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ORIGINAL ARTICLE

Relationship between chronic stress, nutritional status, neutrophil-lymphocyte ratio, and heart rate variability among active military police officers in a metropolitan region

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Abstract

Introduction: Chronic stress, sociodemographic characteristics, and nutritional status can negatively affect heart rate variability (HRV), especially in active-duty military personnel, resulting in altered cardiac autonomic modulation.

Objective: The aim of this study was to relate cardiac autonomic modulation in active-duty military personnel with chronic stress, sociodemographic characteristics, and nutritional status.

Methods: A cross-sectional study was conducted in military personnel from the state of Espírito Santo with 71 participants over 18 years of age from August to November 2022. The analysis of autonomic modulation of heart rate was performed using the Kubios® software. For this analysis, individuals remained in the supine position for 25 minutes. HRV indices were calculated using linear methods in the time and frequency domains. Statistical differences were found between men and women in the variable SDNN (standard deviation of the mean of all normal RR intervals) (p=0.006), RMSSD (square root of the mean of the squares of the differences between successive normal RR intervals) (p=0.028). Between the different BMI (body mass index) ranges mean RR (mean of consecutive RR intervals) (p=0.007) and mean HR (mean heart rate) (p=0.015) and in the different age groups SI (Baevsky stress index) (p=0.001), SDNN (p=0.003), RMSSD (p=0.004).

Results: There was an association between body mass index (BMI) and mean RR interval (Mean RR). People with obesity tend to have a higher mean heart rate, while those with overweight generally have a longer mean RR interval. These differences indicate distinct patterns in cardiac autonomic regulation according to nutritional status.

Conclusion: There was an influence of nutritional status on cardiac autonomic modulation in active military public agents, but there is no relationship with chronic stress suffered by this population.

Keywords: Heart rate; Military; Autonomic nervous system; Sympathetic nervous system; Parasympathetic nervous system; Neutrophil-lymphocyte ratio.

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Authors summary

Why was this study done?
The study was carried out to evaluate cardiac autonomic modulation, biochemical factors, nutritional status in a population of public security agents who live with stress.

What did the researchers do and find?
We carried out a cross-sectional study with 71 active military police officers who presented symptoms of stress screened using the Perceived Stress Scale (PSS-14) questionnaire. Participants were over 18 years of age of both sexes. The study analyzed sociodemographic, anthropometric variables, biochemical variables and cardiac variables. An analysis revealed the influence of nutritional status on cardiac activity and inflammatory markers.

What do these findings mean?
These results emphasize the need to analyze the characteristics and lifestyle of military personnel as this can provide a crucial warning about the health conditions of this population, enabling a more comprehensive, effective and preventive approach. This approach not only directs our understanding of the impacts of specific stress on the HRV of military police officers, but also suggests more specific interventions and health policies adapted to the needs of these professionals, especially in relation to nutritional status and quality of life.

INTRODUCTION

Public security agents face a series of challenges, which directly impact their physical and mental health, given the constant exposure to violence and imminent risk to their own lives[1,2] . These conditions, faced daily, are a significant factor in the development of chronic stress that can result in maladaptive responses and compromise mental and physical health, potentially leading to the development of chronic diseases[3] .

Chronic stress appears to have significant effects on overall health, including increased risk of cardiovascular disease, sleep disorders, depression, and anxiety . Maintaining the health of public safety agents is crucial not only for their individual well-being, but also for their effectiveness in performing their duties.

Finding specific diagnostic parameters, such as Heart Rate Variability (HRV), that can be applied to this group is essential. HRV not only reflects the activity of the Autonomic Nervous System (ANS), but also serves as a clinical marker to assess and monitor the health of agents, allowing early diagnosis of diseases. It reflects the activity of the ANS and is a clinical tool capable of assessing and identifying health impairments through changes in its patterns.

Various factors in the work environment, such as Burnout, depressive symptoms 4 , low quality of life, muscle pain, excessive bureaucracy, family concerns, lack of community support and post-traumatic stress disorder 5,6 can unbalance the body's homeostasis, impairing work productivity and increasing the risk of chronic diseases, such as cardiovascular diseases[1,4,7-9]. Sleep disorders[10], obesity[11,12] and a sedentary lifestyle[13] are also closely related to autonomic imbalance.

