

# Analysis of heart rate variability as identifier of signs of occupational stress: cross-sectional descriptive observational study

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## ABSTRACT

**Background:** There is great concern in the world about worker stress and quality of life, since a significant number of companies show that physical and mental suffering are one of the main causes of absenteeism, generating high business costs due to low productivity. Stress at work ends up affecting not only the professional income but also your health. **Objective:** To investigate the correlation between stress level and heart rate variability (HRV). This is a cross-sectional observational survey of 20 workers from the administrative, maintenance and concierge sectors of a condominium management company. Cardiac biofeedback equipment (BFC) was used, which evaluates the activity of the Autonomic Nervous System (ANS), as well as the influence exerted by the limbic system (system of emotions). A LIPP questionnaire was level of cortisol. **Results:** It can be observed that there is a correlation between the coherence note (BFC) and the working time, a moderate correlation between the consistency score, coherence and evening cortisol, it is also observed that there is an association between the coherence state and the LIPP questionnaire. **Conclusion:** In general, there was an association between the numerical variables and the heart rate variability, but what was shown to be a greater association was the interaction of the questionnaire with the coherence state at the cortisol level.

**Keywords:** Biofeedback, Psychology; Physical therapy modalities; Biological variation, Population.

## BACKGROUND

Currently, there is a significant concern in the world about the stress and quality of life of the worker, since a significant number of companies show that physical and mental suffering is one of the leading causes pointed out by absenteeism, generating high business costs due to low productivity. In Brazil, these diseases in the ergonomic and mental risk group account for 20.76% of all absences. In comparison, those in the traumatic group account for 19.43% of the total, according to data from the Brazilian Ministry of Social Security<sup>(1)</sup>.

Technological development has generated significant changes in the routine of workers, who in their daily lives constantly deal with work functions that reflect the essence of norms, values, and prescriptions such as discipline, commitment, ability to work in a team, and functional versatility, leadership, creativity, and increased productivity, being frequently evaluated in the work environment for their conduct, commitment and results achieved, among other environmental stressors that lead to discomforts that accumulate amid their operational routine, often generating an unwanted overload bringing continuous stress at work with harmful consequences to health<sup>(2)</sup>.

Companies qualify people according to their ability to maintain a balance between these factors, observing the individual as a whole and preparing them to build and fulfill their professional role with quality and

pleasure, investing in the personal process, thus generating self-confidence and higher performance<sup>(3)</sup>.

Pathological stress appears as a direct consequence of external processes and conditions to which individuals are exposed. Physiologically, stress can be defined as a reaction of the organism to maintain the balance of vital biological functions in the face of a high level of emotional imbalance. Excessive stress generates a dysfunction that is perceived through nervous system responses, especially reflected in heart rate variability from the Autonomic Nervous System (ANS). The ANS modulates stress control responses at the systemic level, including oscillating and antagonistic activities of the sympathetic and parasympathetic nervous systems. The sinus node is a connection between the ANS and the cardiovascular system, thus regulating the amount and frequency of heartbeats<sup>(4,5)</sup>. Through the analysis of heart rate variability (HRV), it is possible to observe and understand the mechanisms external to the heart in physiological and pathological situations, such as stress. A direct association between work-related musculoskeletal disorders (WMSDs) is suggested, generating the myofascial pain syndrome (MPS), which has sensory, motor, and autonomic symptoms as a characteristic, caused by myofascial trigger points (PGM's) producing the taut band of the muscle in localized areas or associated muscle groups<sup>(6)</sup>.

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In this context, it can be suggested that occupational physiotherapy plays an important role in preventing or reducing the clinical signs of WRMD. Fatigue, worker errors, and accidents take away the worker's well-being, reducing the company's productivity and profitability. Physiotherapy is a conscious and scientific way to improve the quality of working life and the company's productivity, reinforcing the idea that investing in workers' health preventively is much more advantageous than paying for their occupational weakness<sup>(7)</sup>.

Physiotherapy at work is extremely important in the development of employees, it is available in corporate environments. This management model is most commonly linked to innovative and technological companies because innovation happens when all companies are aware of the surprising benefits they bring in terms of goals and talent retention with little effort on the part of the employer who takes better advantage of it. The balance of the workers and generates a superior income in the company, representing a mutual benefit<sup>(8)</sup>.

