

Perceived Stress, Emotional Regulation, Sleep Quality, and Executive Function Among Operating Room Nurses: A Cross-Sectional Structural Equation Modeling Study

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Abstract

Background: This study aims to examine the relationships among perceived stress, emotion regulation, sleep quality, and executive dysfunction in operating room nurses, who are subjected to high-pressure environments that necessitate continuous complex decision-making, multitasking, and prompt responses.

Methods: 216 Chinese operating room nurses surveyed on executive function (Dysexecutive Questionnaire), perceived stress (Perceived Stress Scale with helplessness/self-efficacy subscales), emotion regulation (Emotion Regulation Questionnaire with reappraisal/suppression subscales), and sleep quality (Pittsburgh Sleep Quality Index). Structural equation modeling explored relationships among these factors.

Results: In operating room nurses, Dysexecutive scores correlated significantly with helplessness and sleep quality, and weakly with self-efficacy. Emotion Regulation scores showed no overall link to Dysexecutive, but cognitive reappraisal was negatively correlated, and expressive suppression positively correlated. SEM fit was good. Helplessness positively predicted expressive suppression and sleep quality; self-efficacy negatively predicted cognitive reappraisal and expressive suppression. Helplessness indirectly impacted Dysexecutive via expressive suppression.

Conclusion: For these nurses, higher helplessness and expressive suppression are strongly tied to executive dysfunction, with helplessness directly and indirectly affecting cognition via poor emotion regulation.

Implications for the profession and/or patient care: These findings highlight the need for targeted interventions in OR nursing to mitigate perceived stress and foster adaptive emotion regulation such as promoting cognitive reappraisal over suppression. Such strategies could enhance executive function, reduce cognitive errors, and improve patient safety during high-stakes procedures

Impact: This study addresses gaps in understanding psychosocial factors influencing executive function in OR nurses, informing workplace wellness programs and stress management training to support cognitive resilience and operational efficiency in surgical environments.

Reporting Method: State here that you have adhered to relevant EQUATOR guidelines and name the reporting method.

Patient or Public Contribution: This study did not include patient or public involvement in its design, conduct, or reporting.

What does this paper contribute to the wider global clinical community

1.Highlights the key roles of perceived helplessness and expressive suppression as predictors of executive dysfunction in high-stress clinical settings.2.Offers a model linking stress, sleep, and emotion regulation to executive function in OR nurses, supporting the development of comprehensive well-being and safety interventions globally.

Introduction

In modern healthcare systems, the operating room serves as the critical site for surgical procedures and acute, life-saving interventions. Its operational effectiveness directly impacts patient safety and perioperative care quality. Operating room(OR) nursing professionals are required not only to perform complex perioperative care tasks in a highly specialized and high-intensity work environment but also to maintain a high level of concentration and make complex decisions under conditions of high noise and frequent interruptions(1). These factors collectively constitute major sources of stress for nursing professionals(2) and simultaneously place greater demands on their executive functions.

Executive function(EF)comprises a set of advanced cognitive processes based in the prefrontal cortex, including components like inhibitory control, working memory, cognitive flexibility, and planning ability(3). For operating-room nurses, good executive function is key to maintain the accuracy of surgical teamwork, ensure strict aseptic technique, improve turnover efficiency, and guarantee surgical safety. When executive function is impaired, nurses are more prone to be distraction during multitasking, decrease working memory, and make poorer decision (4), increasing the risk of medical errors and coordination failures, thereby threatening the safety of patient and the quality of perioperative care.

Evidence from existing studies indicates that executive function is influenced by various of factors. It is not only related to neurological diseases(5)but may also be closely linked with non-neurological factors such as stress(6), emotional regulation(7), and sleep quality(8). However, current research on executive function within nurses—particularly among operating-room nurses, remains relatively limited, and the contributing factors and underlying mechanisms have not been fully elucidated. Previous literature has largely focused on occupational stress, burnout, and sleep problems among operating-room nurses (9-11), with insufficient attention to executive function and its mediating or moderating roles among stress, mood, and sleep factors. Perceived stress, emotion regulation strategies, and sleep quality may interact in complex ways with executive function, suggesting potential mechanisms that warrant systematic empirical investigation driven by theory.

