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AUTONOMIC CONTROL AND LUNG VOLUMES: IMPACTS OF VEHICULAR STRESS ON MOTORCYCLISTS IN THE FEDERAL DISTRICT

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ABSTRACT
Motorcycle workers are in constant exposure to air, noise and life-threatening pollution in the environment leading to an inflammatory response in the respiratory system, increased pulmonary and chronic diseases, cardiorespiratory morbidity. The objective of this research is to evaluate the impacts of vehicular stress on motorcyclists through cardiovascular and cardiorespiratory tests. We analyzed 11 middle-aged male individuals, who had been using motorcycles at least once a week for at least one year, who were non-smokers. The study found a statistically significant difference in the heart rate variability (HRV) indices in the supine, sedated, and orthostatic positions, as well as ventilatory disorders through spirometry. The present study demonstrated that there was no significant difference between the supine and sedented positions. For orthostatism, there was a statistically significant difference ($p<0.05$). In the spirometry test, individuals who presented results within the normal range (45.45%), followed by mild restrictive (36.36%), moderate restrictive (9.09%), and obstructive (9.09%). Thus, it is possible to observe that motorcyclists do not present modulations in different postures as described in the literature, in addition to a restrictive pattern of different levels in 45.45% of the sample.

Keywords: Heart Rate Variability. Bikers. Spirometry. Physiotherapy.

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INTRODUCTION

Motorcyclist workers are in constant exposure to air pollution in the environment, noise and life risks involving urban traffic[1]. Chronic contact with this pollution causes an inflammatory response in the respiratory system [2], increased pulmonary and chronic diseases, and cardiorespiratory morbidity [3]. Inflammatory conditions have been associated with increased risk of cardiovascular disease (CVD), the mechanism that leads to them are increased atherosclerosis, blood viscosity, reduced heart rate variability (HRV) [4]. Reduced HRV values while the individual is in the resting position may indicate a CVD risk [5].

HRV is obtained through the analysis of the R-R intervals of the heartbeats [6], andis a non-invasive method and a tool forclinical evaluation regarding the prevention or treatment of cardiovascular conditions [7].

The heart rate (HR) undergoes changes throughout the day, or in stressful situations such as exercise, and this variability is a normal and expected pattern [8], as the cardiovascular system responds in different ways to stimuli, whether physiological or pathological, internal or external, to maintain the body's homeostasis [9].

The autonomic nervous system (ANS) plays a fundamental role in the control of a part of the cardiovascular system, corresponding to the endings of the sympathetic andsympathetic nervous system that cansustain cardiac and respiratory dynamics[10]. Heart rate variability (HRV) and blood pressure variability (BPV) have an influence on cardiovascular autonomic regulation [11]. Changes in HRV can be a response to factors such as physical and mental stress, heart disease, exercise, and postural changes[12]. As well as, age, gender, body composition [7].

Autonomic control is assessed by recording heart rate (HR) and blood pressure (BP), in different positions, which can be resting positions such as supine, sedation and standing, as well as physical exercise such as the walk test, exercise test, among other conditions[9]. Thus , thisevaluation becomes necessary to obtain information about the sympathetic and parasympathetic systems and changes at the renin, angiotensin-aldosterone, vasomotor, baroreceptor [13] level.

For linear HRV analysis, the time and frequency domain domains are used, the time domain is expressed as: Standard deviation of all normal RR intervals (SDNN); the standard deviation of the means of normal RR intervals every 5 minutes (SDANN); the mean of the standard deviation of normal RR intervals every 5 minutes (SDNNi); the square root of the mean of the square of the differences between adjacent normal RR intervals, in a time interval in ms; (rMSSD) and the percentage of adjacent RR intervals with a difference in duration greater than 50 ms (milliseconds) (pNN50) [10].

The SDNN, SDANN, and SDNNi obtained by the individual RR interval represent sympathetic and parasympathetic activity. The rMSSD and pNN50 indices reflect parasympathetic activity, and are obtained through adjacent RR intervals [10].