This study aims to evaluate occupational stressors through the analysis of heart rate variability and suggest proposals for interventions increasing the chances of the effectiveness of a probable program directed at the organization, aimed at modifying stressors in the work environment, which may include changes in the organizational structure, working conditions, training, development, participation, autonomy, and interpersonal relationships, aiming to reduce the impact of existing risks, through appropriate strategies for the worker to face the proposed challenges<sup>(9)</sup>.

## METHOD

### Type of study and research location

This is a cross-sectional descriptive observational study. The study was carried out at the company Fortaleza Service de Work rental LTDA – Natal/RN.

### Population and sample

The population consisted of 20 volunteers from the administrative, maintenance, and concierge sectors. The following were considered as inclusion criteria in the study: Employees who were part of the company's staff for 24 months, who had a full-time workload (02 shifts), and aged between 25 and 45 years. Exclusion criteria were: non-acceptance to participate in the study, pregnancy, use of contraceptives, presence of health problems involving the endocrine system, use of

corticosteroids by any route, use of sleeping pills, use of antidepressants or those who were with acute illness at the time of collection. The 20 selected participants, 10 from the administrative sector, 07 from maintenance, and 03 from the concierge, were informed about all experimental procedures and the purpose of the research.

### Ethical considerations

This project was submitted to Plataforma Brasil for analysis by the Research Ethics Committee (CEP). After approval, the study with the approved opinion with the number 2,382,453. The study was just started, before data collection, the collaborators read and signed a Free and Informed Consent Term (ICF) (Appendix). The method used was through descriptive qualitative research, applying a questionnaire and intervention with BFC in the interval of the workload of a group of 20 (twenty) employees in 03 (three) sectors in the company Fortaleza Service - Natal/RN.

The employee was evaluated once, with a focus on identifying and analyzing the correlation between the level of stress and heart rate variability in service demands and organizational activities. The research was carried out with three meetings with 20 (twenty) employees, with individualized care and not performed in care or risks, but there may have been discomfort in the collection that was related to individualized care. Data were determined based on what is considered problematic, with problematic outcomes.

### Instruments

The instruments applied in the pre-assessment phase were the analysis of salivary cortisol (with a cotton swab) as a biomarker of occupational stress, which evaluates the free portion of the hormone, considered an easy and low-cost collection method to identify changes in function. cognitive, in situations of stress, anxiety, depression, and fatigue, among others<sup>(10)</sup>. The Lipp Stress Symptom Inventory for Adults (ISSL) was also used, which allows for identifying the symptoms of stress, the phase, according to the three-phase model of stress proposed by Lipp (alert, resistance, and exhaustion), and the most frequent type of symptom. (physical or psychological). The program used in the evaluation was Cardioemotion<sup>®</sup>, which measured HRV.

This software guides the user to follow three steps indicated by the "Rapid Coherence Training": focus attention on the heart region, keep breathing in the rhythm that is shown on the computer and cultivate positive emotions, providing learning of which thoughts



collaborate for the increase in their cardiac coherence, and which ones decrease it<sup>(11)</sup>.

### Procedure

At first, saliva samples were collected from employees in the morning (08:00h) or afternoon (16:00h), specific times when cortisol is at high levels in the bloodstream. There was no need for fasting, but all participants were informed that they should eat at least two hours before the exam and that they should follow a light diet with the meal. Another important point was that they could not collect material if there were oral lesions with active or potential bleeding, therefore, the employee was also duly informed that he could not have dental treatment in the 24 hours before the exam and that it would also be necessary to stay three hours without brushing the teeth. Every procedure was performed by a technical professional in clinical analysis who was at the time previously determined by the researchers and was responsible for taking the samples to be analyzed in a laboratory. On the second day, a questionnaire (Lipp Stress Symptom Inventory for Adults (ISSL) was applied, lasting approximately 20 (twenty) minutes. In carrying out the data collection with Cardioemotion®, we organized a scale of the periods of absence of the employee from their sector, as the intervention took 30 minutes in an individual process.

For the application of the BFC, the collaborator was instructed to sit comfortably, stable, and relaxed during the monitoring, not to move, speak or talk during the measurements, and to breathe so that, naturally, he inhaled and exhaled slowly and deeply, with the help of the diaphragm (diaphragmatic or abdominal breathing), controlling the air to follow the frequency of the float and without holding on to the breath. After following these guidelines, he was asked to put a pulse sensor attached to the ear connected to the computer where it showed the heart rate in real-time on the graph, and a headset to capture the sound signals that the game emitted. Initially, the ambient lights were turned off to facilitate concentration and the monitoring started when the employee felt confident and took all their doubts, being carried out for 5 minutes, at the end the employee could check the average HR on the computer screen. , score reached from 0 to 10, the coherence levels that were identified through the colors of the float being the red float: ANS Imbalance, blue float: Near heart coherence, green float: heart coherence state, and the heart rate graph, ending with all results and graphs being saved in the collaborator's folder. Changes in thought patterns, or some environmental distraction, could make the user go back to low coherence, in

addition, the breathing technique learned could be generalized to other anxiety situations. We end with the calculation of the results, in a self-explanatory table of the three moments of data collection for each employee, evaluating the correlation between stress and the variability of heart rate.

