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Original Article

Salivary cortisol, job stress, and periodontal disease in nursing staff

Cortisol salivar, estresse ocupacional e doença periodontal em enfermagem

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Resumo

Introdução: O cortisol é reconhecido como biomarcador do estresse, desempenhando um importante papel na regulação de diversos sistemas fisiológicos. No entanto, quando liberado de forma crônica, pode afetar os tecidos periodontais, levando à diminuição da resposta imune dos tecidos, que se tornam mais suscetíveis à colonização de microorganismos periodontopatogênicos. **Objetivo:** Investigar a relação entre níveis de cortisol salivar, estresse ocupacional e ocorrência de doença periodontal em profissionais de enfermagem hospitalar. **Material e método:** Foram avaliados 46 profissionais de enfermagem por meio da coleta de cortisol salivar, aplicação da *Job Stress Scale* (Escala de Estresse no Trabalho) e exame clínico da condição periodontal. **Resultado:** Vinte e cinco participantes (54,35%) apresentaram níveis normais de cortisol, enquanto 21 (45,65%) apresentaram níveis baixos. Quanto às dimensões avaliadas pela *Job Stress Scale*, o quadrante de trabalho de alta demanda apresentou associação significativa com a classificação do cortisol, aumentando em 23,9 vezes a chance de níveis baixos. Todos os profissionais apresentaram estresse ocupacional. A prevalência geral de periodontite foi de 63,04%, entretanto, não foi encontrada associação significativa do cortisol com a condição periodontal. **Conclusão:** O estudo evidencia a influência de altas demandas ocupacionais sobre os níveis de cortisol, aumentando o risco para o desenvolvimento de doenças. Não foram encontradas associações entre cortisol salivar e doença periodontal.

Descritores: Cortisol; doença periodontal; estresse ocupacional; saúde ocupacional.

Abstract

Introduction: Cortisol is recognized as a biomarker of stress, playing a crucial role in the regulation of various physiological systems. However, when released chronically, it can adversely affect periodontal tissues by diminishing their immune response, thereby increasing susceptibility to colonization by periodontopathogenic microorganisms. **Objective:** To examine the relationships among salivary cortisol levels, occupational stress, and the occurrence of periodontal disease in nursing professionals working in a hospital environment. **Material and method:** A total of 46 nursing professionals were evaluated through salivary cortisol measurement, completion of the Job Stress Scale, and clinical assessment for periodontal disease. **Result:** Of the participants, 25 (54.35%) exhibited normal cortisol levels, whereas 21 (45.65%) had low cortisol levels. Analysis of the Job Stress Scale dimensions showed that the high-demand work quadrant was significantly associated with cortisol classification, increasing the likelihood of low cortisol levels by 23.9 times. All participants demonstrated occupational stress. The overall prevalence of periodontitis was 63.04%; however, no significant association was identified between cortisol levels and periodontal status. **Conclusion:** The findings suggest that high job demands influence cortisol levels, thereby increasing the risk for disease development. No association was observed between salivary cortisol levels and periodontal disease.

Descriptors: Cortisol; periodontal disease; occupational stress; occupational health.

INTRODUCTION

Chronic stress is defined as prolonged exposure to stressors, leading to continuous activation of the stress response system and persistent release of hormones such as cortisol[1,2]. Occupational stress is a major contributor to chronic stress, particularly among nursing professionals, due to the high demands of their work and their critical role in the healthcare system[3,4].

Stress activates the hypothalamic–pituitary–adrenal (HPA) axis, which regulates the synthesis of cortisol, a glucocorticoid[4]. Measurement of salivary cortisol has been widely recognized as a valid method for assessing free and active cortisol[5,6]. Saliva is increasingly used as a diagnostic tool because it is easily accessible and contains various biomarkers that can reflect the presence and progression of certain diseases[7].

Cortisol plays a central role in regulating physiological systems, including immune function[8]. It can influence cell migration, proliferation, and cytokine release. Chronic secretion of cortisol into saliva may affect oral tissues containing glucocorticoid receptors[9], thereby impairing local immune responses and increasing susceptibility to colonization by periodontopathogenic microorganisms, ultimately leading to tissue deterioration[10,11].