For the analysis of the frequency domain, wave intensity measured in Hertz (Hz), the components of high frequency (HF) and low frequency (Low Frequency (LF) are used. The FH varies from 0.15 to 0.4 Hz, it is part of the respiratory modulation action of the vagus (parasympathetic) nerve of the heart. LF, on the other hand, has a variation between 0.04 and 0.15 Hz, has the action of both the SNP and the SNS, but the predominance is of the sympathetic. Therefore, the LF/HF ratio reflects the sympathovagal activities on the heart [10].

Knowing the relationship between the cardiovascular and respiratory systems, spirometry is another important clinical tool used to assess pulmonary function and track overall respiratory health. It can be used to measure the effect of a disease on the respiratory tract, assess airway capacity, define the prognosis of various lung conditions, and monitor the effects of any therapeutic intervention or progression of a given disease [14].

In addition to being a simple and easily reproducible instrument, it is a promising evaluation tool in population-based studies [15]. The pulmonary function test (PFT) measures the maximum volume of air that an individual can inhale and exhale with maximum effort, especially in the first second of the test [16].

According to the *American Thoracic Society/European Respiratory Society* (ATS/ERS), the main parameters used to assess an individual's respiratory condition are forced vital capacity (FVC; the total amount of air that can be expelled during a maximal exhalation period), forced expiratory volume in one second (FEV1; the amount expelled during the first second of an FVC maneuver), and the relationship between these parameters (FEV1/VT or FEV1/FVC) [14].

The main parameters used for interpretation are the FEV1/FVC, FEV1 and FVC ratio. A decreased FEV1/FVC ratio is used to define the presence of obstruction [16], whereas a decreased VF C identifies a restrictive pattern, and the combination of a decreased FEV1/FVC ratio and decreased FVC is classified as a mixed pattern [17].

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OBJECTIVES

GENERAL OBJECTIVE

To understand vehicular stress in motorcyclists through the assessment of cardiopulmonary capacity through cardiovascular and cardiorespiratory tests.

METHODOLOGY

The project was submitted to and approved by the Research Ethics Committee (CEP) and safeguards ethical care in accordance with the National Health Council (CNS). Personal information will remain confidential. All of them received the free and informed consent form (ICF), together with the IPAQ physical activity evaluation form - short version, all to be completed online to avoid embarrassment in any question and to avoid any changes or stress during the answers. They also received information about what the study was about and all the steps that would be carried out. This is a research funded by the Research Support Foundation of the Federal District (FAP DF).

We analyzed 11 middle-aged (35-58 years) male motorcyclists, with the inclusion criteria being motorcycle users at least once a week, for at least one year, non-smokers. Three (3) were sedentary and nine (9) practiced physical activity. The volunteers were instructed to avoid alcohol or caffeine consumption for 24 hours before the tests, maintain a night of sleep of at least 6 hours with no interruptions the day before, attend in comfortable clothes, take their daily medication, if applicable.

The collections were carried out in the Research Laboratory of the University of Brasília Ceilândia Campus, in a room without noise, with controlled temperature and humidity, aiming at a quiet place so that there would be no interference. HRV was collected using a cardiofrequency meter (Polar WindLink®), which captures and stores HR in the POLAR® software.

The sensor was coupled to an adjustable elastic strap at the height of the xiphoid process. To assess positioning, the volunteer was instructed not to talk, not to sleep during the test, not to move and not to interact with electronic devices so as not to interfere with signal transmission.

The first position to be evaluated was the supine position for 15 minutes. Then the sitting position for 10 minutes, changing to orthostatism and maintaining it for another 10 minutes.

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After 5 minutes of maintaining the orthostatic posture, the volunteer was instructed to sit down and rest for spirometry. The volunteers had their nose clamped by means of a nose clip, were instructed to perform a maximum inhalation and maximum exhalation, with the mouth inserted in the portable spirometer (*Phillips®) for three consecutive times. The data* were stored in the *Spirometer®* software, so that the reports are automatically generated through the *software*, and the equipment does not generate reports if the equipment is not calibrated.

