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# RELATIONSHIP BETWEEN SLEEP QUALITY AND SERUM CORTISOL LEVELS AMONG HEALTHCARE WORKERS: A CROSS-SECTIONAL STUDY

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**Abstract**:
**Background**: Work undertaken during night-shift hours is commonly linked with sleep disturbance, circadian rhythm disruption and increased physiological stress among healthcare providers.
**Objective**: The objective of this study was to explore the relationship between sleep quality and serum cortisol among healthcare workers working regular night shifts in Baghdad, Iraq.
**Methods**: Two hundred healthcare workers working in governmental hospitals in Baghdad completed a cross-sectional study between October 2025 and February 2026. The sleep quality was measured by the Pittsburgh Sleep Quality Index (PSQI). Serum cortisol concentrations were measured using the VIDAS® Cortisol assay, an enzyme-linked fluorescent assay (ELFA) technology.
**Results**: Poor sleep quality was common, with 71.0% of participants poor sleepers. Serum cortisol concentrations increased significantly among poor sleepers compared with good sleepers in the sample (24.7 ± 4.6 vs. 13.4 ± 2.8 µg/dL, $p < 0.001$). Increasing frequency of monthly night-shift duties resulted in progressively rising levels of cortisol. There was a significant positive Pearson correlation established between PSQI score and serum cortisol concentrations ($r = 0.72$, $p < 0.001$), whereas sleep duration showed a significant negative correlation ($r = -0.66$, $p < 0.001$). Multiple linear regression found that: PSQI score, sleep duration, and night-shift frequency were significant independent variables predicting serum cortisol levels (Adjusted $R^2 = 0.61$, $p < 0.001$).
**Conclusions**: Poor sleep quality and frequent night-shift duty were significantly associated with high serum cortisol levels in the healthcare workers indicating a close association between occupational sleep disturbance and physiological stress response.

**Keywords**: Sleep quality; Serum cortisol; Night-shift work; Occupational stress; Healthcare workers.

## Introduction

Sleep is an essential physiological process for the maintenance of metabolic homeostasis, cognitive performance, emotional stability, and normal neuroendocrine function. In healthcare professionals and more specifically those working with rotating and night-shift schedules, sleep quality and sleep duration have become increasingly problematic. There is evidence that occupational sleep disturbance can lead to impaired concentration, fatigue, cardiovascular disorders, metabolic abnormalities, and psychological stress. Healthcare personnel with night-shift duties in healthcare are particularly susceptible to circadian rhythm disruptions owing to changes in work time and long duration of work as a basis for the use of these circadian rhythm disturbances [1]. Work at night is recognized as an important occupational stressor to disrupt the normal hormonal secretion circadian rhythm. One of the major CNS hormones, cortisol, a glucocorticoid hormone secreted from the adrenal cortex through the activation of the HPA axis, is critical in the process of stress regulation and homeostasis, homeostatic-physiological adaptations of the physiology. In normal physiological systems, the production of cortisol happens rhythmically within a day, with maximal levels occurring in the morning and gradually decreasing over the day. But chronic sleep deprivation and repeated night practice would change such cortisol secretion and lead to prolonged stress signaling [2]. Past studies showed strong association between sleep quality and high cortisol in healthcare workers and among shift workers. Insufficient sleep and stress in the workplace have been associated with HPA-axis hyperactivity; however, this is attributed to greater circulating levels of cortisol, which can ultimately mediate impaired recovery mechanisms. In addition, long-term activation of stress-induced hormone signalling pathways may alter immune regulation, cardiovascular function, and mental health for health-care professionals with chronic occupational stressors [3, 4, 5]. In the clinical and occupational contexts, the Pittsburgh Sleep Quality Index (PSQI) is one of the most commonly utilized and validated measures of sleep quality and sleep-related dysfunction. Previous research utilizing nurses and medical personnel demonstrated high prevalence of poor sleep quality primarily among night-duty rotating workers. Further, growing evidence indicates that poor sleep quality of healthcare personnel can negatively impact their professional performance, patient safety, and the overall quality of healthcare services [6,7,8]. Despite the increasing global interest in occupational sleep disorders, few data have been available regarding the association between sleep quality and serum cortisol concentrations among healthcare workers in Iraq. The previous local studies have focused on psychological stress and occupational burnout, and physiological stress biomarkers are not being thoroughly evaluated [9,10]. The aim of the present study was to determine the relationship between sleep quality and serum cortisol levels of health care workers working the night shift in Baghdad, Iraq.

