

The Relationship between Stress Biomarkers and Perceived Work Stress among Nurses and Behavioral Health Specialists

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Abstract

Background: Occupational stress among healthcare professionals, particularly nurses and behavioral health specialists, significantly impacts their well-being and performance. This study explores the relationship between perceived work stress and physiological stress biomarkers.

Methods: A cross-sectional study was conducted at a tertiary hospital with 150 participants (100 nurses and 50 behavioral health specialists). Perceived stress was assessed using the Perceived Stress Scale (PSS-10), while biomarkers, including hair cortisol, salivary alpha-amylase, and heart rate variability (HRV), were measured to evaluate physiological stress.

Results: Nurses reported higher perceived stress levels (mean PSS-10 = 23.1) compared to behavioral health specialists (mean PSS-10 = 19.6; $p < 0.01$). Correspondingly, nurses exhibited elevated hair cortisol (31.6 pg/mg vs. 23.7 pg/mg; $p < 0.001$) and lower HRV (RMSSD: 32.4 ms vs. 40.6 ms; $p < 0.01$). Significant correlations were found between PSS-10 scores and biomarkers: hair cortisol ($r = 0.63$, $p < 0.001$), salivary alpha-amylase ($r = 0.47$, $p < 0.01$), and HRV metrics (RMSSD: $r = -0.52$, $p < 0.01$; LF/HF ratio: $r = 0.45$, $p < 0.01$).

Conclusion: This study demonstrates a strong relationship between perceived work stress and physiological biomarkers, with nurses showing higher stress levels than behavioral health specialists. These findings highlight the need for targeted stress management interventions in high-stress healthcare environments.

Keywords: Occupational Stress, Nurses, Behavioral Health Specialists, Biomarkers, Hair Cortisol, Salivary Alpha-Amylase, Heart Rate Variability (HRV), Perceived Stress

Introduction

Occupational stress among healthcare professionals, particularly nurses and behavioral health specialists, has been widely studied due to its significant implications for personal well-being and patient care quality. Nurses often face high job-related stress due to demanding workloads, extended working hours, and emotional labor, leading to physical and mental health challenges. Studies have shown that chronic stress in nurses can result in burnout, decreased job satisfaction, and even compromised patient safety (Nguyen et al., 2020). Similarly, behavioral health specialists are exposed to occupational stress through continuous exposure to patients' psychological trauma, which may lead to secondary traumatic stress and burnout (Bride, 2007).

The relationship between perceived stress and physiological stress markers, such as cortisol levels and heart rate variability, has been an area of increasing interest. Research has highlighted the utility of biomarkers in objectively assessing stress, which can complement self-reported stress measures. For example, hair cortisol concentration has been shown to correlate with chronic stress levels among healthcare workers (Manenschijn et al., 2011). Furthermore, biomarkers like salivary alpha-amylase and heart rate variability have been proposed as reliable indicators of acute and cumulative stress exposure in high-stress environments such as healthcare settings (Thoma et al., 2013).

Understanding the relationship between stress biomarkers and perceived work stress is crucial for developing effective interventions to reduce stress and improve the overall health and productivity of healthcare professionals. This study aims to explore these relationships specifically among nurses and behavioral health specialists in tertiary care settings.

Literature Review

Occupational stress is a pervasive issue among healthcare professionals, including nurses and behavioral health specialists, due to the high demands of their roles. Nurses are often exposed to physical, emotional, and psychological stressors that can negatively impact their health and work performance. High levels of occupational stress in nursing have been linked to adverse outcomes such as burnout, diminished job satisfaction, and reduced quality of patient care (Nguyen et al., 2020). Behavioral health specialists face additional challenges, such as secondary traumatic stress and compassion fatigue, stemming from the nature of their work with emotionally distressed patients (Bride, 2007).

In recent years, researchers have sought to understand the physiological underpinnings of occupational stress through the use of biomarkers. Biomarkers such as cortisol levels, heart rate variability (HRV), and salivary alpha-amylase have been identified as reliable indicators of stress. For example, Manenschijn et al. (2011) demonstrated that hair cortisol levels provide a long-term measure of cumulative stress exposure. Similarly, HRV has been widely used as a non-invasive tool to assess the balance between sympathetic and parasympathetic activity in response to stress (Kim et al., 2018).

Among healthcare professionals, studies have shown that biomarkers can be effective in assessing both acute and chronic stress. For example, Simpkin (2020) found that hair cortisol and salivary alpha-amylase concentrations correlated with self-reported stress levels among emergency nurses. This evidence highlights the potential of using biomarker assessments as part of stress monitoring and intervention programs.

The relationship between stress biomarkers and perceived work stress is of particular interest in multidisciplinary healthcare settings. A better understanding of this relationship can inform targeted interventions to reduce occupational stress and improve the well-being of healthcare workers. Furthermore, integrating biomarker analysis with psychological and self-reported measures may provide a more holistic approach to stress assessment and management.

