benítez-Agudelo et al., 2025; de Souza et al., 2021).

Heart rate variability (HRV) is a widely used, non-invasive method for investigating cardiac autonomic regulation. Under resting conditions and standardized recording procedures, its indices provide relevant information on autonomic modulation, with particular emphasis on markers strongly associated with cardiac vagal

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activity, such as RMSSD. In psychophysiological research, HRV has been employed as an objective complement to subjective self-report instruments, contributing to a more comprehensive understanding of mental well-being, self-regulation, and stress responsiveness. For this reason, its application in university student populations has attracted increasing interest (Laborde et al., 2017; Malik, 1996; Zhu et al., 2025).

Although university students are sometimes perceived as a relatively active population, systematic reviews indicate insufficient adherence to physical activity recommendations among a substantial proportion of this group. This finding is particularly relevant because higher levels of habitual physical activity and cardiorespiratory fitness are generally associated with more favorable autonomic responses to stress-related demands, suggesting a potential protective role in maintaining psychophysiological homeostasis (Ara et al., 2022; Moreno-Arrebola et al., 2019; Muniz & Garrido, 2021). Evidence further demonstrates that higher levels of aerobic fitness are correlated with attenuated autonomic reactivity to stressors, suggesting that physical conditioning functions as a protective mechanism for physiological homeostasis (van der Mee et al., 2023).

Although psychometric questionnaires are essential for assessing symptoms and emotional states, their subjective nature limits the ability to capture underlying physiological processes. In this regard, the incorporation of heart rate variability (HRV) offers a complementary physiological dimension for describing cardiac autonomic modulation, without establishing a diagnostic measure of anxiety. Furthermore, habitual physical activity and psychosocial perceptions related to academic life and health may act as important modulators of both the subjective experience of anxiety and autonomic functioning. Despite the growing interest in subjective measures of mental health and objective physiological indices among university students, studies simultaneously examining anxiety, habitual physical activity, and HRV within the same analytical framework remain relatively scarce. In light of this context, the present study aimed to describe the autonomic profile, physical activity level, anxiety levels, and psychosocial perceptions of university students and to compare their observed distributions by sex and by exploratory groupings derived from the Brazilian IPAQ classification (Ahmed et al., 2023; de Souza et al., 2021; Zhu et al., 2025).

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2. Methods

2.1 Participants

This observational, cross-sectional study employed non-probabilistic sampling, with data collected from May 2025 to June 2026. Undergraduate students at the State University of Rio Grande do Norte (UERN) were eligible regardless of degree program if they were at least 18 years old and enrolled in the first through fourth academic semesters. The sample comprised 243 students of both sexes, aged 18–43 years, enrolled at UERN's main campus in Mossoró, Rio Grande do Norte, Brazil. Assessments were conducted at the Exercise Neurophysiology Laboratory (LANEX) of UERN. The study was approved by the institution's Research Ethics Committee under CAAE No. 82811524.9.0000.5294, in accordance with National Health Council Resolution No. 466/2012. All participants were informed of the study's objectives, procedures, risks, and benefits, as well as the confidentiality of the information provided, the guarantee of privacy, their right to withdraw from the study at any time, and their rights regarding reimbursement and compensation.

2.2 Materials and Instruments

2.2.1 Sociobehavioral Characteristics

Sociobehavioral characteristics were assessed using a questionnaire developed by the authors, consisting of six dichotomous-response items. A second questionnaire, composed of nine items, was designed to assess aspects related to Personal–Academic Satisfaction and Psycho-Academic Strain using a numerical rating scale ranging from 1 to 10, where 1 represented the lowest intensity/perception of the phenomenon and 10 represented the highest intensity/perception. Initially, the variables were analyzed individually, taking into account the conceptual specificity of each item. Additionally, for analytical purposes, the items were grouped into two theoretical domains. The first domain, termed Personal–Academic Satisfaction, comprised Q1 (satisfaction with health), Q2 (satisfaction with economic situation), Q3 (satisfaction with university structure and organization), and Q4 (satisfaction with the undergraduate program). The second domain, termed Psycho-Academic Strain,

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comprised Q5 (academic routine perceived as exhausting), Q6 (desire to be on vacation), Q7 (self-perception as an anxious individual), Q8 (anxiety interfering with academic activities), and Q9 (perceived worsening of mental health after entering the undergraduate program). For each participant, domain scores were calculated as the simple arithmetic mean of the corresponding items, thereby preserving the original 1-to-10 scale. Higher scores in the satisfaction domain indicated greater Personal–Academic Satisfaction, whereas higher scores in the burden domain indicated greater Psycho-Academic Strain. The internal consistency of these item sets was evaluated using Cronbach's alpha and McDonald's omega, and these domains were interpreted as exploratory composite measures, not as validated scales or diagnostic instruments.