## Materials and Methods

### Study Design and Setting

This cross-sectional study was carried out in Baghdad between October 2025 to February 2026. This study was conducted with a sample of medical personnel who worked at a number of state

hospitals in Baghdad, Iraq, focusing specifically on the nurses' routine night and rotating roles and staff of these hospitals. The study was designed to evaluate the relationship between sleep quality and serum cortisol concentrations among individuals exposed to occupational stress associated with night-shift schedules.

**Study Population**

There were 200 healthcare workers participating, based on predefined inclusion and exclusion criteria. Demographic and occupational variables including age, gender, BMI, smoking status, marital status, years of employment, and frequency of monthly night-shift duties were measured through a structured questionnaire created for the study. All participants were informed of the objectives and procedures of the investigation before their enrollment.

**Inclusion Criteria**

Study participants were healthcare workers 22 to 55 years of age, a demographic composed of nurses and medical staff who were assigned to regular night-shift duties. The study enrolled only apparently healthy people who voluntarily agreed to participate.

**Exclusion Criteria**

Individuals taking corticosteroid therapy or taking sedative or sleep-modifying medications did not participate. Patients with Cushing's syndrome, Addison's disease, thyroid dysfunction, or diabetes mellitus were also excluded. Pregnant women and subjects suffering from chronic inflammatory diseases, psychiatric disorders, or severe systemic illnesses were also excluded in order to minimize possible confounders that could affect serum cortisol levels and sleep quality.

**Assessment of Sleep Quality**

Sleep quality was evaluated using the Pittsburgh Sleep Quality Index (PSQI), a validated tool commonly used to assess sleep patterns and disturbances over the past month. The questionnaire covers seven domains that evaluate perceived sleep quality, time to fall asleep, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleep medications, and impairment in daytime functioning. The PSQI scores range from 0 to 21, with higher scores reflecting lower sleep quality. According to the established scoring system, participants with scores of 5 or less were considered good sleepers, and those with scores of more than 5 were considered poor sleepers.

**Blood Sample Collection**

A total of 5 mL from each participant’s venous blood in the morning at between 8:00 and 10:00 AM was collected to minimize the influence of circadian rhythm on cortisol secretion. Blood samples were collected aseptically in simple tubes and allowed to clot at room temperature.

Serum was separated by centrifugation (3000 rpm for 10 min) and stored at −20 °C until laboratory analysis.

**Measurement of Serum Cortisol**

Serum cortisol concentrations were determined using the VIDAS® Cortisol assay on the VIDAS automated immunoassay system manufactured by bioMérieux, France. Based on the enzyme-linked fluorescent assay (ELFA) concept, which integrates enzyme immunoassay and fluorescent detection technology, it is a widely used molecular methodology. All analysis and checks of quality were conducted according to the manufacturer's instructions and recommendations.

**Statistical Analysis**

Statistical analyses were conducted using IBM SPSS Statistics (version 26.0, IBM Corp.) and GraphPad Prism (version 9.0, GraphPad Software). Continuous variables were presented as mean ± SD and categorical variables as frequency and percentage. Normality of the data was tested using the Shapiro-Wilk test. The independent sample t-test, one-way ANOVA, Pearson correlation and Chi-square tests were performed as appropriate and p-value ≤0.05 was considered statistically significant in the study.

**Results**

**Demographic and Occupational Characteristics of the Study Population**

Demographic Profile of the Study Population. A total of 200 healthcare workers from different hospitals in Baghdad participated in the study. Most of the study population were nurses and medical personnel on their regular night shifts. Table 1 summarizes the demographic and occupational characteristics of the participants. The mean age of the subjects was 37.8±7.4 years. 54.0% of participants were males and 46.0% were females in the research population. Mean BMI was 27.1 ± 3.5 kg/m². Nurses accounted for 66.0% of the total enrolled subjects in this study, and other medical personnel 34.0%. Among occupational traits, the average period of employment was 11.2 ± 6.3 years. Also, they had relatively high monthly night shifts (mean 12.8 ± 4.6 shifts/month). The average sleep duration of the study population was 5.4 ± 1.2 hours/day.