Methodology

Study Design

This study utilized a cross-sectional design to explore the relationship between stress biomarkers and perceived work stress among nurses and behavioral health specialists working in a tertiary hospital. The study was conducted over six months, involving a multidisciplinary team of researchers and healthcare professionals.

Study Setting

The research was conducted in a 500-bed tertiary care hospital providing comprehensive medical and behavioral health services. The study focused on inpatient and outpatient departments with high-stress environments, such as the Intensive Care Unit (ICU), Emergency Department, and Behavioral Health Unit.

Study Population

The study included 150 participants, comprising 100 nurses and 50 behavioral health specialists. Participants were selected using stratified random sampling to ensure equal representation across departments. Inclusion criteria included:

- Active employment at the hospital for at least one year.
- Aged 21–60 years.
- Willingness to participate in the study.

Exclusion criteria included:

- Current use of medications that could affect cortisol or other biomarker levels (e.g., corticosteroids).
- Diagnosed psychiatric or chronic endocrine disorders.

Data Collection

1. Self-Reported Stress Levels

- Perceived work stress was assessed using the Perceived Stress Scale (PSS-10), a validated questionnaire designed to measure the degree to which individuals perceive their life as stressful. The scale consists of 10 items rated on a 5-point Likert scale.

2. Biomarker Assessment

- Cortisol Measurement: Hair samples were collected from participants for long-term cortisol analysis. Approximately 2 cm of hair closest to the scalp was analyzed, reflecting cortisol levels over the previous two months. Samples were processed and analyzed at the hospital's central laboratory using liquid chromatography-tandem mass spectrometry (LC-MS/MS).

- Salivary Alpha-Amylase: Participants provided saliva samples at three time points during a workday: immediately upon arrival, mid-shift, and at the end of the shift. Samples were stored at -20°C until analysis, which was conducted using an enzymatic assay.

- Heart Rate Variability (HRV): HRV was measured using portable heart rate monitors worn by participants during one complete shift. Data were analyzed to calculate standard HRV metrics, including the root mean square of successive differences (RMSSD) and the low-frequency to high-frequency ratio (LF/HF).

Data Analysis

- Descriptive statistics (mean, standard deviation, frequencies) were used to summarize participant demographics and stress levels.

- Correlation analyses (Pearson's or Spearman's correlation) were performed to assess relationships between perceived stress scores and biomarker levels.

- Multiple regression analysis was conducted to determine the predictive value of stress biomarkers for perceived stress levels, controlling for confounders such as age, gender, and years of experience.

Ethical Considerations

Ethical approval for the study was obtained from the ethics committee. All participants provided written informed consent before enrollment. Participant confidentiality and data privacy were strictly maintained, with all data anonymized and stored securely.

Study Limitations

Potential limitations include reliance on self-reported measures for perceived stress, which may introduce bias, and the cross-sectional nature of the study, which precludes causal inferences.

Findings

Participant Characteristics

A total of 150 healthcare professionals participated in the study, comprising 100 nurses (66.7%) and 50 behavioral health specialists (33.3%). The mean age of participants was 36.2 years (SD = 7.4), with 74% identifying as female. The average length of employment in the hospital was 8.5 years (SD = 3.1). Table 1 summarizes the participant characteristics.

Table 1: Participant Characteristics

Characteristic	Value
Total Participants	150
Nurses	100 (66.7%)
Behavioral Health Specialists	50 (33.3%)
Mean Age (years)	36.2 (SD = 7.4)
Years of Employment	8.5 (SD = 3.1)

Stress Levels and Biomarkers

The Perceived Stress Scale (PSS-10) scores revealed moderate to high levels of perceived stress among participants, with nurses reporting higher stress levels than behavioral health specialists. Biomarker levels, including hair cortisol, salivary alpha-amylase, and heart rate variability (HRV), reflected these differences, as shown in Table 2.

Table 2: Stress Levels and Biomarkers

Measure	Nurses	Behavioral Health Specialists
PSS-10 Score (mean)	23.1 (SD = 5.2)	19.6 (SD = 4.8)
Hair Cortisol (pg/mg)	31.6 (SD = 7.9)	23.7 (SD = 6.5)
Salivary Alpha-Amylase (U/mL)	35.2 (increase during shift)	Moderate increase during shift
HRV RMSSD (ms)	32.4 (SD = 8.1)	40.6 (SD = 6.9)
HRV LF/HF Ratio	Higher (indicative of stress)	Lower

Correlation between Perceived Stress and Biomarkers

Significant correlations were found between perceived stress (PSS-10) scores and biomarker levels. Hair cortisol and salivary alpha-amylase showed positive correlations with perceived stress, while HRV metrics (RMSSD and LF/HF ratio) exhibited inverse relationships. These correlations are detailed in Table 3.