2.2.2 State–Trait Anxiety Inventory

The State–Trait Anxiety Inventory (STAI) was used in this study. The instrument is derived from the State-Trait Anxiety Inventory developed by Spielberger et al. (1970) and assesses two distinct dimensions of anxiety: state anxiety, defined as a transient emotional condition, and trait anxiety, defined as a relatively stable predisposition to respond with anxiety across different situations. The Brazilian version of the instrument was developed and adapted by Biaggio et al. (1977) and has been widely used in national studies. The instrument consists of two 20-item scales, and its scores should be interpreted as psychometric indicators of anxiety intensity rather than as a clinical diagnosis (Fioravanti et al., 2006).

2.2.3 Habitual Physical Activity Level

This component was assessed using the International Physical Activity Questionnaire (IPAQ), short version, an instrument developed for population-based monitoring of physical activity across different countries and validated for the Brazilian population. In its short version, the questionnaire assesses the frequency and duration of vigorous-intensity activities, moderate-intensity activities, and walking performed for at least 10 consecutive minutes, as well as time spent in a sitting position, thereby allowing for the estimation of weekly habitual physical activity volume (Craig et al., 2003; Matsudo et al., 2001).

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2.2.4 Heart Rate Variability

Heart rate variability (HRV) was assessed using interbeat (RR) intervals recorded with a Polar H10 chest strap sensor (Polar Electro Oy, Finland), connected to a compatible application that allowed the recording and export of RR interval series. Recordings were obtained under standardized resting conditions, with participants in the supine position for 15 consecutive minutes. The first five minutes were allocated to physiological stabilization, the subsequent five minutes (300 seconds, corresponding to minutes 5–10) were selected for short-term HRV analysis, and the final five minutes were excluded from the analytical procedure. The predefined analysis window was inspected to ensure relative heart rate stability and the absence of abrupt physiological transitions.

The exported RR interval series were processed in the R statistical environment using the open-source RHRV package (Martínez et al., 2024). Signal preprocessing involved automated artifact detection followed by visual inspection to identify anomalous RR intervals, missed or additional heartbeat detections, ectopic beats, and irregularities inconsistent with the local pattern of successive intervals. Artifact-affected observations were filtered, and interpolation was applied when necessary to reconstruct an evenly sampled signal for frequency-domain analysis.

Signal quality was assessed according to the proportion of artifact-affected intervals within each analytical window. Segments containing up to 3% affected intervals were preferentially accepted. Segments containing more than 3% and up to 5% underwent additional individual inspection, whereas those exceeding 5% were excluded from the primary analysis. Recordings exhibiting prolonged signal loss, marked nonstationarity, or suspected arrhythmias preventing reliable identification of normal sinus intervals were also excluded.

HRV was characterized using time-domain, frequency-domain, and nonlinear indices. Time-domain measures included SDNN (standard deviation of normal-to-normal intervals, ms), RMSSD (root mean square of successive differences between adjacent normal-to-normal intervals, ms), and pNN50 (percentage of successive normal-to-normal intervals differing by more than 50 ms, %). Frequency-domain

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analysis included low-frequency power (LF: 0.04–0.15 Hz) and high-frequency power (HF: 0.15–0.40 Hz), expressed in absolute units (ms²), as well as the dimensionless LF/HF ratio. Nonlinear analysis was performed using Poincaré plot-derived indices SD1 and SD2 (ms), representing short-term and longer-term variability of successive RR intervals, respectively. All preprocessing and analytical procedures followed consistent criteria across participants to promote measurement reliability and reproducibility (Malik, 1996; Laborde et al., 2017; Martínez et al., 2024).

2.3 Procedures

Students enrolled in the 1st to 4th semesters of undergraduate programs offered by the institution were considered eligible, provided that they did not report regular use of medications related to psychiatric disorders or drugs with documented effects on the autonomic nervous system, such as beta-blockers and psychostimulants. Given the observational nature of the study, habitual consumption of caffeinated beverages or energy drinks was not adopted as an exclusion criterion. Caffeine consumption was recorded by self-report and described in Table 1. The group comparisons reported in this manuscript are unadjusted; therefore, caffeine-related residual confounding cannot be excluded (Laborde et al., 2017).

After agreeing to participate in the study and signing the relevant ethical consent forms, the students completed the questionnaire-based instruments in the following sequence: Sociobehavioral Characteristics; Personal-Academic Satisfaction and Psycho-Academic Strain; the STAI; and IPAQ.

HRV was recorded with participants in the supine position for 15 consecutive minutes. For the analyses, a stable five-minute segment judged suitable for analysis was selected, a procedure consistent with classical recommendations for short-term HRV analysis. Data were processed in the R environment using specific routines for RR interval series preprocessing and HRV index extraction. In the time domain, SDNN, rMSSD, and pNN50 were considered. In the frequency domain, the LF and HF bands, as well as the LF/HF ratio, were analyzed, in accordance with classical HRV standardization guidelines and recent applications in psychophysiological research on anxiety and mental well-being (Laborde et al., 2017; W. Liu et al., 2025; Malik, 1996;

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Rueda-Ochoa et al., 2024; Sundas et al., 2025; Tomasi et al., 2024; Tomes et al., 2025; Zhu et al., 2025). The submitted analysis reports use of the RHRV package in RStudio (Martínez et al., 2024); software settings and segment-quality thresholds should be documented from the original processing records before final submission.