Therefore, this study aims to recruit operating-room nurses as the target population, employing a cross-sectional design and using structural equation modeling (SEM) to analyze the relationships among perceived stress, emotional regulation, sleep quality, and executive function. The study will assess model fit and robustness to provide theoretical justification and empirical support for the development of targeted psychological interventions and management strategies.

Background

Stress and Coping Theory: The Relationship Between Perceived Stress and Executive Function

The stress and coping theory proposed by Lazarus and Folkman (12) posits that individuals cognitively appraise stressors, dividing the process into primary appraisal (assessing whether an event poses a threat) and secondary appraisal (evaluating personal resources and coping options), thereby providing a theoretical framework for understanding the processes and outcomes of stress exposure. In this study, perceived stress is defined as the subjective experience reflecting an individual's sense of unpredictability, uncontrollability, and inadequacy of coping resources in life situations (13). Based on this theoretical framework, the Perceived Stress Scale (PSS) was developed and it was divided into two dimensions: perceived helplessness and perceived self-efficacy(14). Research indicates that stress can activate the hypothalamic-pituitary-adrenal (HPA) axis, leading the neuroendocrine substances such as cortisol and norepinephrine to be released quickly, which act on key brain regions like the prefrontal cortex and influence various neurochemical and molecular pathways, ultimately impairing executive functions including impulse control, working memory, and cognitive flexibility (15). In the high-risk operating room environment, if operating room nurses experience prolonged high levels of perceived stress, it may compromise their executive function, directly threatening perioperative nursing quality and patient safety.

Therefore, we proposed the following hypotheses:

H1

Perceived stress is significantly negatively correlated with executive function.

H1a

The higher the level of perceived helplessness, the lower the executive function level.

H1b

The higher the perceived self-efficacy, the higher the executive function level.

Emotion Regulation Process Theory: The Relationship Between Emotion Regulation and Executive Functions

Professor Gross's (16) emotion regulation process model delineates the emotion generation process into five stages: situation selection, situation modification, attentional deployment, cognitive change, and response modulation. Based on this model, emotion regulation strategies are categorized into two primary dimensions: cognitive reappraisal and expressive suppression (16), which form the basis of the Emotion Regulation Questionnaire (ERQ). Cognitive reappraisal effectively reduces the subjective experience and physiological arousal of negative emotions by altering the emotional experience at its

source. In contrast, expressive suppression involves the conscious inhibition of external emotional expression, thereby consuming substantial cognitive resources.

Empirical studies have demonstrated that emotion regulation exerts a protective effect on cognitive function (17). Cognitive reappraisal enhances task-switching efficiency in executive function, while expressive suppression impairs control performance in executive function(18), further confirming the association between emotion regulation and executive function. Neuroscientific research indicates that both cognitive reappraisal and expressive suppression modulate brain networks closely linked to the prefrontal cortex(19), which serves as the core neural foundation for executive function, suggesting a substantial overlap in the neurofunctional mechanisms between emotion regulation and executive function. In the high-pressure, high-risk operating room environment, the emotion regulation strategies preferred or habitually employed by operating room nurses may influence their executive function by affecting prefrontal resource allocation.

Therefore, we hypothesize:

H2a

Cognitive reappraisal can positively predict executive function.

H2b

Expressive suppression can negatively predict executive function.

The Mediating Effect of Emotion Regulation on the Perceived Stress and Executive Function

Stress response, emotion regulation, and executive function are all associated with brain networks in the prefrontal cortex from a neuroscience perspective, thus there may be potential interrelationships among this three. Research has demonstrated that perceived stress can influence cognition through emotions(20). Cognitive reappraisal can prevent stress-related cognitive decline. It has indicated that cognitive reappraisal may regulate the negative relationship between stress and executive function to some extent. On the other hand, expressive suppression may further strengthen the association between stress and memory decline, and could even mediate or amplify the relationship between stress and cognitive impairment (21). In the demanding and multitasking environment of the operating room, nurses face quite a lot pressure. There are currently no report on whether expressive suppression mediates the relationship between perceived stress and executive function. Moreover, expressive suppression magnifies the adverse impact of stress on executive function could further affect surgical quality and patient safety.