HRV refers to the variation in the intervals between heartbeats. Modulated by the ANS, it becomes an effective tool for measuring the relationship between the cardiovascular system and the dynamic balance of homeostasis. The ANS plays a central role in the response to stress, leading to a constant activation of the sympathetic nervous system in situations of prolonged stress, resulting in an imbalance between the sympathetic and parasympathetic systems, generating negative impacts on the individual's general health[8]. Therefore, HRV is a measure that reflects the activity of this system[3,7,16,17] Understanding the relationship between the regulation of SNA and the biochemical parameters that reflect these consequences is essential to assess the impact on the health and well-being of public security agents.

Grani *et al.,* (2022)[19] noted a reduction in HRV in military agents after armed confrontation, suggesting reduced parasympathetic activity due to acute stress. Therefore, HRV, due to its ability to estimate the activity of the autonomic nervous system and identify individuals in unfavorable health conditions, emerges as a crucial tool in assessing the health, well-being and fitness of the military population[1,20,21] .

However, there is still a significant gap in studies investigating the relationship between HRV, biochemical parameters such as measures of inflammation related to chronic stress, and nutritional status in active military police officers. The underlying hypothesis is that HRV will be negatively affected by high levels of chronic stress, manifesting itself in changes in biochemical parameters of inflammation and nutritional status, indicating a greater health vulnerability of these professionals.

Thus, the objective is to report cardiac autonomic modulation in active military public agents with chronic stress, sociodemographic characteristics and nutritional status.

METHODS

Study Design

This is a cross-sectional study involving 71 active military police officers who worked in a metropolitan area in the state of Espírito Santo, Brazil, and presented symptoms of stress as assessed using the Perceived Stress Scale (PSS-14) questionnaire. Only those who presented symptoms of chronic stress identified by the questionnaire were included in the study[3,22].

Study Location and Period

Data collection was carried out at the Interprofessional Health Outpatient Clinic of the Federal University of Espírito Santo (UFES), in the morning, between August and November 2022.

Study Population and Eligibility Criteria

The study participants were public security officers who worked in the Military Police. Healthy adults, over 18 years of age, of both sexes, who signed the Free and Informed Consent Form (FICF) were included.

Individuals with heart disease, who had previously suffered a heart attack, who had a pacemaker, and who were pregnant were excluded from the study. Individuals who were unable to remain for the HRV exam were discontinued, as were those who showed any sign of pain and/or discomfort and abandoned the study at any point during data collection.

Study Variables

Sociodemographic variables (age and sex), anthropometric variables (weight, height and body mass index), biochemical variables such as: glucose, basal cortisol, total leukocytes, total neutrophils, platelets, RPL, NLR, blood pressure and the following HRV variables were analyzed: standard deviation of the mean of all normal RR intervals (SDNN); root mean square of the squares of the differences between successive normal RR intervals (RMSSD); Baevsky stress index (SI); very low frequency band (VLF); low frequency band (LH), high frequency band (HF), mean heart rate (mean HR); mean of consecutive RR intervals (Mean RR).

Nutritional status

In addition to the cardiological evaluation, the individuals underwent an anthropometric evaluation, in which their weight and height were measured. Height was measured using a stadiometer with a maximum capacity of two meters and ten centimeters and an accuracy of half a centimeter. Weight was measured using an eight-electrode segmental bioimpedance scale (InBody 230; InBodyCo, Seoul, Korea) (with 100g division and a maximum capacity of 150 kg).

The Body Mass Index (BMI) was calculated by dividing the weight by the square of the height and following the WHO (2000) reference for adults, grouping all underweight individuals who presented BMI values; 18.5 kg/m2 , normal weight: 18.5 to 24.9 kg/m2 , overweight: 25.0 to 29.9 kg/m2 and obesity: BMI ≥ 30.0 kg/ m2 .

Heart rate variability (HRV)

HRV data were collected in a quiet room with a temperature monitored between 21° and 23° C. Participants were instructed not to consume alcoholic beverages or caffeine and not to perform exhaustive exercises 24 hours before the exam.