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**Table 1.** Demographic and Occupational Characteristics of the Healthcare Workers Included in the Study

| Variable | Value |
|---|---|
| Number of participants | 200 |
| Age (years), mean ± SD | 37.8 ± 7.4 |
| Male, n (%) | 108 (54.0%) |
| Female, n (%) | 92 (46.0%) |
| BMI (kg/m²), mean ± SD | 27.1 ± 3.5 |
| Nurses, n (%) | 132 (66.0%) |
| Medical staff, n (%) | 68 (34.0%) |
| Years of employment, mean ± SD | 11.2 ± 6.3 |
| Night shifts/month, mean ± SD | 12.8 ± 4.6 |
| Sleep duration (hours), mean ± SD | 5.4 ± 1.2 |

**Distribution of Healthcare Workers According to Sleep Quality**

The Pittsburgh Sleep Quality Index (PSQI) was used to assess sleep quality and subjects were segregated into good and poor sleep quality groups according to the assessed PSQI scores. Distribution of participants to sleep quality is described in Table 2. Findings showed the prevalence of poor sleep quality was extremely high among those who completed usual night-shift services. A total of 142 participants (71.0%) were classified as poor sleepers and had PSQI scores of >5, while only 58 participants (29.0%) scored ≤5 and were of good sleep quality.

**Table 2.** Distribution of Healthcare Workers According to Sleep Quality

| Sleep Quality Group | Number (%) |
|---|---|
| High-quality sleep (PSQI ≤5) | 58 (29.0%) |
| Poor quality of sleep (PSQI >5) | 142 (71.0%) |

**Comparison of Serum Cortisol Levels and Sleep Parameters Between Study Groups**

Serum cortisol and sleep measures were contrasted between subjects that had a good quality sleep and those who were not. The present results were summarized in Table 3. Poorly sleeping individuals had markedly elevated serum cortisol as compared to good sleep quality controls (24.7 ± 4.6 vs. 13.4 ± 2.8 µg/dL, $p < 0.001$). Moreover, poor sleepers have much shorter mean sleep duration than good sleepers (4.8 ± 0.9 vs. 7.1 ± 0.7 hours/day, $p < 0.001$). In addition, PSQI scores were significantly increased for participants with poor sleep quality vs. good sleepers (11.8 ± 2.3 vs. 4.1 ± 1.2, $p < 0.001$). There was highly significant statistical change in serum cortisol concentration, sleep time and PSQI score in the two groups.

**Table 3.** Comparison of Serum Cortisol Levels and Sleep Parameters Between Good and Poor Sleep Quality Groups

| Variable | Good Sleep Quality | Poor Sleep Quality | p-value |
|---|---|---|---|
| Serum cortisol (µg/dL), mean ± SD | 13.4 ± 2.8 | 24.7 ± 4.6 | <0.001 |
| Sleep duration (hours), mean ± SD | 7.1 ± 0.7 | 4.8 ± 0.9 | <0.001 |
| PSQI score, mean ± SD | 4.1 ± 1.2 | 11.8 ± 2.3 | <0.001 |

**Association Between Night-Shift Frequency and Serum Cortisol Levels**

The association between the frequency of monthly night-shift duties and serum cortisol levels was investigated and summarized in Table 4. Participants with 5–9 night shifts/month were found with the lowest mean serum cortisol levels (14.6 ± 3.1 µg/dL). By contrast, the mean cortisol concentrations were dramatically elevated at 10–14 night shifts/month (M = 20.8 ± 4.2 µg/dL). In addition, participants serving ≥15 night shifts monthly had the highest serum cortisol concentrations, 28.1 ± 4.8 µg/dL ($p < 0.001$).