Based on the preceding rationale, the following hypotheses are proposed:

H3a

Expressive suppression may play a mediating role between perceived stress and executive function.

H3b

Cognitive reappraisal may play a mediating role between perceived stress and executive function.

The Prefrontal Cortex Vulnerability Hypothesis: The Relationship Between Sleep Quality and Executive Function

The prefrontal cortex vulnerability hypothesis is a concept gradually summarized and derived from a series of research evidences in the scientific community(22). It posits that the prefrontal cortex (PFC) is more sensitive and vulnerable to sleep deprivation, poor sleep quality, or insufficient sleep duration(23). Sleep deprivation impairs the maintenance of synaptic plasticity, reduces cerebrospinal fluid (CSF) flow, which in turn affects the brain's waste clearance system, while also triggering inflammatory factors that disrupt neuronal signaling(24).

Among the nursing population, issues such as frequent night shifts, irregular schedules, and insufficient sleep duration are prevalent, as evidenced by previous studies (4). Declined sleep quality are closely associated with impaired concentration, reduced alertness, and increased medical errors (25, 26). Furthermore, perceived stress has been found to be significantly correlated with sleep quality, it is that higher stress levels linked to poorer sleep quality(27). This indicates that perceived stress has a negative influence on sleep quality. Additional research suggests that sleep affects nurses' executive function(28, 29). However, whether it plays a mediating role between perceived stress and executive function in operating room nurses remains unclear.

Therefore, we proposed the following hypotheses:

H4a

Sleep quality can positively predict executive function.

H4b

Sleep quality may play a mediating role between perceived stress and executive function.

In summary, the prefrontal cortex vulnerability hypothesis shows that in the high-pressure operating room, long-term perceived stress, poor sleep quality, and weak emotional regulation all harm the prefrontal cortex structure and function. This weakens executive function in operating room nurses. This study uses stress cognitive appraisal theory and emotional regulation process theory to build a structural equation model of stress-emotion-sleep-executive function for operating room nurses. The goal is to show the psychological reasons for executive function problems in high-pressure nursing. This

gives theory and advice for interventions in stress management, emotional regulation, and sleep improvement. These steps can improve cognitive function in operating room nurses and the quality of perioperative nursing care.

Methods

Study design and sample size

This study looked at nurses at one point in time. We asked operating room nurses who had worked for at least one year. This meant they knew their job and had experience. We did not include nurses who were pregnant during the study or who had health problems that stopped them from filling out the survey.

We asked nurses to join using a simple method. We used both online and paper surveys. We gave out 230 surveys. Some people did not participate or their answers had big mistakes or missing parts. We kept 216 good surveys. This means 93.9% of the surveys

we could use were completed well. Sample size estimation was conducted using G*Power 3.1. With a medium effect size ($f = 0.15$), a significance level of $\alpha = 0.05$, and a desired statistical power of $1 - \beta = 0.95$, assuming 15 predictors, the minimum required sample size was approximately 199 cases. The actual sample size of 216 meets the statistical requirements and provides adequate analytic power.

Study instruments

General information questionnaire

Demographic characteristics collected included age, gender, professional title, marital status, educational level, position, daily working hours, years of work experience, average number of night shifts per month, exercise habits, and consumption of coffee or other energy drinks.