2.4 Data Analysis

Continuous variables were described as mean ± standard deviation, whereas categorical variables were presented as absolute and relative frequencies. Data distribution was assessed using graphical methods and normality tests, which informed analytical decision-making. In comparisons between sexes, continuous variables were analyzed using Welch's t-test, accounting for the possibility of unequal variances between groups. Categorical variables were compared using the chi-square test of independence, with Fisher's exact test applied when appropriate.

For exploratory comparisons, the five Brazilian IPAQ categories were pooled into three analytically defined groups: sedentary (n = 22); irregularly active A or B (n = 49); and active or very active (n = 172). This regrouping preserves the original category ordering but does not implement the international IPAQ low/moderate/high scoring algorithm, which applies distinct frequency, duration, and MET-min/week criteria (IPAQ Research Committee, 2005). Continuous outcomes were compared between sexes using Welch's t-test, and the three pooled groups were compared using Welch's ANOVA; Games–Howell post hoc comparisons were considered when applicable. Hedges' g was reported for sex contrasts; categorical comparisons used bias-corrected Cramér's V. The three-group comparisons report eta squared (η^2), whose computational implementation requires verification against the original analysis code. Cases with missing values were excluded separately from each comparison. Because the analyses were exploratory, nominal two-sided p-values at the 0.05 level were reported without adjustment for multiple comparisons; results close to this threshold should be interpreted cautiously.

3. Results

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Table 1 - Sociodemographic, Anthropometric, and Sociobehavioral Characteristics of University Students According to Sex

Characteristics	Men (n = 140)	Women (n = 103)	p	TE [CI95%]
Age (years)	21.07 ± 3.86	20.31 ± 3.51	.11	0.21 [-0.05, 0.47]
Weight (kg)	74.06 ± 14.68	62.82 ± 12.20	**< .001**	**0.84 [0.58, 1.11]**
Height (m)	1.74 ± 0.07	1.62 ± 0.06	**< .001**	**1.88 [1.58, 2.19]**
BMI (kg/m²)	24.36 ± 4.40	23.99 ± 4.02	.50	0.09 [-0.17, 0.35]
Academic Semester				
1st semester	55 (39%)	53 (51%)	.06	0.13
2nd semester	31 (22%)	10 (9,7%)		
3rd semester	28 (20%)	21 (20%)		
4th semester	26 (19%)	19 (18%)		
Physical Activity Level (IPAQ)				
Sedentary	16 (11%)	6 (5,8%)	.54	0.00
(Irregularly Active B)	8 (5,7%)	9 (8,7%)		
(Irregularly Active A)	17 (12%)	15 (15%)		
(Active)	47 (34%)	34 (33%)		
(Very Active)	52 (37%)	39 (38%)		
Self-reported Anxious Behavior/Appearance				
No	61 (44%)	22 (21%)	**<.001**	**0.22**
Yes	79 (56%)	81 (79%)		
Caffeine Consumption				
No	70 (50%)	49 (48%)	.71	0.00
Yes	70 (50%)	54 (52%)		

Source: Mean ± standard deviation or n (%). Welch's t-test, chi-square, or Fisher's exact test, as appropriate. ES = effect size; 95% CI = 95% confidence interval; BMI = body mass index; IPAQ = International Physical Activity Questionnaire. For continuous variables, ES is Hedges' g with its reported 95% CI. For categorical variables, ES is the point estimate of bias-corrected Cramér's V (no confidence intervals shown).

Mean age was similar between sexes, with no statistically significant difference. As expected, men exhibited higher mean values for body weight and height, both showing statistically significant differences and large effect sizes. In contrast, body

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mass index did not differ significantly between men and women, suggesting that the observed anthropometric differences primarily reflect expected sex-related variations in body dimensions rather than proportional differences in weight status.

The distribution of students across the initial semesters of the undergraduate program did not differ significantly between sexes, although a higher proportion of women was observed in the first semester. Similarly, the original five-category IPAQ classification showed no significant sex differences, with no statistically significant difference detected between men and women in this sample. Most participants were classified as active or very active, suggesting an overall high level of self-reported physical activity in the study sample.

Regarding psychosocial perceptions, men reported greater satisfaction with their health. In contrast, women reported higher levels of academic routine fatigue, perceived themselves as more anxious, reported greater interference of anxiety with academic activities, and more frequently perceived a deterioration in their mental health after entering the program. Despite the absence of significant differences in overall STAI scores, women exhibited a greater subjective burden of distress associated with the university experience. The composite psycho-academic strain score was also higher among women, further reinforcing the consistency of this pattern.