After the initial assessment, the capture belt was placed on the volunteer's chest and the Polar® V800 heart rate receiver (Polar Electro, Finland) was placed on the wrist. This equipment was previously validated to capture beat-to-beat heart rate and use the data to analyze HRV.

Data collection was performed individually and after placing the belt and monitor, the individuals were positioned in the supine position and remained at rest for 25 minutes, breathing spontaneously. At least 256 consecutive intervals were used for data analysis.

Only series with more than 95% of sinus beats were used for analysis in the Kubios ® HRV Standart software - version 3.5.0. The normal RR interval sequences stored in the heart rate monitor were exported as text files and imported into the Kubios ® HRV Standart software - version 3.5.0 for automatic HRV processing as recommended by the European Society of Cardiology and the North American Society of Pacing and Electrophysiology (1996). Subsequently, digital filtering was performed to eliminate premature ectopic beats and artifacts.

HRV data analysis

HRV analysis was performed using linear methods (time and frequency domains), mean RR intervals and mean heart rate. In the time domain, the mean square of the square of the differences between adjacent normal RR intervals (RMSSD), the standard deviation of the means of normal RR intervals (SDNN) and the stress index (SI) were used. The means of the RR intervals and heart rate were also analyzed.

The RMSSD reflects parasympathetic regulation, the SDNN reflects the participation of both branches of the ANS, and the SI is known as the Baevsky Index or stress index and estimates the sympathetic activity of the heart15,16.

To analyze HRV in the frequency domain, spectral components of very low frequency (VLF – range from 0.003 to 0.004 Hz), low frequency (LF – range from 0.04 to 0.15 Hz) and high frequency (HF – range from 0.15 to 0.4 Hz) were used. The algorithm used for spectral analysis was the fast Fourier transform - FFT 16 .

Data Analysis

The normality of the data was verified by the Kolmogorov Smirnov test (n>30)[23,24] . Regarding the data analysis, descriptive statistics were applied to characterize the participants and the results were reported as mean and standard deviation values as measures of central tendency and dispersion respectively, and median and interquartile range when the data did not follow a non-normal distribution . Pearson's chi-square test and Fisher's exact test 25 were used to assess the association between the independent variables and the outcome (normal weight, overweight and obesity).

For paired samples with normal distribution, Student's t-test was used to compare two groups and the One Way ANOVA repeated measures test 26 in the comparison of three groups. For variables considered non-parametric, the Kruskal-Wallis test 27 was performed whenever necessary and the Dunn post hoc test for multiple comparisons.

To examine the relationship between the parameters of heart rate variability and chronic stress[19], RPL[28], RNL[29,30] and BMI[11,12] comprised the crude model and were adjusted for sociodemographic factors (sex, age), health (glucose, basal cortisol, total leukocytes, total neutrophils, platelets, RPL, RNL, blood pressure) and lifestyle (smoking, sedentary lifestyle) confounding variables selected from previous analyses and examples contained in the literature [31,32] for this the generalized linear model (GZLM) was used in model 1 (Model 1). GLZM promotes an extension of general linear models. This model allows an extension of generalized linear models in a regression model for a dependent variable that does not follow a normal distribution without requiring categorization or transformation of the data. In addition to making necessary the need for equality or constancy of variances in traditional linear models[33]. In addition, the Akaike information criterion (AIC) was used to compare the models and determine the one that best fits the sample. The model that included the confounding factors described demonstrated greater adherence to the data, as indicated by the lower AIC value[34].

The statistical significance adopted was p<0.05 for two-tailed p-value[35]. All analyses were performed using the Statistical Package for the Social Sciences - SPSS, version 28.0 (SPSS, Inc., Chicago, IL, USA). And for the graphical representation of the results, GraphPad Prism®, version 7.0 (GraphPad® Software Inc, CA, USA) was used.

Ethical and Legal Aspects of the Research

Informed consent was signed by all subjects prior to data collection. The experimental procedures were approved by the Research Ethics Committee of the Federal University of Espírito Santo, UFES (CAAE53145521.1.0000.5060) and in accordance with the 2013 Declaration of Helsinki.