Dysexecutive Questionnaire (DEX)

The **Dysexecutive Questionnaire (DEX)** was originally developed by Wilson et al. in 1996 and subsequently adapted and validated for the Chinese population by Chen Chuqiao et al.(30). It is used to assess the severity of executive function impairment. The scale comprises **20 items** distributed across **five domains**: Inhibition, Intentionality, Knowing–Doing Dissociation, Resistance, and Social Regulation. Each item is rated on a **5-point Likert scale** (0 = "Never" to 4 = "Frequently"). Higher scores indicate a greater degree of executive function impairment. Previous studies have demonstrated that the Chinese version of this scale exhibits high reliability and good structural validity in healthy populations (31).

Perceived Stress Scale (PSS-10)

The **Perceived Stress Scale (PSS-10)** was developed by Cohen et al. in 1983(13) to evaluate the level of subjective stress experienced by individuals over a specific period. The Chinese version of the PSS-10 was translated and revised by Zhen Wang et al(14), and studies have confirmed its good reliability and validity for use in Chinese populations. This scale consists of **10 items** and measures two dimensions: perceived helplessness (6 items) and perceived self-efficacy (4 items, reverse-scored). Responses are rated on a **5-point Likert scale** (0 = "Never" to 4 = "Always"). Previous research has applied the PSS-10 to Chinese nurse populations, demonstrating high internal consistency(32).

Emotional Regulation Questionnaire (ERQ)

The Emotional Regulation Questionnaire (ERQ) was developed by Gross and John(33). It assesses individuals' tendencies to use two core emotion regulation strategies in daily life: Cognitive Reappraisal and Expressive Suppression. This validated version comprises 10 items covering two dimensions: Cognitive Reappraisal (6 items) and Expressive Suppression (4 items, reverse-scored). Each item is rated on a 7-point Likert scale (1 = "Not at all" to 7 = "Completely"). The scores for items within each subscale are summed. Higher scores indicate a greater tendency to use the corresponding emotion regulation strategy. The questionnaire has been applied to nurses, with findings indicating good internal consistency and applicability in this population(34).

Pittsburgh Sleep Quality Index (PSQI)

The **Pittsburgh Sleep Quality Index (PSQI)** was developed by Buysse et al. in 1989(35). It is used to evaluate subjective sleep quality and sleep disorders over the past month. The scale consists of **19 self-rated items** and **5 companion/bed partner observation items** (only the first 19 items are used for scoring). It covers **seven components**: Subjective Sleep Quality, Sleep Latency, Sleep Duration, Sleep Efficiency, Sleep Disturbances, Use of Sleep Medications, and Daytime Dysfunction. Each component is scored on a 0–3 scale, with higher scores indicating more severe sleep problems. The sum of the scores for these seven components constitutes the total score (0–21 points). A total score of **> 5** is generally considered indicative of poor sleep quality. Previous studies have validated the PSQI in nursing populations, demonstrating good internal consistency and applicability(36).

Statistical Analysis

Data analysis and model construction were performed using **IBM SPSS V20.0** and **IBM SPSS AMOS V29.0**. **Harman's single-factor test** was employed to assess potential common method bias (CMB). Descriptive statistics were calculated for the participants' general information and the scores of the DEX, PSS, ERQ, and PSQI. Continuous variables were presented as mean $\pm$ standard deviation ($M \pm SD$), and categorical variables were presented as frequencies and percentages. **One-way Analysis of Variance (ANOVA)** was used to compare differences in executive function among groups with different demographic characteristics. **Spearman correlation analysis** was conducted to examine the relationships between perceived stress (PSS), emotion regulation (ERQ), sleep quality (PSQI), and executive function (DEX). Subsequently, a **multiple linear regression analysis** was performed with the total DEX score as the dependent variable to explore the influencing factors of executive function.

In the theoretical model testing phase, we used Structural Equation Modeling (SEM) to analyze and check the causal paths among the main latent variables(37). The model path coefficients came from the Maximum Likelihood (ML) estimation method. To check model robustness, we used a Bootstrap method with 5000 resamples.

Results

Common Method Bias (CMB)

We checked for a problem called common method bias in our survey answers. We did a test called Harman's single-factor test. The test found 12 main groups of answers (factors) with a certain level of importance. The biggest group (first factor) explained only 26.28% of the answers. This is less than the 40% we look for. This means the answers are explained by many different things, not just one main idea. So, there was no big problem with common method bias in this study.