In addition to the individual analysis of items Q1 through Q9, two composite scores were derived based on theoretically oriented groupings: Personal-Academic Satisfaction (Q1–Q4) and Psycho-Academic Strain (Q5–Q9). The scores were calculated as the mean of their constituent items, ranging from 1 to 10, thereby allowing direct interpretation using the same scale as the original responses. The internal consistency of each item set was examined to assess the adequacy of these groupings as composite indicators.

Although the composite scores were useful for summarizing conceptually related dimensions, it should be noted that the items were specifically developed for the present study and do not, a priori, constitute a previously validated psychometric scale. Therefore, these item sets should be interpreted as exploratory composite measures that complement the item-by-item analyses. The Personal-Academic Satisfaction block (Q1–Q4) had an alpha and omega below 0.70, with a Cronbach's

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alpha of 0.666 and a McDonald's omega of 0.682. In contrast, the Psycho-Academic Strain block (Q5–Q9) had higher internal consistency coefficients, with a Cronbach's alpha of 0.743 and a McDonald's omega of 0.751.

Table 2 - Psychosocial Perception Items and Composite Scores of Psycho-Academic Satisfaction and Strain According to Sex

Items	Men n = 140	Women n = 103	P	TE [CI95%]
Q1 – Satisfaction with health	7.48 ± 1.78	6.54 ± 1.71	**< .001**	**0.55 [0.29, 0.82]**
Q2 – Satisfaction with economic status	5.64 ± 1.84	5.17 ± 2.32	.091	0.25 [-0.04, 0.53]
Q3 – Satisfaction with the university structure/organization	6.89 ± 1.81	6.99 ± 2.08	.70	-0.06 [-0.33, 0.22]
Q4 – Satisfaction with the undergraduate program	8.16 ± 1.78	8.25 ± 1.78	.70	-0.05 [-0.32, 0.21]
Q5 – Exhausting academic routine	7.24 ± 1.70	8.06 ± 1.95	**< .001**	**-0.48 [-0.76, -0.20]**
Q6 – Desire to be on vacation	7.64 ± 2.16	8.17 ± 2.04	.056	-0.26 [-0.52, 0.00]
Q7 – Perception of oneself as an anxious person	6.19 ± 2.80	7.52 ± 2.31	**< .001**	**-0.53 [-0.79, -0.27]**
Q8 – Anxiety interferes with academic activities	5.64 ± 3.03	6.75 ± 2.93	**.004**	**-0.39 [-0.65, -0.12]**
Q9 – Perceived worsening of mental health after enrollment in the program	4.37 ± 2.90	5.31 ± 3.06	**.017**	**-0.33 [-0.60, -0.06]**
Personal-academic satisfaction	7.04 ± 1.32	6.74 ± 1.36	.083	0.24 [-0.03, 0.50]
Psycho-academic strain	6.22 ± 1.83	7.16 ± 1.65	**< .001**	**-0.55 [-0.82, -0.29]**

Source: Mean ± standard deviation. Q1–Q9 use a 1–10 numerical rating scale; the two composites are exploratory and not validated diagnostic scales. p-values are nominal Welch t-tests; ES = Hedges' g (men minus women) with 95% confidence intervals. Positive values indicate higher means in men; negative values indicate higher means in women. No multiplicity adjustment was applied to the reported p-values.

In the comparison between sexes, men reported greater satisfaction with their health (Q1), whereas women reported a greater perception of an academically fatiguing routine (Q5), perceived themselves as more anxious (Q7), reported a greater impact of anxiety on academic activities (Q8), and more frequently perceived a worsening of their mental health after entering the program (Q9). No statistically

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significant sex differences were observed for Q2, Q3, Q4, Q6, or the composite Personal-Academic Satisfaction score. The Psycho-Academic Strain score was higher among women.

Table 3 - Sedentary Behavior, Anxiety, and Heart Rate Variability Indices Across Exploratory Groupings of the Brazilian IPAQ Categories

Characteristics	Physical Activity Level (IPAQ)			p	η^2
	Sedentary n = 22	Irregularly active n = 49	Active/very active n = 172		
IPAQ-Derived Measures					
MET-min/week	-	848.13 ± 1,276.89	5,873.23 ± 4,739.60	-	
Estimated Energy Expenditure (kcal/week)	-	972.69 ± 1,104.68	7,148.37 ± 6,138.86	-	
Total Sitting Time/Week (h)	52.78 ± 27.22	50.23 ± 23.46	55.44 ± 29.49	.44	.006
Average Sitting Time/Day (h)	7.54 ± 3.89	7.18 ± 3.35	7.92 ± 4.21	.44	.006
STAI					
State Anxiety	40.32 ± 8.43	42.80 ± 9.84	43.47 ± 10.72	.29	.008
Trait Anxiety	46.23 ± 11.86	44.86 ± 10.32	47.05 ± 12.34	.46	.005
HRV					
SDNN (ms)	65.13 ± 29.33	62.19 ± 24.35	62.68 ± 23.62	.92	.001
RMSSD (ms)	55.88 ± 32.88	53.31 ± 29.42	52.75 ± 24.38	.91	.001
pNN50 (%)	28.08 ± 22.76	28.31 ± 20.23	27.78 ± 17.86	.99	.001
LF	563.90 ± 606.46	502.00 ± 409.65	476.60 ± 412.56	.77	.003
HF	466.53 ± 454.53	434.60 ± 450.15	385.67 ± 443.85	.63	.004