RESULTS

Table 1 shows that the median age varied significantly between groups. Individuals with normal weight (NW) had a median age of 34 years (IQ32;37), while those with overweight (OW) had a median age of 37 years (IQ33;44) and those with obesity (OB) had a median age of 42 years (IQ38;48). There was a statistically significant difference (p = 0.006) between the NW and OW groups in relation to age. However, the OB group had a significantly higher median age compared to the NW and OW groups. The median age of individuals varies according to nutritional status, being higher in individuals with obesity compared to those with normal weight and overweight.

Table 1: Characteristics of participants in relation to body mass index.

Variable*	Nutritional status				
	NW	OW	OB	Total	p-value
Age	34 (32;37)[a]	37 (33; 44)[a]	42 (38;48)[ab]	37 (33;44)	0.006
Sex					
Female	9 (60.0)	3 (8.1)	5 (26.3)	17 (23.9)	<0.001
Male	6 (40.0)	34 (91.9)	14 (73.7)	54 (76.1)	
Smoker					
Does not smoke	11 (84.6)	32 (88.9)	17 (89.5)	60 (88.2)	0.535
Have you ever smoked?	1 (7.7)	0 (0.0)	1 (5.3)	2 (2.9)	
Currently smoking	0 (0.0)	2 (5.6)	1 (5.3)	3 (4.4)	
PNA	1 (7.7)	2 (5.6)	0 (0.0)	3 (4.4)	
Sedentary					
Yes	9 (75.0)	22 (64.7)	9 (52.9)	40 (65.5)	0.467
No	3 (25.0)	12 (35.3	8 (47.1)	23 (56.5)	
Glucose	86.0 (83.0; 99.0)	92.0 (87.0; 98.0)	98.0 (96.0; 103.0)	95.0 (87.5; 100.0)	0.007
Basal cortisol	10.9 (10.1;15.5)	12.1 (9.5; 13.3)	11.3 (7.0; 13.4)	11.61 (9.23; 13.4)	0.780
Total leukocytes	6100 (5400; 6800)	6050 (5150; 6900)	6300 (5100; 6700)	6100 (5200; 6800)	0.907
Total neutrophils	3315 (2560; 3510)	3078 (2295; 3592)	3127.5 (2760.0; 3648.0)	3135 (2520; 3564)	0.682
Platelets	224000 (194000; 302000)	204500 (167000; 221500)	242000 (192000; 294000)	216000 (181000; 259000)	0.042
RPL	140 (85; 152)	101 (85; 122)	97.5 (79.0; 122.0)	101 (82; 140)	0.373
RNL	0.51 ± 0.07	0.48 ± 0.15	0.53 ± 0.08	0.50 ± 0.12	0.414
PAS	122.5 ± 22.2 a	135.8 ± 16.3 b	132.5 ± 15.2 ab	132.1 ± 17.9	0.049
PAD	73.9 ± 12.2 a	82.1 ± 11.1 b	82.9 ± 9.2 bc	80.6 ± 11.3	0.031
PA - n (%)					
Suitable	12 (80.0)	25 (67.6)	15 (78.9)	35 (49.3)	0.529
Changed	2 (20.0)	12 (32.4)	4 (21.1)	17 (23.9)	
YES	7.4 (5.3; 10.4)	8.1 (6.5; 10.9)	9.7 (6.4; 12.3)	8.5 (6.3; 11.0)	0.300
MeanHR	69.1 ± 6.81 c	67.4 ± 9.7 ab	74.9 ± 10.9 b	69.8 ± 9.9	0.023
MeanRR	878.1 ± 165.7 b	948.9 ± 126.6 a	811.7 ± 184.4 b	897.2 ± 161.1	0.008

continuation - Table 1: Characteristics of participants in relation to body mass index.