Demographic Characteristics

We studied 216 operating room nurses. Basic details of the participants are in Table 1. Most were women (83.33%), and a few were men (16.67%). Many nurses were 31–40 years old (48.61%), and others were 26–30 years old (27.31%). Most nurses were married (75.93%). Almost all had a college degree (90.28%). About half were Head Nurses (50.46%), and many were Registered Nurses (37.50%). Few were just Nurses (5.56%). Most nurses had 5–10 years of work experience (55.09%). More than 10 years of experience was seen in 31.48%. Most were staff nurses (74.54%). Some were team leaders (17.13%), and a few were nurse managers (8.33%). About half of the nurses exercised sometimes (64.81%). A smaller group exercised often (14.35%), and few exercised every day (5.09%). Many nurses drank coffee or energy drinks sometimes (53.70%). Some drank them often (24.54%), and a few drank them daily (11.57%). Most nurses worked over 8 hours a day (65.28%). On average, they had about 2.88 night shifts each month.

Table 1
Demographic characteristics (N = 216)

Variables	n(%)	Variables	n(%)	Mean $\pm$ SD
Gender		Professional title		
Male	36 (16.67%)	Nurse	12 (5.56%)	
Female	180 (83.33%)	Registered nurse	81 (37.50%)	
Age(years)		Head nurse	109 (50.46%)	
18–25	19 (8.80%)	Associate chief nurse	12 (5.56%)	
26–30	59 (27.31%)	Chief nurse	2 (0.93%)	
31–40	105 (48.61%)	Exercise habits		
41–50	28 (12.96%)	Never	34 (15.74%)	
> 50	5 (2.31%)	Occasionally	140 (64.81%)	
Education level		Frequently	31 (14.35%)	
Bachelor's degree	195 (90.28%)	Daily	11 (5.09%)	
Master's degree	3 (1.39%)	Working hours(h/d)		
Associate degree	18 (8.33%)	≤ 8	75 (34.72%)	
Marital status		>8	141 (65.28%)	
Married	164 (75.93%)	Intake of coffee and other energy drinks		
Unmarried	49 (22.69%)	Never	22 (10.19%)	
Divorced	3 (1.39%)	Occasionally	116 (53.70%)	
Work experience (years)		Frequently	53 (24.54%)	
<5	29 (13.43%)	Daily	25 (11.57%)	
5–10	119 (55.09%)	Night shifts (times/month)		2.88 $\pm$ 2.65
>10	68 (31.48%)			

Variables	n(%)	Variables	n(%)	Mean ± SD
Gender		Professional title		
Roles				
Staff nurse	161 (74.54%)			
Team leader	37 (17.13%)			
Nurse manager	18 (8.33%)			
Data are presented as n (%) or mean ± SD.				

Reliability Analysis of Scales

Table 2 shows that all scales have good internal consistency. Cronbach's alpha values range from 0.816 to 0.962. This shows high reliability. The Perceived Stress Scale (PSS) and the Emotion Regulation Questionnaire (ERQ) subscales have good internal consistency. Their alpha values are between 0.755 and 0.928. The Dysexecutive Questionnaire (DEX) has excellent overall reliability ($\alpha = 0.962$). Its subscales have alpha values between 0.663 and 0.896. The Pittsburgh Sleep Quality Index (PSQI) has good reliability ($\alpha = 0.826$). These results show that all scales in this study have good measurement consistency in the sample.

Table 2
Reliability (Cronbach's) of the study instruments

α			
Scales	Subscales	Cronbach's α	Items (n)
PSS	Total scale	0.816	10
	Perceived helplessness	0.894	6
	Perceived self-efficacy	0.817	4
ERQ	Total scale	0.865	10
	Cognitive Reappraisal	0.928	6
	Expressive Suppression	0.755	4
PSQI	Total scale	0.826	18
DEX	Total scale	0.962	20
	Inhibition	0.896	5
	Intentionality	0.824	4
	Knowing–Doing Dissociation	0.838	4
	Resistance	0.794	3
	Social Regulation	0.663	2

Note. All Cronbach's α coefficients were greater than 0.70, indicating acceptable to excellent internal consistency reliability across all scales and subscales used in this study.