Previous studies have suggested that salivary cortisol is a promising biomarker for identifying psychological factors associated with periodontitis[10,12]. Periodontitis is a common inflammatory disease that affects the tooth-supporting structures and is primarily caused by dysbiotic biofilm[13]. Chronic inflammation progressively destroys periodontal tissue and may result in tooth loss[2,14]. Known risk factors include smoking and diabetes mellitus, while stress has been shown to alter the host immune responses[14]. Growing evidence suggests that chronic stress may contribute to the progression of periodontal disease[10].

Nevertheless, the association between stress biomarkers and periodontal disease remains unclear. Therefore, this study aimed to investigate the relationships between salivary cortisol levels, occupational stress, and periodontal conditions in a hospital-based nursing team.

MATERIAL AND METHOD

This cross-sectional analytical epidemiological study was conducted with nursing professionals from the Cassiano Antônio de Moraes University Hospital (HUCAM). The calculated sample size was 46 individuals, based on an assumed prevalence of low cortisol of 75%[15]. A significance level (α) of 0.05, test power of 80%, and effect size of 0.19 were considered. The study was approved by the Ethics Committee of the Federal University of Espírito Santo (UFES) under opinion no. 4.768.935, and all participants provided written informed consent.

The study population included nurses and nursing technicians from HUCAM. Exclusion criteria were pregnancy, lactation, diabetes, smoking, alcohol use, antibiotic or anti-inflammatory therapy in the previous 3 months, use of medications affecting the HPA axis, and diseases that interfere with cortisol production.

Data collection was carried out at the UFES dental clinic. Morning salivary cortisol was measured between 8:00 and 10:00 a.m. to minimize circadian rhythm variations. Participants were instructed to avoid dental treatment in the previous 24 h, refrain from toothbrushing, and fast for at least 2 h[16]. Saliva was collected using a Salivette kit (SARSTEDT, Nümbrecht, Germany). The swab was placed under the tongue for 3 min, and once saturated, it was stored in a sterile tube[17]. Samples were subsequently analyzed at an independent laboratory.

Salivary cortisol analysis was performed by the Tommasi Laboratory using liquid chromatography-tandem mass spectrometry (LC-MS/MS). Reference values were defined as follows: normal (100–670 ng/dL), low (<100 ng/dL), and high (>670 ng/dL).

Occupational stress was assessed using the shortened version of the Job Stress Scale (JSS), a validated self-administered instrument that evaluates workplace stress. The questionnaire consisted of 17 items on a 4-point Likert scale: five items assessed psychological job demand (5–20 points), six measured job control (6– 24 points), and six evaluated social support (6–24 points). Based on the demand–control–support model, these dimensions were dichotomized as "high" or "low" and categorized into high-demand work, passive work, or low-demand work[18].

A periodontal examination was performed by a single calibrated examiner, with inter-examiner agreement confirmed through a calibration process (κ = 0.96). The examination used a manual North Carolina periodontal probe with 1-mm markings (PCP UNC 15, Hu-Friedy, Chicago, Illinois). Clinical parameters evaluated included visible plaque index, gingival index, probing pocket depth, clinical attachment level, bleeding on probing, suppuration, tooth mobility, and furcation involvement.

Based on the clinical findings, participants were classified as having gingival/periodontal health, gingivitis, or periodontitis. The diagnosis of periodontitis followed the criteria proposed by Papapanou et al.[14] Periodontitis was staged (1–4) according to severity and complexity of management. Extent and distribution were also assessed and categorized as localized (≤30% of teeth affected), generalized (≥30% of teeth affected), or molar/incisor pattern.

Statistical analysis was performed using IBM SPSS Statistics, version 24.0 (IBM Corp., Armonk, New York). Categorical and quantitative variables were expressed as mean, frequency, percentage, and standard deviation. Logistic regression analysis was used to examine associations between cortisol and periodontal variables. Fisher's exact test, the Shapiro–Wilk test, and Student's t test were also applied. Statistical significance was set at 5%, with a 95% confidence interval.

RESULT

The sociodemographic profile of the sample indicated a predominance of women, married individuals, and professionals with higher education. The mean age was 42.43 ± 7.48 yr. Regarding occupation, 31 participants (67.39%) were nursing technicians, and 15 (32.61%) were nurses. Most participants (37; 80.43%) had graduated 11 yr or more prior to the study.