**Table 4.** Association Between Night-Shift Frequency and Serum Cortisol Concentrations

| Night Shifts/Month | Participants (n) | Serum Cortisol (µg/dL), mean ± SD | p-value |
|---|---|---|---|
| 5–9 shifts | 48 | 14.6 ± 3.1 | <0.001 |
| 10–14 shifts | 82 | 20.8 ± 4.2 | |
| ≥15 shifts | 70 | 28.1 ± 4.8 | |

**Correlation Analysis Between Serum Cortisol Levels and Sleep-Related Parameters**

Pearson correlation analysis was done to explore the association between serum cortisol concentrations and sleep related variables among the participants. The results indicated a positive correlation between serum cortisol concentrations and PSQI scores ($r = 0.72$, $p < 0.001$) as shown in Table 5, which meant that the higher the concentration of cortisol, the worse the sleep quality. Furthermore, serum cortisol levels showed a positive correlation with the number of night shifts per month ($r=0.69$, $p<0.001$). By contrast, sleep duration was significantly inversely correlated with cortisol concentrations ($r = −0.66$, $p < 0.001$), showing that shorter sleep duration was associated with higher physiological stress. Additionally, BMI showed a weak but statistically significant-positive correlation with serum cortisol concentrations ($r = 0.18$, $p < 0.05$).

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**Table 5.** Pearson Correlation Matrix Between Serum Cortisol Levels and Sleep-Related Parameters

| Variable | Serum Cortisol | PSQI Score | Sleep Duration | Night Shifts/Month | BMI |
|---|---|---|---|---|---|
| Serum Cortisol | 1 | 0.72** | -0.66** | 0.69** | 0.18* |
| PSQI Score | 0.72** | 1 | -0.74** | 0.63** | 0.12 |
| Sleep Duration | -0.66** | -0.74** | 1 | -0.58** | -0.09 |
| Night Shifts/Month | 0.69** | 0.63** | -0.58** | 1 | 0.11 |
| BMI | 0.18* | 0.12 | -0.09 | 0.11 | 1 |
| *At $p < 0.05$, the correlation is significant.<br>** At $p < 0.001$, the correlation is extremely significant. | | | | | |

**Multiple Linear Regression Analysis for Predicting Serum Cortisol Concentrations**

The independent predictors of serum cortisol levels for the healthcare workers were determined by applying multiple linear regression analysis. We entered serum cortisol concentration as the dependent variable with PSQI score, sleep duration, BMI, and monthly night-shift frequency considered as independent predictor variables. Results of the regression model are shown in Table 6. The regression analysis showed that PSQI score and monthly night-shift frequency were significant, positive predictors of serum cortisol concentrations ($p < 0.001$). In contrast, sleep duration showed a significant negative association with serum cortisol concentrations ($p < 0.001$). A weak positive impact of BMI was seen on cortisol concentrations ($p = 0.041$). In general, the regression model was significant and accounted for a high proportion of the variation of serum cortisol concentrations (Adjusted $R^2 = 0.61$, $p < 0.001$).

**Table 6.** Multiple Linear Regression Analysis for Predicting Serum Cortisol Concentrations Among Healthcare Workers

| Predictor Variable | β Coefficient | Standard Error | t-value | p-value |
|---|---|---|---|---|
| PSQI score | 0.84 | 0.09 | 9.41 | <0.001 |
| Sleep duration (hours) | −1.27 | 0.24 | −5.29 | <0.001 |
| Night shifts/month | 0.58 | 0.11 | 5.14 | <0.001 |
| BMI (kg/m²) | 0.19 | 0.09 | 2.06 | 0.041 |
| Model statistics: Adjusted $R^2 = 0.61$, $F = 78.4$, $p < 0.001$. | | | | |

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**Correlation Between PSQI Score and Serum Cortisol Levels Among Healthcare Workers**

Moreover Pearson correlation analysis was performed to explore the correlation between the PSQI score and serum cortisol concentrations. As shown in Figure 1, a significant positive linear correlation between PSQI scores and cortisol concentrations was observed. Higher PSQI scores were associated with a trend towards higher serum cortisol concentrations in subjects. Statistical analysis indicated that poorer sleep quality was significantly correlated with higher cortisol concentrations ($r = 0.72$, $p < 0.001$). These results suggest that sleep disruption related to night shift work may be involved in the activation of physiological stress response mechanisms.