Table 3 shows that all scales have good construct validity. The Kaiser–Meyer–Olkin (KMO) values range from 0.851 to 0.961. Bartlett's test of sphericity is statistically significant ($p < 0.001$). This shows suitability for factor analysis. The extracted factors explain 62.24% to 68% of the variance. This means the factor structure matches the theoretical dimensions well. The Confirmatory Factor Analysis (CFA) results show good convergent validity and discriminant validity for all latent variables. Factor loadings are significant and meet statistical requirements. Specific results are in Additional Tables 1–3.

Table 3
Construct validity results of study instruments (Exploratory Factor Analysis)

Scales	KMO	Bartlett's χ^2	Df	p	Number of extracted factors	Cumulative variance explained (%)
Perceived Stress Scale (PSS)	0.832	1058.273	45	***	2	65.700
Emotion Regulation Questionnaire (ERQ)	0.881	1237.344	45	***	2	68.000
Pittsburgh Sleep Quality Index (PSQI)	0.851	1355.215	153	***	7	62.240
Dysexecutive Questionnaire (DEX)	0.961	3265.635	190	***	5	64.200
Note. KMO > 0.70 and p < 0.001 indicate an adequate sample and suitability for factor analysis.***p < 0.001.						

Descriptive Statistics of Scale Scores

The total score for the Pittsburgh Sleep Quality Index (PSQI) was 6.16 ± 3.50 , indicating an overall low quality of sleep. (The sleep efficiency item, with a constant score of 0.00 ± 0.00 , was excluded from the analysis). The total score for the Perceived Stress Scale (PSS) was 15.87 ± 5.74 . The total score for the Emotion Regulation Questionnaire (ERQ) was 44.39 ± 10.00 . The total score for the Dysexecutive Questionnaire (DEX) was 23.99 ± 14.27 . Scores for individual dimensions of each scale are presented in Table 4.

Table 4

Levels of sleep quality, perceived stress, emotion regulation, and executive dysfunction among operating room nurses (n = 216)

Variables	Mean $\pm$ SD	Score range
PSQI	6.16 $\pm$ 3.5	0–17
Daytime dysfunction	1.50 $\pm$ 1.01	0–3
Sleep latency	1.31 $\pm$ 0.81	0–3
Subjective sleep quality	1.27 $\pm$ 1.04	0–3
Sleep disturbance	1.13 $\pm$ 0.6	0–3
Sleep duration	0.71 $\pm$ 0.77	0–3
Use of sleeping medication	0.25 $\pm$ 0.7	0–3
Sleep efficiency	0 $\pm$ 0	0
PSS	15.87 $\pm$ 5.74	0–33
Perceived helplessness	8.79 $\pm$ 4.32	0–24
Perceived self-efficacy	7.17 $\pm$ 3.22	0–16
ERQ	44.39 $\pm$ 10	10–70
Cognitive Reappraisal	29.34 $\pm$ 7.38	6–42
Expressive Suppression	15.05 $\pm$ 4.76	4–28
DEX	23.99 $\pm$ 14.27	0–80
Inhibition	5.72 $\pm$ 3.94	0–20
Intentionality	5.42 $\pm$ 2.94	0–16
Knowing–Doing Dissociation	4.16 $\pm$ 3.23	0–16
Resistance	3.82 $\pm$ 2.4	0–12
Social Regulation	2.44 $\pm$ 1.57	0–8
Data are presented as mean $\pm$ standard deviation (SD). PSQI: Pittsburgh Sleep Quality Index; PSS: Perceived Stress Scale; ERQ: Emotion Regulation Questionnaire; DEX: Dysexecutive Questionnaire.		