### Data analysis

For data analysis, the software (SPSS) version 22.0 was used. qualitative analysis of the variables was also performed, with frequency distribution among the analyzed variables, in addition to the Spearman correlation tests, Chi-square association, and simple linear regression, adopting a confidence interval of 95% and  $p < 0.05$ .

## RESULTS

It was observed that the volunteers in this study had a mean age of  $39.2 \pm 8.8$  years, with a mean time of service in the company of  $60.95 \pm 39.60$  months. Table 1 presents the distribution of workers according to gender, marital status, position in the company, and the final results of the state of coherence and the LIPP questionnaire.

**Table 1.** Absolute and relative frequency distribution of worker characteristics, coherence status and LIPP questionnaire

	Absolute frequency	Relative frequency
<b>Genre</b>		
Male	16	80%
Female	4	20%
<b>Marital status</b>		
Single	9	45 %
Married	9	45 %
Divorced	2	10 %
<b>Office</b>		
Administrative	10	50 %
Concierge	3	15%
ASG	7	35 %
<b>State of Coherence</b>		
Coherence	12	60 %
Almost coherence	1	5 %
No coherence	7	35 %
<b>Lipp Questionnaire Phases</b>		
No symptom	4	20 %
Alert (Initial Phase)	1	5%
Resistance (Intermediate Phase)	2	10 %
Exhaustion (Final Phase)	10	50 %





Table 2 presents the average of the scores obtained in the analysis of the coherence state, obtained from the cardioemotion software (cardiac biofeedback) and the level of total salivary cortisol and in the morning and afternoon hours.

**Table 2.** Mean and standard deviation of cardiac coherence score and cortisol levels.

	Mean $\pm$ Standard deviation
Cardiac Coherence Score	5,9 $\pm$ 2,62
Morning cortisol	0,24 $\pm$ 0,25
Evening Cortisol	0,086 $\pm$ 0,02

Table 3 presents the correlations between the coherence score and cortisol levels, working time.

**Table 3.** Correlation between the coherence score and the cortisol level

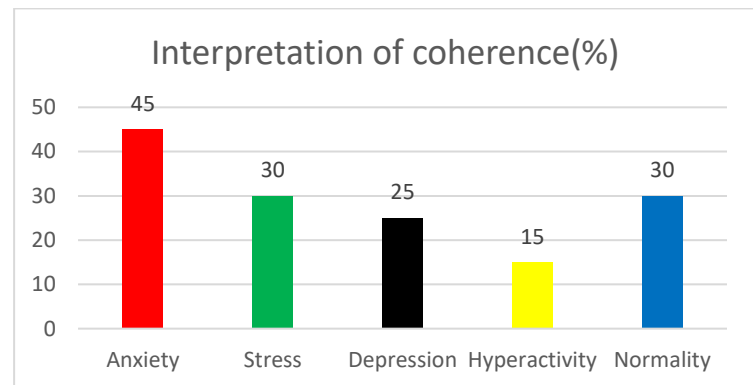
	R value	P Value
Note of consistency x Morning cortisol	-0,55	0,02
Note of consistency x Evening Cortisol	-0,43	0,04
Note of consistency x Work time	-0,80	0,03

It is observed that there is a strong correlation between the coherence score and working time, a moderate correlation between the coherence score and the values of total cortisol, and coherence and afternoon cortisol.

**Table 4.** Correlation between the coherence score and the stress level

	$\chi^2$	P value
State of Coherence x Phases of the lipp questionnaire	0,83	0,01

It is observed that there is an association between the state of coherence and the LIPP questionnaire.



**Figure 1.** Clinical interpretation of the state of coherence (Interpretation of curves)

In the interpretation of the curves of the graphs of the volunteers who performed the cardiac biofeedback assessment, it was found that 45% of the volunteers showed signs of anxiety, 30% of depression, and 25% of depression. About 30% had curves in the normality pattern, expected for the coherence state.