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Characteristics	Physical Activity Level (IPAQ)			p	η²
	Sedentary n = 22	Irregularly active n = 49	Active/very active n = 172		
IPAQ-Derived Measures					
LF/HF	2.12 ± 1.80	1.96 ± 1.42	2.07 ± 1.67	.88	.001
SD1 (ms)	39.57 ± 23.28	37.75 ± 20.83	37.42 ± 17.18	.92	.001
SD2 (ms)	82.22 ± 36.51	78.01 ± 30.36	78.28 ± 27.26	.88	.002

Source: Mean ± standard deviation. Groups are an exploratory pooling of the five Brazilian IPAQ categories: sedentary; irregularly active A/B; and active/very active. They are not equivalent to the international low/moderate/high IPAQ algorithm. Nominal p-values are from Welch's ANOVA; η² = eta squared as originally reported. The dash indicates that the respective summary was not provided in the original table; it must not be interpreted as zero.

The analysis across the three exploratory groupings of habitual physical activity—sedentary, irregularly active, and active/very active—did not reveal statistically significant differences in total weekly sitting time, average daily sitting time, state anxiety, trait anxiety, or HRV indices. Furthermore, the reported eta-squared estimates were small. These group comparisons do not establish equivalence or the sensitivity of the original IPAQ classification.

In the comparison between sexes, state and trait anxiety scores did not differ significantly. When assessed using a standardized psychometric instrument, no statistically significant difference was detected for either anxiety dimension. However, HRV indices revealed differences in resting HRV indices: women exhibited higher RMSSD, pNN50, HF, and SD1 values, as well as a lower LF/HF ratio. These resting differences are compatible with higher values of selected cardiac vagal modulation-related indices in women under the recorded conditions, without establishing superior autonomic health. No significant differences were observed for SDNN, LF, and SD2.

Table 4 - State Anxiety, Trait Anxiety, and Resting Heart Rate Variability Indices by Sex

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Characteristics	Men n = 140	Women n = 103	p	TE [CI95%]
STAI				
State Anxiety	42.56 ± 10.70	43.71 ± 9.89	.39	-0.11 [-0.37, 0.15]
Trait Anxiety	45.87 ± 12.11	47.44 ± 11.61	.31	-0.14 [-0.40, 0.13]
HRV				
SDNN (ms)	62.83 ± 21.27	62.77 ± 27.87	.98	0.00 [-0.29, 0.29]
RMSSD (ms)	49.83 ± 23.51	57.66 ± 28.98	**.026**	**-0.33 [-0.61, -0.04]**
pNN50 (%)	25.01 ± 17.27	31.86 ± 20.01	**.006**	**-0.39 [-0.67, -0.11]**
LF	525.14 ± 431.88	441.36 ± 428.17	.130	0.20 [-0.06, 0.47]
HF	346.76 ± 383.93	479.10 ± 508.88	**.028**	**-0.33 [-0.62, -0.04]**
LF/HF	2.47 ± 1.77	1.50 ± 1.22	**< .001**	**0.65 [0.39, 0.91]**
SD1 (ms)	35.36 ± 16.54	40.83 ± 20.52	**.027**	**-0.32 [-0.61, -0.04]**
SD2 (ms)	80.30 ± 27.12	76.24 ± 30.73	.290	0.15 [-0.13, 0.43]

Source: Mean ± standard deviation. p-values are nominal, unadjusted Welch t-tests. ES = Hedges' g (men minus women) and 95% CI. Positive values indicate higher means in men, whereas negative values indicate higher means in women. LF and HF are spectral power measures.

3. Discussion

The present study provided an integrated description of habitual physical activity, anxiety, psychosocial perceptions, and HRV among university students. The main findings were as follows: women reported a higher self-reported frequency of anxious behavior or appearance and greater psycho-academic strain; no sex differences were observed in state or trait anxiety scores; no statistically significant differences in anxiety, sitting time, or HRV were detected among the three analytically pooled physical activity groups; and women exhibited higher values of selected resting HRV indices.