Variable*	Nutritional status				
	NW	OW	OB	Total	p-value
SDNN	51.9 (39.6;75.6)	44.7 (31.4; 56.3)	37.6 (29.1; 66.4)	44.7 (31.1; 66.0)	0.260
RMSSD	48.7 (31.2; 89.8)	39.5 (26.5; 58.7)	37.2 (22.7; 64.8)	40.9 (25.2; 69.0)	0.689
VLF hz	0.037 (0.030; 0.040)	0.037 (0.037; 0.040)	0.037 (0.033; 0.040)	0.037 (0.033; 0.040)	0.182
LF hz	0.073 (0.043; 0.100)	0.093 (0.077; 0.110)	0.087 (0.060; 0.097)	0.09 (0.06; 0.11)	0.602
Score stress	32.3 ± 4.1	31.1 ± 5.0	30.2 ± 5.5	31.1 ± 4.9	0.502

*PLR: platelet to lymphocyte ratio; NLR: neutrophil to lymphocyte ratio; BP: blood pressure; SBP: Systolic blood pressure; DBP: Diastolic blood pressure; NW: Normal weight; OW: Overweight; OB: Obese; SI: Stress index (SI); MeanHR: Mean heart rate; MeanRR: means of RR intervals; SDNN: standard deviation of the means of normal RR intervals; RMSSD: square of the mean of the square of the differences between adjacent normal RR intervals; PNA: Prefer not to answer. Data are presented as mean ± standard deviation, p-value, median, and interquartile range (Q 1;Q 3). years ago; kg: kilograms; cm: centimeters; kg/m2 kilograms per square meter. BMI: Body mass index. Categorical variables are presented as relative (%) and absolute (n) frequencies. P-value for tests: ANOVA One Way Kruskal-Wallis chi-square, at 5% significance level. Significance of 5%, adjusted by Bonferroni (p<0.004). Equal letters results do not differ between the group.

Table 2: GlzM results for association between HRV and independent variables sex, age, sedentary lifestyle, smoking, cortisol, BMI.

VFC Parameter	Variable	*B*	Std. Error	95% Wald Confidence Interval		p-value	AIC
				Lower	Upper		
				Crude model			
SI	Chronic stress	0.01700	0.0131	-0.009	0.042	0.208	298.4
	RPL	0.00012	0.0015	-0.003	0.003	0.936	
	RNL	0.43147	0.4363	-0.424	1,287	0.323	
	BMI	0.02827	0.0147	0.000	0.057	0.054	
				Model 1			
	Chronic stress	-0.00144	0.0125	-0.026	0.023	0.908	301.3
	RPL	0.00114	0.0017	-0.002	0.004	0.497	
	RNL	0.11482	0.4026	-0.674	0.904	0.775	
	BMI	-0.00312	0.0155	-0.033	0.027	0.840	
				Crude model			
MeanHR	Chronic stress	0.44492	0.2732	-0.091	0.980	0.103	399.4
	RPL	0.02810	0.0340	-0.038	0.095	0.408	
	RNL	20.92464	10.2343	0.866	40,983	0.041	
	BMI	0.80154	0.3259	0.163	1,440	0.014	
				Model 1			
	Chronic stress	0.33239	0.2729	-0.203	0.867	0.223	410.5
	RPL	0.00230	0.0389	-0.074	0.079	0.953	
	RNL	18.70379	9,2197	0.634	36,774	0.042	
	BMI	0.62629	0.3619	-0.083	1,336	0.083	
				Crude model			
MeanRR	Chronic stress	-4.66313	3,8973	-12,302	2,975	0.232	681.2
	RPL	-0.56297	0.4846	-1,513	0.387	0.245	
	RNL	-381.07006	145.9941	-667,213	-94.927	0.009	
	BMI	-8.53901	4,6496	-17,652	0.574	0.066	
				Model 1			
	Chronic stress	-1.80678	3,9878	-9.623	6,009	0.650	694.8
	RPL	-0.09640	0.5681	-1,210	1,017	0.865	
	RNL	-343.36018	134.7127	-607,392	-79,328	0.011	
	BMI	-2.67124	5,2872	-13,034	7,692	0.613	

Table 2: GlzM results for association between HRV and independent variables sex, age, sedentary lifestyle, smoking, cortisol, BMI.