## DISCUSSION

This research did not harm its participants as it was a study that applied non-invasive techniques and methods and no intervention or intentional modification in the physiological, psychological, and social variables of the individuals. Of the 20 volunteers, there was no need for any exclusion, as all were able to meet the inclusion criteria that were proposed in the research and continued until the end of the study.

In the analysis of heart rate variability, it can be seen that in the coherence score, most volunteers were in a state of quasi-coherence, indicated by the blue color, during the test. This result indicates the difficulty that workers had to maintain a consistent rhythm during work activities. This result may have happened since current work relationships do not encourage the maintenance of a state of relaxation or tranquility to carry out their administrative, ordinance, and maintenance functions. It is observed that both the administrative activity and the support functions such as ESG and porters presented, in their different professional peculiarities, conflict factors and stressors that favored the modification of coherence<sup>(12)</sup>.

In the analysis of cortisol levels, it can be seen that the average values identified in the morning and afternoon, did not present values higher than the

expectation found in the reference values of these tests. However, it is known that cortisol levels can be influenced by different environmental, psychological, and clinical factors. However, another factor is relevant in this clinical situation, since even with cortisol levels within the normal range, the other variables of cardiac coherence show alterations. This may mean that the volunteers had a continuous state of non-coherence, even without the presence of stressors<sup>(13)</sup>.

It was observed that the score of coherence is inversely proportional to the level of cortisol, that is, the lower the level of coherence, the higher the level of cortisol, however with a moderate and weak association between these variables. It is worth noting that the cortisol reference values did not necessarily need to be within the normality score, but if the levels varied according to the stress level of the individuals under study.

On the other hand, the relationship between the coherence score and working time was strong, therefore, the longer the working time, the lower the coherence status of the volunteers. It is suggested that the maintenance of time in certain jobs, with repetition of functions, cognitive overload, and functional stress, would favor a state of disharmony between cardiac and respiratory rhythms, being responsible for the clinical manifestation of physical symptoms, over time, which can lead to absence from work<sup>(1)</sup>.

Therefore, it is recommended that employers and other companies include physical therapy programs in the workplace, which are extremely important and contribute to improving the quality of life of professionals. This practice allows employees to improve their performance and productivity within the company, in addition, they promote physical and social well-being, aiming at reducing absences from work, and reducing cognitive and functional stress<sup>(14)</sup>.

In the interaction of the questionnaire with the state of coherence at the level of cortisol, a strong correlation was observed. The questionnaire showed clinical signs commonly seen in individuals with exhaustion from work, such as headaches, nausea, irritability, skin changes, anxiety, and depressive signs, among others. Therefore, similar behavior of changes is also observed in the state of coherence, with lower scores, and an absence of balance in the variation of heart rate<sup>(15)</sup>.

The work environment, the monotony of activities, and the repetition of functions can cause changes in the activity of the autonomic nervous system, which can cause states of sympathetic or parasympathetic hypersensitivity. These findings can be

translated and interpreted by heart rate variability. The analyzed curves show signs of anxieties, stress, and depression, signs that can be observed in people with alterations in the autonomic nervous system. Work stress is a state caused by stimuli that cause physical and emotional excitement, which, when disturbing the balance of the body, can generate muscle pain in the cervical and shoulder region<sup>(16,17)</sup>.

Despite the constant search in literary databases, there are still few studies that address the correlation between heart rate variability and occupational stress, so the interest and commitment to obtain complete results that significantly contribute to new thresholds of research.

## CONCLUSION

To verify if the heart rate variability has possible indications of associations with the signs and symptoms of occupational stress, we first sought to acquire an understanding of the problem proposed in this study, for that, research was carried out in current literature. Factors inherent to stress were reflected in this group of employees, due to the position held.

The analysis instruments applied in this study were correlated and, in general, there was an association between the numerical variables and the heart rate variability, however, what was shown to be most associated was the interaction of the questionnaire with the state of coherence in the cortisol level. The questionnaire evaluated clinical signs commonly seen in individuals with exhaustion from work and, therefore, similar behavior of changes was also observed in the state of coherence, with lower scores, and absence of balance in the variation of heart rate.

**Authors' contribution:** Work orientation / statistical analysis / critical review: Rodrigo Marcel Valentim da Silva. Data collection and writing of the article: Jouse Marri Palmeira de Oliveira Bitencourt, Luara Lee Pereira de Lima, Nathália Julie Tavares

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