The higher frequency of self-reported anxious behavior and greater psycho-academic strain among women is consistent with the literature on the mental health of university students. A systematic review and meta-analysis published in *BMC Psychiatry*, including 89 studies and approximately 130,000 students, estimated a pooled prevalence of non-specific anxiety of 39.65% among university students and found that, in approximately half of the included studies, female sex was associated with higher anxiety scores or a greater likelihood of a positive anxiety screening

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(Ahmed et al., 2023). These findings reinforce the relevance of the present study, particularly because the differences between men and women were more evident in subjective and contextual indicators of academic strain than in overall STAI scores.

The lack of a statistically significant sex contrast in STAI scores should not be interpreted as equivalence of anxiety between men and women. The STAI and the author-developed Q5–Q9 items assess different, partially overlapping domains: general anxiety-related psychometric scores and perceptions specifically framed within academic life. Accordingly, the differences observed in contextual items, but not in the STAI, may reflect differences in item content and measurement scope. This finding does not demonstrate greater sensitivity, psychometric validity, or diagnostic accuracy of the exploratory items.

This pattern also suggests that assessing university students' mental health may benefit from combining standardized instruments with contextual measures. Validated psychometric questionnaires are essential, but they may not capture specific nuances of the academic experience. In a recent study involving university students, Zhu et al. highlighted the limitations of subjective measures of psychological functioning and suggested that HRV may serve as a complementary, albeit complex, physiological index of mental well-being (Zhu et al., 2025).

From an autonomic perspective, women had higher RMSSD, pNN50, HF, and SD1 values in the available five-minute resting segments. RMSSD and SD1 are mathematically closely related, and these estimates should not be treated as independent confirmations of the same effect. HF power is also influenced by respiratory conditions. Methodological recommendations for psychophysiological studies using HRV recognize its utility as an index of cardiac vagal tone but not as a direct clinical assessment of mental health or stress resilience. Furthermore, the use of five-minute segments is consistent with the classical short-term recording standard recommended to ensure comparability across studies (Laborde et al., 2017; Quigley et al., 2024).

The observed female–male differences were confined to the resting indices reported here; they do not establish a globally more favorable autonomic profile, differential stress reactivity, or mental health protection. The direction of selected

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findings is consistent with the meta-analysis by Koenig and Thayer (2016), which reported higher HF power and lower LF/HF ratios among women in some contexts. However, LF/HF should not be interpreted as a direct measure of sympathovagal balance (Quigley et al., 2024). At the group level, more frequent reports of contextual psycho-academic strain among women coexisted with higher values for some resting vagal-related indices. These between-group patterns cannot establish the absence, direction, or magnitude of individual-level associations between perceived strain and HRV.

On the other hand, these findings partially differ from those of recent studies involving university students that have reported poorer psychological well-being and lower HRV indices among women. Zhu et al., for instance, found higher anxiety scores and lower SDNN, RMSSD, pNN50, and HF values in Chinese female university students (Zhu et al., 2025). The discrepancies between studies may be attributable to differences in sample characteristics, data collection protocols, control of circadian factors, menstrual cycle phase, caffeine intake, physical fitness level, psychometric instruments, and sociocultural characteristics of the university environment. Thus, the findings of the present study should not be interpreted as contradicting the association between anxiety and autonomic dysfunction, but rather as indicating that cross-study comparisons are sensitive to measurement conditions and participant characteristics.

Studies of clinically diagnosed anxiety disorders, including the meta-analysis by Chalmers et al. (2014), often report lower HRV values relative to control groups; however, those findings are not directly transferable to the present university-based sample. Clinical diagnoses were not established or ruled out using a diagnostic interview in the procedures reported here. Thus, the sample should be described as university students recruited outside a clinical service, rather than as a clinically confirmed non-anxious group. Associations between the individual STAI or psycho-academic strain scores and HRV indices were not estimated in the analyses presented, and neither their presence nor their absence can be inferred from sex-stratified group means.

The absence of differences across habitual physical activity levels should also be interpreted with caution. Most participants were classified into the pooled active/very

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active group, which may have resulted in an imbalance across groups and reduced the ability to detect meaningful differences. In addition, the IPAQ estimates physical activity through self-report and may overestimate weekly activity levels, particularly among young and highly educated populations. Another important consideration is that habitual physical activity level does not necessarily correspond to cardiorespiratory fitness. Recent studies suggest that cardiorespiratory fitness may represent an important pathway through which physical activity is associated with mental health. In university students, Xu et al. observed that physical activity was negatively associated with depression, anxiety, and stress, whereas cardiorespiratory fitness partially mediated the relationships between physical activity, sedentary behavior, and mental health (Xu et al., 2025).

Therefore, the absence of differences across IPAQ physical activity levels in the present study does not imply that physical activity is irrelevant to mental health or autonomic regulation. The exploratory regrouping used in this study, the marked imbalance between groups, and reliance on self-report limit the precision and generalizability of these null contrasts; they do not demonstrate limited sensitivity of the IPAQ instrument. Recent reviews and meta-analyses have consistently shown that physical exercise interventions reduce symptoms of anxiety, depression, and stress among university students, with clinically meaningful effects, particularly when interventions are regular, of sufficient duration, and structured (L. Liu et al., 2025).