RESULTS

A total of 11 individuals were selected and evaluated by convenience, with a mean age of 46.5 years (Table 1) and 10 ±9.42 years of motorcycle use. Of these, 27.27% are sedentary and 72.73% practice regular physical activity.

Table 1. Anthropometric variables of the study.

Variables	**Average±DP**
Age	46.5±11.5
Weight	88±24 am
Height	1.81±0.13

Legend: DP – Standard deviation

Table 2 presents the descriptive data of the VCF indices in the time and frequency domain in the supine, sedated and orthostatic positions. A statistically significant difference (p<0.05) was found for the HF variable between the positions mentioned.

Table 2 – Values referring to the median HRV of the participants HRV at rest in the supine position, standing and sedation.

Variables	**Supine**	**Sedation**	**Orthostatism**	**Average**	**P**
rMSSD (ms)	19.0 ±1.6	12.0±0.96	14.0±1.5	15,0	0,44
pNN50 (%)	4.8 ±2.7	6.5±1.1	2.5±0.7	4,6	0,2
LF (ms)	0.910 ±0.07	0.15±0.01	0.74 ±0.29	0,06	0,1
HF (ms)	0.074 ±0.18	0.092±0.07	0.086 ±0.07	0,059	0,02
LF/HF (ms)	0.6 ±0.5	1.6±0.07	0.93±0.68	0,38	0,14

Source: Authorship. **Legend:** SD: standard deviation, rMSSD: square root of the mean square of the difference between adjacent normal R-R intervals; pNN50: percentage of adjacent R-R intervals lasting more than 50ms; LF: low frequency; HF: high frequency; LF/HF, low frequency and high frequency ratio; P: Significance index.

The values found in the HF frequency domain High Frequency (HF) component, ranging from 0.15 to 0.4 Hz, correspond to the parasympathetic modulation of the heart.

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Table 3 - Values related to the spirometry of the 11 participants.

Variables	Minimum	Maximum	Average±DP
FEV1	0,54	4,43	2.48±1.94
FVC	0,93	4,72	2.82±1.89
FEV1/FVC	34,4	100	67.2±32.8
FEF 25-75%	0,48	4,94	2.71±2.23

Source: Authorship. **Legend:** FVC = forced vital capacity; FEV1 = forced expiratory volume in one second, FEV1/FVC = ratio of forced expiratory volume in one second to forced vital capacity, and FEV25-75% = forced expiratory flow between 25 and 75% of FVC; SD: standard deviation.

Table 4. Spirometric result of the sample.

Pattern	N	%
Obstructive	1	9,09%
Within normality	5	45,45%
Mild Restrictive	4	36,36%
Moderate restrictive	1	9,09%

In the sample, they were within the normal range (45.45%). The most common lung disease was mild restrictive (36.36%), moderate restrictive (9.09%) and obstructive (9.09%).

In restrictive lung disease, the FEV1/FVC ratio is normal or increased, forced vital capacity is reduced, and may be related to inflammatory lung diseases. In the obstructive pattern, there is a reduction in FEV1 and in the FEV1/FVC ratio, which may indicate a pattern present in bronchial asthma.

For a spirometry report, it is necessary to consider the patient's clinical history, as well as a physical evaluation.

DISCUSSION

HRV is a predictor of cardiovascular health analysis. Studies estimate that a low level of HRV helps identify heart disease risk. The autonomic nervous system (ANS), through the interaction between the sympathetic nervous system (SNS) and the peripheral nervous system (PNS), interacts with the contractility of the heart through the sinoatrial node, which is evaluated by HRV [18].

The present study observed a reduction in rMSSD levels in relation to the transition from the supine to the seated position, but without statistically significant difference, while the transition from the seated to the standing position showed a significant increase ($p<0.02$).

In contrast to what was identified in this study, Acharaya et al (2004) analyzed the heart rate variability of 60 healthy individuals, showing that modulation between postures, with higher rMSSD levels in sedated postura compared to supine postura[19].

These modulation characteristics are justified by the adjustment of HR to preserve cardiac output (CO). In the supine position, the CO is facilitated by venous return, while in the sedating posture, this return is lower due to gravity, there is an increase in HR to maintain the CO [19].