VFC Parameter	Variable	B	Std. Error	95% Wald Confidence Interval		p-value	AIC
				Lower	Upper		
SDNN	Crude model						
	Chronic stress	-0.01144	0.0146	-0.040	0.017	0.435	496.1
	RPL	0.00136	0.0019	-0.002	0.005	0.468	
	RNL	-0.16773	0.6209	-1,385	1,049	0.787	
	BMI	-0.01804	0.0183	-0.054	0.018	0.325	
	Model 1						
	Chronic stress	0.01172	0.0134	-0.015	0.038	0.382	496.4
	RPL	0.00003	0.0020	-0.004	0.004	0.988	
	RNL	0.14448	0.4560	-0.749	1,038	0.751	
	BMI	0.02341	0.0190	-0.014	0.061	0.217	
RMSSD	Crude model						
	Chronic stress	-0.01675	0.0176	-0.051	0.018	0.340	505.9
	RPL	-0.00001	0.0022	-0.004	0.004	0.995	
	RNL	-0.31987	0.7596	-1,809	1,169	0.674	
	BMI	-0.03157	0.0217	-0.074	0.011	0.146	
	Model 1						
	Chronic stress	0.01085	0.0143	-0.017	0.039	0.450	494.5
	RPL	-0.00152	0.0022	-0.006	0.003	0.489	
	RNL	0.08815	0.4946	-0.881	1,057	0.859	
	BMI	0.01939	0.0207	-0.021	0.060	0.348	

*PLR: platelet to lymphocyte ratio; NLR: neutrophil to lymphocyte ratio; SBP: Systolic blood pressure; DBP: Diastolic blood pressure; BMI: Body mass index; NW: Normal weight; OW: Overweight; OB: Obese; SI: Stress index (SI); MeanHR: Mean heart rate; MeanRR: Means of RR intervals; SDNN: Standard deviation of means of normal RR intervals; RMSSD: Square of the mean of the square of the differences between adjacent normal RR intervals

DISCUSSION

This study assessed public security agents in a metropolitan region and highlighted important changes in this population that lives with stress. It is known that this group faces a series of challenges that directly impact their physical and mental health, given their constant exposure to violence and imminent risk to their own lives. This can result in maladaptive responses that can compromise mental and physical health and lead to the development of chronic diseases.

It was possible to observe that the OB (obese) group had a significantly higher median age compared to both the NW (normal weight) and OW (overweight) groups. Most men were overweight and obese. Serum glucose showed statistically significant differences between the groups, with higher medians in the OW and OB groups compared to the NW group. Other parameters, such as platelets and systolic (SBP) and diastolic (DBP) blood pressure, also showed significant differences between the groups, being higher in the OW and OB groups.

The observed changes may lead to an imbalance in body homeostasis, increasing the risk of chronic diseases, such as cardiovascular diseases. The results of this study showed that the variables neutrophil-to-lymphocyte ratio (NLR) and body mass index (BMI) were significantly associated with mean heart rate (Mean HR) and mean RR interval (Mean RR). On the other hand, chronic stress and the RPL variable did not show consistent and significant associations with the HRV parameters analyzed. These results highlight the importance of nutritional status for cardiovascular health and suggest that interventions aimed at weight control may have positive effects on the health of military personnel.

The analyses highlighted that obese military personnel had a significantly higher median age when compared to the groups with normal weight and overweight. This suggests that obesity tends to be more prevalent in older individuals. Some studies also show this relationship between age and obesity[36] . A study carried out in the USA showed that the prevalence of overweight and obesity in veterans treated in a health system was 5%. greater than the population average. This prevalence was also higher among veterans with mental health conditions, particularly major depressive disorder, bipolar disorder, and PTSD (post-traumatic stress disorder)[37,38,39] , another study carried out in the United Kingdom also highlights the relationship between obesity and physical and mental comorbidities[40] . The World Health Organization (WHO) estimates that obesity among adults tripled from 1975 to 2021[41]. Increasing the risk of several diseases, including cardiovascular diseases[42,43] .

Obesity is identified as a pathological condition that can trigger chronic low-grade inflammatory diseases and increase the risk of other health conditions[44-47]. The interaction between disease and obesity has a significant impact, especially with regard to the influence on low-grade systemic inflammation. Studies have shown that metabolic differences caused by obesity not only exacerbate inflammation but also compromise antitumor immunity[64].

Although no significant difference was found in the inflammatory markers RPL and RNL, RPL is numerically higher in individuals with normal weight. Perhaps these military personnel may perform their activities in a different environment from those, such as external service, which may require greater energy expenditure and greater exposure to stress when compared to groups that are supposed to perform their activities internally within the corporation. Studies have shown the importance of these markers as potential predictors of acute kidney injury, cardiovascular diseases, infectious diseases, among others[48,49].