Regarding sedentary behavior, no differences were observed across physical activity levels. This finding reinforces the need to consider physical activity and sedentary behavior as distinct constructs. A student may achieve a high weekly volume of physical activity and still spend many hours sitting in class, studying, commuting, or using screens. Recent evidence suggests that sedentary behavior may be directly or indirectly associated with mental health, although the findings remain heterogeneous and depend on the type of sedentary behavior assessed (Xu et al., 2025).

In summary, women reported higher scores on several contextual psycho-academic strain items, while sex contrasts in STAI scores were not statistically significant. Some resting HRV indices differed by sex, but these between-group patterns do not reveal how psychosocial strain and cardiac variability covary within

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individuals. The cross-sectional, single-institution design, non-probabilistic recruitment, uneven activity group sizes, unadjusted analyses, and incomplete reporting of potential measurement confounders constrain the interpretation of these findings.

5. Conclusion

Female university students reported greater psycho-academic strain on exploratory context-specific measures, although no statistically significant sex differences were detected in state or trait anxiety scores. Women also exhibited higher RMSSD, pNN50, HF, and SD1 values and a lower LF/HF ratio, suggesting differences in specific indices of cardiac autonomic modulation at rest. No statistically significant differences in sedentary behavior, anxiety, or HRV indices were detected across the three analytically regrouped IPAQ categories, without establishing equivalence between physical activity levels.

These findings highlight the importance of considering psychosocial perceptions, anxiety, habitual physical activity, and autonomic indicators as distinct but complementary dimensions of university students' psychophysiological health. Given the cross-sectional design, convenience sampling, self-reported measures, exploratory psychosocial composites, and potential uncontrolled influences on HRV, the results should be interpreted cautiously. Further investigations employing validated contextual measures, standardized HRV protocols, and more balanced physical activity groups are warranted.

References

Ahmed, I., et al. "A Systematic Review and Meta-Analysis of Studies Exploring Prevalence of Non-Specific Anxiety in Undergraduate University Students." *BMC Psychiatry*, vol. 23, no. 1, 2023, doi:10.1186/s12888-023-04645-8.

Ara, N. B., et al. "Rendimiento académico, actividad física, sueño y género en universitarios durante la pandemia-2020." *Cultura, Ciencia y Deporte*, vol. 17, no. 53, 2022, pp. 109–131, doi:10.12800/ccd.v17i53.1897.

Benitez-Agudelo, J. C., et al. "Longitudinal Effects of Stress in an Academic Context on Psychological Well-Being, Physiological Markers, Health Behaviors, and Academic

REMUNOM
ISSN 2178-6925

Received: 13/08/2026 - **Accepted:** 13/09/2026
Vol:
DOI:
Pages: 1-25

Performance in University Students." *BMC Psychology*, vol. 13, no. 1, 2025, doi:10.1186/s40359-025-03041-z.

Biaggio, A. M. B., L. Natalício, and C. D. Spielberger. "Desenvolvimento da forma experimental em português do Inventário de Ansiedade Traço-Estado (IDATE) de Spielberger." *Arquivos Brasileiros de Psicologia Aplicada*, vol. 29, no. 3, 1977, pp. 31–44.

Chalmers, J. A., et al. "Anxiety Disorders Are Associated with Reduced Heart Rate Variability: A Meta-Analysis." *Frontiers in Psychiatry*, vol. 5, 2014, doi:10.3389/fpsyt.2014.00080.

Craig, C. L., et al. "International Physical Activity Questionnaire: 12-Country Reliability and Validity." Medicine & Science in Sports & Exercise, vol. 35, no. 8, 2003, pp. 1381–1395, doi:10.1249/01.MSS.0000078924.61453.FB.

de Souza, K. C., et al. "Medical Students Show Lower Physical Activity Levels and Higher Anxiety than Physical Education Students: A Cross-Sectional Study during the COVID-19 Pandemic." *Frontiers in Psychiatry*, vol. 12, 2021, doi:10.3389/fpsyt.2021.804967.

Fioravanti, A. C. M., et al. "Evaluation of the Factorial Structure of the Trait Anxiety Scale of the STAI." *Avaliação Psicológica*, vol. 5, no. 2, 2006, pp. 217–224.

IPAQ Research Committee. Guidelines for Data Processing and Analysis of the International Physical Activity Questionnaire (IPAQ): Short and Long Forms. Revised Nov. 2005. https://sites.google.com/view/ipaq/score.

Koenig, J., and J. F. Thayer. "Sex Differences in Healthy Human Heart Rate Variability: A Meta-Analysis." *Neuroscience & Biobehavioral Reviews*, vol. 64, 2016, pp. 288–310, doi:10.1016/j.neubiorev.2016.03.007.