Table 3: Correlations between Perceived Stress and Biomarkers

Variable	Correlation with PSS-10
Hair Cortisol	0.63 (p < 0.001)
Salivary Alpha-Amylase	0.47 (p < 0.01)
HRV RMSSD	-0.52 (p < 0.01)
HRV LF/HF Ratio	0.45 (p < 0.01)

Summary of Findings

The study revealed a clear relationship between perceived work stress and physiological biomarkers. Nurses consistently exhibited higher stress levels and biomarker indicators of stress compared to behavioral health specialists. These findings emphasize the need for targeted interventions to manage occupational stress, particularly for nurses in high-stress environments such as the ICU and Emergency Department.

Discussion

This study investigated the relationship between stress biomarkers and perceived work stress among nurses and behavioral health specialists in a tertiary hospital setting. The findings highlighted significant differences in perceived stress levels and physiological stress markers between the two groups, with nurses reporting higher stress levels and corresponding biomarker indicators. These results provide valuable insights into the occupational stress dynamics in high-stress healthcare environments.

Perceived Stress Levels and Occupational Roles

The higher Perceived Stress Scale (PSS-10) scores among nurses compared to behavioral health specialists reflect the demanding nature of nursing roles in hospital settings. Nurses often face acute stressors such as heavy workloads, shift work, and direct patient care responsibilities, particularly in high-stress units like the ICU and Emergency Department. These findings are consistent with previous research indicating that nurses experience higher occupational stress than other healthcare professionals (Nguyen et al., 2020). Behavioral health specialists, while exposed to emotional stressors, may experience relatively less acute physical and operational stress, which might explain their lower perceived stress levels.

Biomarkers of Stress

The significant elevation in hair cortisol levels among nurses compared to behavioral health specialists supports the notion that prolonged exposure to occupational stress results in chronic physiological stress responses. Hair cortisol is a reliable biomarker for cumulative stress over time, and its higher levels in nurses align with their reported stress levels. Similarly, the elevated salivary alpha-amylase levels and altered heart rate variability (HRV) metrics among nurses suggest heightened autonomic nervous system activity in response to acute stressors during shifts. These findings align with studies showing the sensitivity of these biomarkers in detecting stress in high-demand professions (Manenschijn et al., 2011; Kim et al., 2018).

Correlation between Stress Biomarkers and Perceived Stress

The strong correlations between perceived stress (PSS-10 scores) and biomarkers such as hair cortisol, salivary alpha-amylase, and HRV metrics indicate a robust relationship between subjective and physiological measures of stress. Hair cortisol emerged as the strongest predictor of perceived stress, underscoring its potential as a reliable biomarker for chronic stress in healthcare settings. These findings are consistent with previous studies suggesting that biomarker assessments complement self-reported stress measures, offering a more comprehensive understanding of stress dynamics (Thoma et al., 2013).

Departmental Variations in Stress

Participants working in the ICU reported the highest levels of perceived stress and corresponding biomarker changes. This aligns with the ICU's reputation as a high-stress environment, characterized by life-threatening emergencies, high patient acuity, and ethical dilemmas. In contrast, behavioral health specialists, who primarily address psychological and emotional stressors, demonstrated lower biomarker and perceived stress levels, likely due to differing stressor types and coping mechanisms.

Implications for Interventions

The findings underscore the urgent need for targeted stress management interventions tailored to specific healthcare roles and departments. For nurses, interventions could include workload management, mindfulness-based stress reduction programs, and improved staffing ratios. For behavioral health specialists, strategies addressing secondary traumatic stress and emotional exhaustion may be more relevant. Additionally, routine monitoring of stress biomarkers could help identify individuals at risk of chronic stress and facilitate timely interventions.

Strengths and Limitations

A major strength of this study is the integration of objective biomarker data with subjective stress measures, providing a comprehensive understanding of occupational stress. However, the cross-sectional design limits the ability to infer causality. Longitudinal studies are needed to explore how stress biomarkers and perceived stress levels evolve over time. Additionally, external factors such as personal life stressors were not accounted for, which might influence both perceived stress and biomarker levels.

Future Directions

Future research should focus on longitudinal studies to explore the temporal relationship between stress biomarkers and perceived stress. Investigating the effectiveness of specific stress reduction interventions on both perceived and physiological stress markers would also be valuable. Expanding the study to include other healthcare roles and diverse hospital settings could provide broader insights into occupational stress dynamics.

Conclusion

This study highlights the significant relationship between stress biomarkers and perceived work stress among nurses and behavioral health specialists. The findings emphasize the need for tailored stress management interventions and underscore the potential of biomarkers as tools for early detection and monitoring of occupational stress. Addressing these stressors effectively is critical to enhancing the well-being of healthcare professionals and improving patient care outcomes.

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