Salivary cortisol analysis showed that 25 participants (54.35%) had normal levels, while 21 (45.65%) had low levels; no participant presented high cortisol levels. The mean salivary cortisol concentration for the total sample was 118.83 ± 69.65 ng/dL.

For the JSS dimensions, 39 participants (84.79%) reported low psychological demand, 38 (82.61%) reported low job control, and seven (15.22%) reported low social support. Based on the demand–control–support model, 31 participants (67.39%) were classified as having passive work (Table 1). The overall prevalence of periodontitis was 63.04%. Periodontal health and disease classifications are presented in Table 1.

Analysis of the association between work quadrant and salivary cortisol revealed that participants in the high-demand quadrant were significantly more likely to present low cortisol levels compared with those in the low-demand quadrant. Specifically, being in the high-demand quadrant increased the odds of low cortisol by 23.9 times (odds ratio [OR] = 23.92; 95% confidence interval [95% CI], 1.31–438.04; p = 0.032), as determined by multiple logistic regression using the backward method.

No significant association was found between salivary cortisol levels and the length of time since graduation. Thus, graduation time did not influence cortisol classification. Similarly, no significant association was observed between cortisol levels and periodontal condition (Table 2).

Table 1. Description of the job stress scale dimensions scores and periodontal disease classifications in the hospital nursing team

Job Stress Scale		n	%
Psychological Demand	High	7	5.22
	Low	39	84.78
Control over Work	High	8	17.39
	Low	38	82.61
Social Support	High	39	84.78
	Low	7	15.22
Work Quadrant	Low Demand Work	8	17.39
	Passive Work	31	67.39
	High Demand Work	7	15.22
Periodontal Disease Classifications		**n**	**%**
Stage	Gingival and Periodontal Health	7	15.22
	Gingivitis	10	21.74
	Periodontitis Stage 1	16	34.78
	Periodontitis Stage 2	7	15.22
	Periodontitis Stage 3	1	2.17
	Periodontitis Stage 4	5	10.87
Location	Not applicable	7	15.22
	Generalized	9	19.57
	Localized	29	63.04
	Molar/Incisor	1	2.17

Table 2. Association of cortisol classification (normal vs. low) with time since graduation of nursing professionals and periodontal condition (periodontal health and gingivitis vs. periodontitis)

Cortisol Classification						
		Normal		Low		p-value*
		n	%	n	%	
Time Since Graduation	Up to 10 years	7	28.00	2	9.52	0.151
	11 years or more	18	72.00	19	90.48	
Stage	Periodontal Health and Gingivitis	9	36.00	8	38.10	0.999
	Periodontitis	16	64.00	13	61.90	

*Fisher's Exact Test; significant if $p \leq 0.050$

DISCUSSION

Salivary cortisol measurement is widely recognized as a reliable method for assessing free and active cortisol levels and is considered a potential biomarker for stress[4-6]. In a meta-analysis of 107 studies, Miller et al.[1] reported that chronic stress is characterized by dysregulated hormonal secretion, with morning salivary cortisol production being lower than normal. Chronic disease initially activates the HPA axis, leading to increased cortisol levels; however, over time, this activation decreases, and cortisol secretion falls below normal. In line with these findings, nearly half (45.65%) of our participants had low cortisol levels, possibly related to occupational stress, while none exhibited elevated levels.

In the JSS assessment, 38 professionals (82.61%) reported low control over their work. Job control is considered a motivating factor, as it allows workers autonomy and opportunities to acquire new skills. Low control, on the other hand, often reflects repetitive tasks with limited autonomy and scarce opportunities for learning. This scenario can lead to demotivation, reduced self-esteem, and negative impacts on health[18]. In our study, most participants were classified as having passive work, a finding

consistent with Urbanetto et al.[19], who reported similar conditions among nursing staff. Passive work has been linked to skill deterioration, disinterest, and health issues.

A noteworthy finding of our study is the significant association between high work demands and lower morning cortisol concentrations. Professionals in the high-demand quadrant were 23.9 times more likely to exhibit low cortisol levels. High demand, characterized by elevated workload and low control, is considered the most harmful quadrant for professional health. It has been associated with negative mental health outcomes, including fatigue, anxiety, and depression[19]. Ella et al.[3] also highlighted that occupational stress compromises the performance and well-being of nursing professionals, with main stressors including work overload, lack of incentives, multitasking, unclear role definitions, and unfavorable work environments.