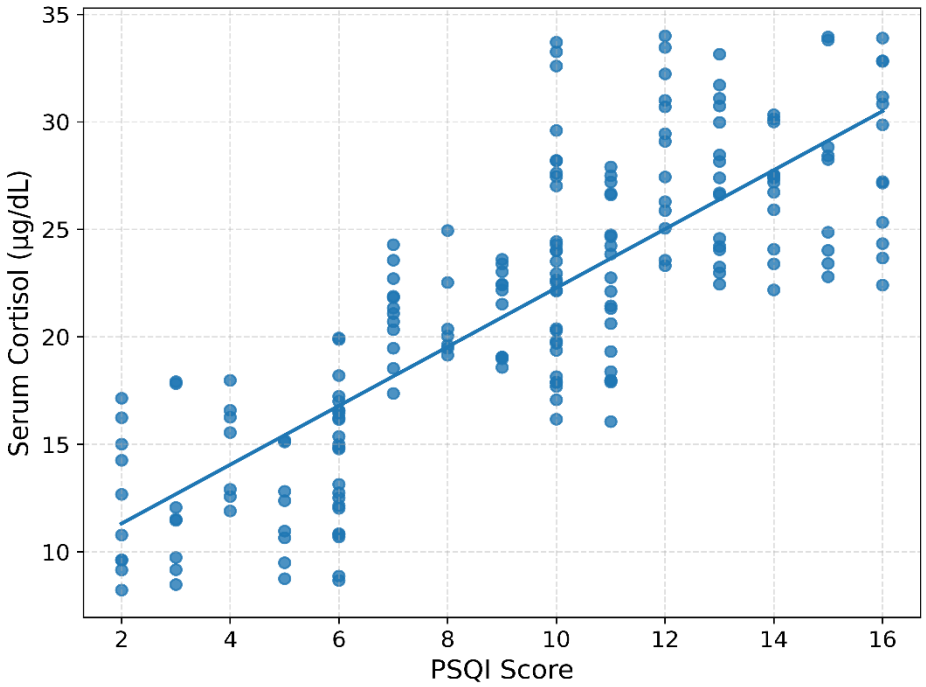


**Figure 1.** Correlation Between PSQI Score and Serum Cortisol Levels Among Healthcare Workers

**Comparison of Serum Cortisol Distribution Between Good and Poor Sleep Quality Groups**

We further examined the distribution of serum cortisol concentrations among participants with good and poor sleep quality using a box plot analysis. Poor sleep quality was significantly associated with higher serum cortisol concentrations than good sleepers (Figure 2). Also, the median cortisol levels were greater and more variable in the terrible sleep quality group than in the good sleep quality group. Statistical analysis showed a high significance of the difference between groups ($p < 0.001$) confirming a strong link between worse sleep quality and increased physiological stress response of the people involved in regular night-shift employment.

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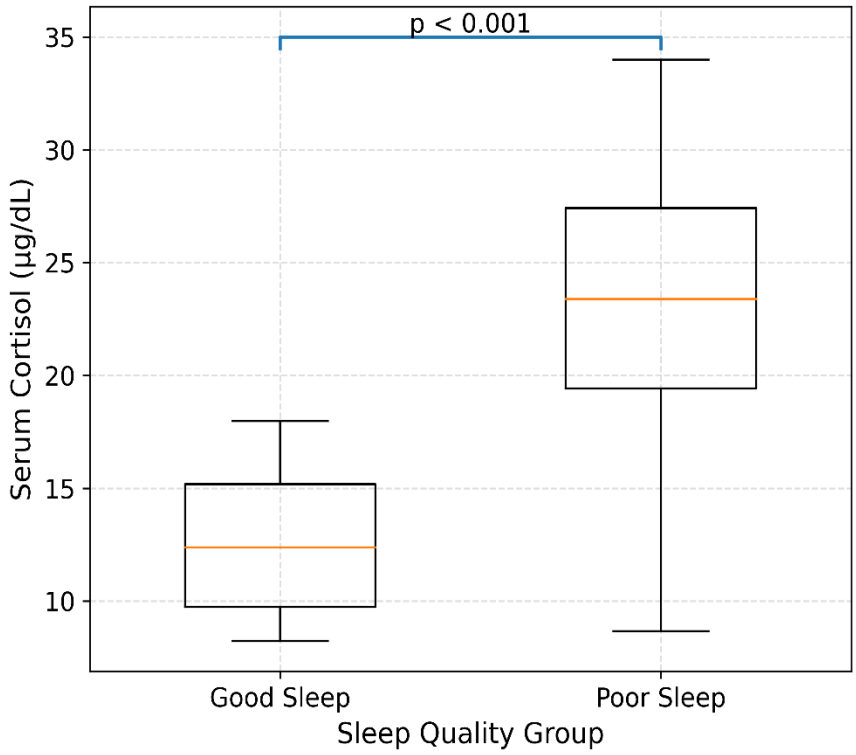


**Figure 2.** Box plot analysis demonstrates significantly elevated serum cortisol concentrations among poor sleepers compared with good sleepers ($p < 0.001$).