Laborde, S., et al. "Heart Rate Variability and Cardiac Vagal Tone in Psychophysiological Research: Recommendations for Experiment Planning, Data Analysis, and Data Reporting." *Frontiers in Psychology*, vol. 8, 2017, doi:10.3389/fpsyg.2017.00213.

Liu, L., et al. "Effectiveness of Physical Exercise on Mental Health among University Students: A Systematic Review and Meta-Analysis." *Frontiers in Psychology*, vol. 16, 2025, doi:10.3389/fpsyg.2025.1612408.

REMUNOM
ISSN 2178-6925

Received: 13/08/2026 - **Accepted:** 13/09/2026
Vol:
DOI:
Pages: 1-25

Liu, W., et al. "Heart Rate Variability, a Potential Assessment Tool for Identifying Anxiety, Depression, and Sleep Disorders in Elderly Individuals." *Frontiers in Psychiatry*, vol. 16, 2025, doi:10.3389/fpsyt.2025.1485183.

Malik, M. "Heart Rate Variability: Standards of Measurement, Physiological Interpretation, and Clinical Use: Task Force of the European Society of Cardiology and the North American Society for Pacing and Electrophysiology." *Annals of Noninvasive Electrocardiology*, vol. 1, no. 2, 1996, pp. 151–181, doi:10.1111/j.1542-474X.1996.tb00275.x.

Martínez, C. A. G., et al. *Heart Rate Variability Analysis with the R Package RHRV*. 2nd ed., Springer, 2024, doi:10.1007/978-3-031-65753-5.

Matsudo, S., et al. "Questionário internacional de atividade física (IPAQ): estudo de validade e reprodutibilidade no Brasil." Revista Brasileira de Atividade Física & Saúde, vol. 6, no. 2, 2001, pp. 5–18.

Moreno-Arrebola, R., et al. "Insufficient Adherence to the Physical Exercise of University Students: A Systematic Review." *SPORT TK-EuroAmerican Journal of Sport Sciences*, vol. 8, no. 1, 2019, pp. 39–50, doi:10.6018/sportk.362041.

Muniz, G. B. A., and E. N. Garrido. "Mudanças de hábitos e saúde dos estudantes após ingresso na universidade." *Revista Psicologia, Diversidade e Saúde*, vol. 10, no. 2, 2021, pp. 235–245, doi:10.17267/2317-3394rpds.v10i2.3443.

Quigley, K. S., et al. “Publication Guidelines for Human Heart Rate and Heart Rate Variability Studies in Psychophysiology—Part 1: Physiological Underpinnings and Foundations of Measurement.” Psychophysiology, vol. 61, no. 9, 2024, e14604, doi:10.1111/psyp.14604.

Rueda-Ochoa, O. L., et al. "Which Indices of Heart Rate Variability Are the Best Predictors of Mortality after Acute Myocardial Infarction? Meta-Analysis of Observational Studies." *Journal of Electrocardiology*, vol. 84, 2024, pp. 42–48, doi:10.1016/j.jelectrocard.2024.03.006.

Spielberger, C. D. *Manual for the State-Trait Anxiety Inventory (Self-Evaluation Questionnaire)*, 1970.

Sundas, A., et al. "Heart Rate Variability over the Decades: A Scoping Review." *PeerJ*, vol. 13, 2025, doi:10.7717/peerj.19347.

REMUNOM
ISSN 2178-6925

Received: 13/08/2026 - **Accepted:** 13/09/2026
Vol:
DOI:
Pages: 1-25

Tomasi, J., et al. "Heart Rate Variability: Evaluating a Potential Biomarker of Anxiety Disorders." *Psychophysiology*, vol. 61, no. 2, 2024, doi:10.1111/psyp.14481.

Tomes, C., et al. "Heart Rate Variability Is More Sensitive to Stress than Heart Rate in Specialist Police Undergoing Selection." *PLoS ONE*, vol. 20, no. 1, 2025, doi:10.1371/journal.pone.0317124.

van der Mee, D. J., et al. "Cardiorespiratory Fitness, Regular Physical Activity, and Autonomic Nervous System Reactivity to Laboratory and Daily Life Stress." *Psychophysiology*, vol. 60, no. 4, 2023, doi:10.1111/psyp.14212.

Xu, L., et al. "Associations of Physical Activity and Sedentary Behavior with Mental Health among University Students: The Mediating Role of Cardiorespiratory Fitness and Moderating Role of Gender." *BMC Public Health*, vol. 25, no. 1, 2025, doi:10.1186/s12889-025-24528-9.

Zhu, Y., et al. "Mental Well-Being of College Students: Focus on Sex Differences and Psychophysiological Indices." *BMC Public Health*, vol. 25, no. 1, 2025, doi:10.1186/s12889-025-24231-9.