To better understand the relationship between heart rate variability (HRV) parameters, a generalized linear model (GLZM) was used to analyze the impact of the variables chronic stress, RPL, NLR, and body mass index (BMI). The results indicated that, in the Crude model, body mass index (BMI) demonstrated a positive trend of significance in relation to the MeanRR parameter, suggesting that BMI may exert an influence on this variable. Furthermore, this model proved to be more adjusted compared to Model 1 when considering the covariates.

Both mean heart rate and mean RR interval varied significantly between the nutritional status groups studied. Obesity, in particular, is associated with a higher mean heart rate compared with normal weight and overweight. Furthermore, the mean RR interval is longer in the overweight group compared with the other two groups.

For the MeanFc (Mean Heart Rate) parameter in the Crude model, both the NLR and BMI variables increase. In Model 1, adjusted with the covariates, the NLR relationship with MeanFc remains significant. BMI, on the other hand, showed a trend towards significance. The Crude model was better adjusted than Model 1.

Regarding Mean RR, each increase in NLR reduces Mean RR (Average RR Interval) for the Crude model. BMI showed a trend towards significance. For Model 1, the NLR relationship remained significant, where the increase in NLR reduces Mean RR. This model is better adjusted than the Crude model. These differences may have important implications for cardiovascular health and should be considered in clinical and research contexts.

This study observed the negative influence of obesity on parameters related to cardiac activity such as SBP, DBP, MeanRR and MeanHR and biochemical parameters such as glucose and platelets. Furthermore, in model 1, even after adjustments for several factors, NLR was positively associated with MeanHR and negatively associated with MeanRR. This demonstrates how much the inflammatory state of the organism affects parameters related to heart rhythm. Studies show that high NLR is associated with an increased risk of developing heart problems, increasing mortality among patients with some cardiac condition[32, 50-52].

These findings corroborate other studies that indicate that obesity may have an adverse influence on cardiovascular parameters, suggesting a potential reduction in the adaptive capacity of the autonomic nervous system in obese individuals[53, 54]. In addition, NLR also impacts on changes in these parameters.

The activity of the autonomic nervous system has an influence on the proliferation of inflammatory cells, such as neutrophils, lymphocytes and monocytes[28,55]. Adrenaline and acetylcholine receptors are found on the surfaces of neutrophils and lymphocytes that are controlled by the sympathetic and parasympathetic nervous system. Greater activation of the sympathetic nervous system results in an increase in the number of neutrophils, a decrease in the number of lymphocytes and an increase in the NLR index[28]. Therefore, health conditions such as obesity can contribute to increased sympathetic activity and the triggering of a chronic inflammatory process. On the other hand, stimulation of the parasympathetic nerve decreases the number of neutrophils, increases the number of lymphocytes and reduces the NLR value[56].

Furthermore, studies have shown that stress is associated with a decrease in HRV and a longer recovery time to baseline levels even after the source of stress is exhausted[2, 57–60], but this finding was not observed in our study. HRV imbalance is identified as a prognostic marker in several diseases, including neurological and psychiatric disorders. Disorders of the autonomic nervous system may precede the incidence of arterial hypertension and cardiovascular risk factors[61–63]. Highlighting the importance of this biomarker in various health conditions.

The police profession is recognized as a dangerous activity with daily exposure to traumatic events that threaten physical and mental integrity, generating high levels of tension and stress. The combination of stressors and risk factors such as a sedentary lifestyle, obesity, smoking and age can amplify the health risks of these individuals.

Altered HRV can serve as an important indicator of the health status of military personnel. However, it is important to emphasize that chronic stress among military personnel can be influenced by several variables, such as past experiences, previous training, nature of the tasks performed and specific stressors to which they are exposed in their daily activities 1 .

Even though they were not significant in the present study, chronic stress, biochemical and nutritional markers should be taken into account when assessing HRV, so that future studies should take these factors into account to obtain a more complete understanding of these dynamics, since this group plays a very important role in the public safety of society.