**Discussion**

According to the present study, 71.0% of all healthcare professionals who worked night shifts were poor sleepers according to PSQI's diagnostic criteria which is characterized by a significant disparity in sleep quality among individuals. This finding is also supportive of previous research showing that nurses and medical personnel who work night/rotating shifts often experience poorer sleep quality, shorter sleep duration & circadian misalignment. Huang et al. recorded a high prevalence of poor sleep quality in nurses who worked consecutive night shifts, whereas Alreshidi et al. found that night-shift nurses had significantly worse PSQI scores than day-shift nurses. This correlation with these studies may be explained by comparable work patterns (e.g., long working hours, rotating work hours and inadequate rest time) between shifts [11,12]. Serum cortisol levels were significantly higher in poor sleepers compared to good sleepers. The latter provides support for the physiological hypothesis in which sleep disturbance induces the hypothalamic–pituitary–adrenal axis activation and elevates the production of cortisol. New evidence is emerging that work on nights can disrupt cortisol and melatonin cycles, diminish long-term sleep duration and lead to sleep deprivation. Burek et al. also reported altered stress cortisol levels on night shift in hospital staff, suggesting that circadian disruption disturbs the normal glucocorticoid homeostasis. The concordance of prior

findings and present findings could be explained by the morning blood samples period as the cumulative response to stress upon repeated night-shift exposure [13,14]. The current study reported a stepwise change in the level of blood cortisol with an upsurge in the number of night shifts monthly. People working ≥15 night shifts each month had the highest cortisol amounts. This finding is consistent with other research in occupational sleep suggesting that higher concentrations of night shifts correlate with greater sleep disturbance and an increase in physiological load. Chang and Peng reported that the quality and duration of nurses' sleep varied in the type of shift time and the scheduling characteristics. Likewise, Harris et al. found the sleep and mental health outcomes worsened after beginning on shift employment [15,16]. A consistent pattern emerged from the data indicated that the physiologic impact of nocturnal labor might be dose-dependent, increasing with exposure at all times and suboptimal recovery. Statistical analysis of Pearson correlation indicated a significant positive relationship between PSQI score and serum cortisol concentration and a significant negative correlation between sleep duration and cortisol level. Literature suggests that poor quality sleep, fatigue, and stress linked to shift work are important mediators for neuroendocrine dysregulation. Zhang et al. revealed the associations of sleep-wake pattern, exhaustion and salivary cortisol in female shift workers, where AL-hrinat et al. reported that the night-shift stress and sleep disturbances negatively affected the quality of life for nurses. Small differences between studies can be due to differences in sample characteristics such as sample size, shift systems, biological sample category, measurement time of cortisol, and demographic characteristics [17,18]. The findings of this study show that low quality sleep, as well as a more frequent night-shift schedule are associated with higher serum levels of cortisol amongst health workers. Such results indicate that improvements in shift scheduling methods, the increase of recovery time periods, and the implementation of sleep-monitoring programs can reduce physiological stress and occupational stress among health workers that is confirmed in recent studies discussing the influence of night shift work on sleep and occupational health [19,20].

## Conclusion

The present study identified a high prevalence of poor sleep quality among healthcare professionals who work frequent night shifts. Subjects who had inadequate sleep quality demonstrated significantly higher serum cortisol, reduced sleep duration, and elevated PSQI scores relative to subjects with adequate sleep. Also, a high monthly number of night shifts was associated with gradually higher levels of cortisol over time. The results showed strong relationships between serum cortisol and sleep-related correlates, suggesting that problems in the sleep function of staff may activate physiological stress-response systems. The results suggest that fatigue in health professionals' work may have an impact on neuroendocrine regulation and on the overall health of the workforce due to occupation. As a result, effective scheduling of the desired shift, sufficient recovery intervals, and sleep-health surveillance programs might alleviate occupational stress and optimise health-related benefits in healthcare workers.

**Competing interests:** The authors declare that they have no financial, personal or professional relationship with other people or organizations that could inappropriately influence their work.

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