The relationship between cortisol levels and stress is complex. As Miller et al.[1] proposed, chronic stress initially increases cortisol production, followed by reduced secretion over time. This dynamic helps explain conflicting evidence in the literature regarding hypercortisolism and hypocortisolism. The duration of stress exposure may influence HPA axis activity and reflect different phases of the stress process.

In our sample, most professionals had more than 10 yr of nursing experience, suggesting long-term exposure to occupational stress, which may explain the high prevalence of low cortisol levels. However, no significant association was observed between salivary cortisol and time since graduation. Because only 19.57% of participants had fewer than 10 yr of experience, comparisons between groups were limited.

The association between chronic stress and periodontitis has been addressed in several studies. Peruzzo et al.[20] suggested that work-related stress may contribute to periodontitis, while Varma et al.[2] reported a higher frequency of periodontitis among stressed individuals. Stress may influence periodontal health through behavioral pathways (e.g., poor oral hygiene and smoking) as well as physiological mechanisms[21]. Chronic HPA axis activation and cortisol dysregulation can alter immune responses, thereby contributing to periodontal tissue breakdown[22]. Salivary cortisol has thus been explored as a biomarker for stress-related progression of periodontitis[2,10].

Nevertheless, findings remain inconsistent. Baumeister et al.[9] investigated serum cortisol and periodontitis and found no consistent evidence of an association, which is consistent with our results showing no significant link between salivary cortisol and periodontal condition. Similarly, Haririan et al.[21] and Rosalin[23] reported no significant relationships between salivary cortisol levels and periodontal health indices. Conversely, Rosania et al.[24] found that chronic stress and low cortisol were associated with milder forms of periodontitis, although these results should be interpreted cautiously, as cortisol levels may also reflect inflammatory responses rather than stress alone.

Other studies have reported positive associations between elevated cortisol due to acute stress and periodontitis. Zhang et al.[25] observed that individuals with high salivary cortisol levels had a greater risk of periodontitis, suggesting that cortisol could serve as a marker for psychological factors influencing disease progression. Similarly, Refulio et al.[22] found higher salivary cortisol levels in patients with moderate than mild periodontitis. These findings support the hypothesis that elevated cortisol is linked to an increased risk of periodontal disease, although the overall relationship remains inconclusive.

Obulareddy et al.[8] emphasized the growing interest in the interplay between stress and periodontitis over the past two decades. Their study showed that salivary cortisol increased with stress level and was associated with the extent of periodontal destruction.

Our study focused on nursing professionals who voluntarily participated, which may have excluded individuals experiencing higher stress levels who chose not to participate. Moreover, the high prevalence of stress in this profession limited the possibility of identifying a truly stress-free control group. These factors restrict the generalizability of our findings. Although no direct association was found between salivary cortisol and periodontal disease in this sample, it is possible that unexamined biological or behavioral pathways link chronic stress with oral health outcomes.

CONCLUSION

High work demands were significantly associated with low cortisol levels, suggesting an increased risk for the development of stress-related diseases. However, no significant association was observed between salivary cortisol levels and periodontal disease.

AUTHORS' CONTRIBUTIONS

Alessandra Arthuso Alves: Conceptualization, Methodology, Validation, Formal analysis, Investigation, and Writing—Original Draft. Arthur Maciel Araujo: Conceptualization, Methodology, Validation, Formal analysis, Investigation, and Writing—Original Draft. Rebeca Ferreira Badaró: Data curation, Formal analysis, Writing—Review & Editing, and Visualization. Maiara Campos Linhares Sampaio: Data curation, Formal analysis, Writing—Review & Editing, and Visualization. Julia Saraiva de Almeida Barbosa: Conceptualization, Methodology, Validation, and Writing—Original Draft. Umberto Demoner Ramos: Conceptualization, Methodology, Validation, and Writing—Review & Editing. Elizabeth Pimentel Rosetti: Conceptualization, Methodology, Validation, Formal analysis, Investigation, Writing—Original Draft, Writing—Review & Editing, and Visualization. All authors have read and approved the final version of the manuscript.

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CONFLICTS OF INTERESTS

The authors declare no conflicts of interest.

DATA AVAILABILITY

The contents underlying the research text are included in the manuscript. The contents are already available.

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