Although our study adds to the existing body of knowledge about cardiovascular health biomarkers that can be used to monitor the health of these individuals, it is not without limitations, since cross-sectional studies provide valuable insights but do not define cause and effect or track changes over time. Furthermore, in the present study we did not take into account the variety of factors that can interfere with HRV results, such as: military personnel's work shift, station, hierarchical level, length of service, among others. However, we know that this is an environment already recognized as having a high level of stressors and with the potential to generate chronic diseases. These factors can be considered in future studies.

Thus, analyzing the characteristics and lifestyle of military personnel can provide a crucial warning about the health conditions of this population, enabling a more comprehensive, effective and preventive approach. This approach not only directs our understanding of the impacts of chronic stress on the HRV of military police officers, but also suggests directions for more specific interventions and health policies adapted to the individual needs of these professionals, especially regarding nutritional status and quality of life.

CONCLUSION

There was an influence of nutritional status on cardiac activity and inflammatory markers in active military public agents, however it was not possible to observe a relationship with chronic stress suffered by this population.

Author Contributions

Andressa Pestana and Tamires Vieira conceptualized this study, conducted the literature search, performed the statistical analysis, and wrote the original draft. Gabriel Roni, Gabriella Santos, and Edna Moratti organized the datasets. Bianka de Freitas Cordeiro Bassini Tosta , Elizeu Batista Berlot, Carmem Luíza Sartório, Luiz Claudio Barreto Silva Neto, Pedro Luiz Ferro, Ivana Acele Arantes Moreno, Amanda Sgrancio Olinda, Adriana Madeira Álvares da Silva, and Luiz Carlos de Abreu conceptualized this study, reviewed, and edited this article.

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Conflicts of Interest

The authors have no conflicts of interest to declare.

The study observed an elevated neutrophil-lymphocyte ratio indicating greater inflammation or stress, which reduces heart rate variability and decreases the average RR interval. This results in a faster and less variable heart rate. This association helps assess the impact of stress and inflammation on the cardiovascular and autonomic system.

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Resumo

Introdução: o estresse crônico, as características sociodemográficas e o estado nutricional podem afetar negativamente a variabilidade da frequência cardíaca (VFC), especialmente em agentes públicos militares da ativa, resultando em uma modulação autonômica cardíaca alterada.

Objetivo: o objetivo deste estudo foi relacionar a modulação autonômica cardíaca em agentes públicos militares da ativa com o estresse crônico, características sociodemográficas e o estado nutricional.

Método: foi realizado um estudo transversal em militares do estado do Espírito Santo com 71 participantes maiores de 18 anos no período de agosto a novembro de 2022. A análise da modulação autonômica da frequência cardíaca foi realizada através do software Kubios®. Para esta análise os indivíduos permaneceram em decúbito dorsal por 25 minutos. Os índices de VFC foram calculados utilizando métodos lineares nos domínios do tempo e da frequência. Foram encontradas diferenças estatística entre homens e mulheres na variável SDNN (desvio padrão da média de todos os intervalos RR normais) (p=0,006), RMSSD (raiz quadrada da média dos quadrados das diferenças entre intervalos RR normais sucessivos intervalos) (p=0,028). Entre as diferentes faixas de IMC (Índice de massa corporal) RR médio (média de intervalos RR consecutivos) (p=0,007) e FC média (frequência cardíaca média) (p=0,015) e nas diferentes faixas etárias SI (índice de estresse Baevsky) (p=0,001), SDNN (p=0,003), RMSSD (p=0,004). Houve associação entre o índice de massa corporal (IMC) e o intervalo RR médio (Mean RR).

Resultado: pessoas com obesidade tendem a ter uma frequência cardíaca média mais alta, enquanto aquelas com sobrepeso geralmente apresentam um intervalo RR médio maior. Essas diferenças indicam padrões distintos na regulação autonômica cardíaca conforme o estado nutricional.

Conclusão: houve influência do estado nutricional na modulação autonômica cardíaca em agentes públicos militares da ativa, porém não há relação com estresse crônico sofrido por esta população.

Palavras-chave: Frequência cardíaca; Militares; Sistema nervoso autonomo; Sistema nervoso simpático; Sistema nervoso parassimpático, Neutrophil-lymphocyte ratio.