Still on rMSSD, Teixeira *et al* (2017) compared the cardiovascular adaptations of 19 individuals with heart failure (HF) and individuals without comorbidities, it was possible to observe that rMSSD levels reduced from supine to seated posture in people with HF, while healthy individuals showed a reduction without significant difference in rMSSD levels (supine 21.3± 10, seded 20.0 ± 6.8). Thus, it is possible to observe that the reduction of this index in these postures presents a considerable decrease (bench press 19 ±1.6, sedation 12± 0.96) in motorcyclists.

Marães et al (2013) demonstrate in the article that HRV has been an excellent tool in clinical practice, being a good marker for the analysis of research in pathologies within cardiorespiratory physiotherapy, as well as for evaluating the cardiovascular response during therapy programs for cardiovascular rehabilitation, so that the values identified in the present study demonstrate the need for evaluations regarding nonlinear values for concrete statements regarding health prognosis.

The variation in positioning can be evaluated in motorcyclists during motorcycle riding where a bent posture is adopted for the upright position. During the upright position, there is a decrease in blood return towards the heart, causing a decrease in stroke volume, which justifies the modulations being high when in the state of thestate compared to the seatof the station.

Still on the HRV components, the pNN50 indices reflect the parasympathetic activity, so that in the present there was an increase in these values in the seated posture and a reduction in the orthostatic posture, and an increase in these values is expected in the supine posture compared to the other postures, which may evidence a greater parasympathetic activity in the seated posture in motorcyclists.

In addition, the pNN50 values were close to the values obtained by Oliveira (2019) who identified that the longer the period of exposure to air pollution, the lower the

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modulation of parasympathetic activities, correlating with the average time of motorcycle use of the volunteers 10 ±9.42 years.

The HF index, which allows the evaluation of the respiratory modulation of the vagus (parasympathetic) nerve of the heart, corroborates the alterations identified in the pNN50 index, showing an increase in parasympathetic activity during sedation and a reduction in the supine and orthostasis positions. Corroborating PIETTERS et al (2012) who show that exposures to pollution can trigger lower FH values in resting positions.

It is also noteworthy that there was a moderate correlation between pNN50 values and age (r:0.72, p:0.013), so that the older the age, the higher the values in this posture, dissonating from the literature, which shows that the older the age, the lower the pNN50 values.

Regarding respiratory variables, 45.45% of the sample presented a restrictive pattern, which can be classified as mild or moderate, with a moderate correlation (r: 0.6, p:0.03) between the time of motorcycle use and the FEF values of 25-75%.

This corroborates the study by Ferreira (2009) with 30 healthy motorcycle couriers who, when compared with a control group, showed alterations in respiratory variables, the highest being FEF 25-75% (p< 0.001), being associated with worsening of pulmonary function with prolonged exposure to polluting agents.

Regarding lung capacities, the FVC values obtained in the present study are similar to those found by DE SOUSA *et al* 2023 for sedentary individuals, although the sample of the present study is composed mostly of intermediate actives. With this, it is possible to observe that the forced vital capacity of motorcyclists is reduced even in active individuals.

STUDY LIMITATIONS

This study has some limitations, such as the difficulty in finding female non-smoking motorcycle volunteers, leading to a limitation in the sample size, as well as the comparison between the groups. In addition, there is a lack of studies on the motorcyclist population. In this sense, the immediate need for studies on motorcyclists and the impact of vehicular stress on autonomic control and lung volumes is clear.

CONCLUSION

The study showed no significant difference in the rMSSD indices in postural changes from supine to sedated, while there was a difference between sedated and

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orthostatic posture, showing an increase in this index compared to the previous position ($p<0.05$). There is a lower modulation of parasympathetic activities, correlating with the average time of motorcycle use of the volunteers.

Regarding respiratory variables, it is possible to understand that 45.45% of the sample has a restrictive pattern identified, at mild or moderate levels, so that the expiratory forced vital capacity presents values similar to those evidenced in the literature for sedentary individuals, even though they are composed of physically active volunteers.

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