Differences in Executive Function Across Demographic Characteristics

A comparison of the total scores for executive dysfunction among 216 operating room nurses across various demographic characteristics revealed no statistically significant differences based on gender, age, education level, marital status, years of work experience, professional title, position, working hours,

exercise habits, or consumption of beverages such as coffee (all $P > 0.05$). Detailed results are provided in Appendix Table 4. Overall, the degree of executive dysfunction among operating room nurses showed minimal variation across general demographic and occupational characteristics.

Correlation Analysis

Spearman correlation analysis, illustrated in Fig. 1, revealed significant correlations between Dysexecutive Questionnaire (DEX) and several variables among operating room nurses. The DEX scores were significantly positively correlated with overall sleep quality (PSQI) and its sub-dimensions, with the exception of sleep efficiency (all $P < 0.05$). Significant positive correlations were found between DEX and perceived stress (PSS) and its sub-dimension of perceived helplessness, while a weak positive correlation was observed with perceived self-efficacy (all $P < 0.01$). In terms of emotion regulation, the total ERQ score did not show a significant correlation with DEX. However, the cognitive reappraisal sub-dimension was significantly negatively correlated with DEX ($P < 0.01$), whereas the expressive suppression sub-dimension was significantly positively correlated with DEX ($P < 0.01$). These findings suggest that executive dysfunction in operating room nurses is closely related to sleep quality and stress levels. Furthermore, effective cognitive reappraisal may potentially mitigate executive function impairment. More detailed results are presented in Appendix Table 5.

Table 5
Standardized path coefficients and significance of the structural equation model (SEM)

Path			Estimate	S.E.	C.R.	P
WE2	<---	PSS1	0.419	0.155	5.047	***
WE1	<---	PSS1	0.084	0.118	1.375	0.169
MPSQI	<---	PSS1	0.554	0.11	6.815	***
WE1	<---	PSS2	-0.714	0.188	-7.526	***
MPSQI	<---	PSS2	0.109	0.099	1.512	0.13
WE2	<---	PSS2	-0.407	0.169	-4.587	***
YDEX	<---	WE2	0.304	0.253	3.695	***
YDEX	<---	MPSQI	0.045	0.34	0.559	0.576
YDEX	<---	WE1	-0.149	0.269	-1.628	0.104
YDEX	<---	PSS1	0.458	0.525	4.982	***
YDEX	<---	PSS2	-0.062	0.624	-0.585	0.558

Note. PSS1 = Perceived helplessness; PSS2 = Perceived self-efficacy; WE1 = Cognitive reappraisal; WE2 = Expressive suppression; MPSQI = Subjective sleep quality; YDEX = Executive dysfunction. *** $p < 0.001$.

Figure 1. Heatmap representing Pearson correlation coefficients among Dysexecutive Questionnaire (DEX), Pittsburgh Sleep Quality Index (PSQI), Perceived Stress Scale (PSS), and Emotion Regulation Questionnaire (ERQ) and their subdimensions among operating room nurses (n = 216). Red indicates positive correlations and blue indicates negative correlations; deeper color represents stronger correlation magnitude ($|r| \leq 1$).

Structural Equation Modeling Results

Figure 2 illustrates the structural model depicting the relationships between perceived stress, emotion regulation, sleep quality, and executive function among operating room nurses. Table 4 presents the path coefficients and their significance. The model demonstrated good fit to the data ($\chi^2/df = 1.728$, CFI = 0.936, TLI = 0.929, RMSEA = 0.058), with detailed results provided in Appendix Table 6. This indicates a high degree of consistency between the theoretical model and the observed data.

Table 6
Summary of Hypotheses

Hypothesis	Result
H1: Perceived stress is significantly negatively correlated with executive function.	True
H1a: The higher the level of perceived helplessness, the lower the executive function level.	True
H1b: The higher the perceived self-efficacy, the higher the executive function level.	False
H2a: Cognitive reappraisal can positively predict executive function.	False
H2b: Expressive suppression can negatively predict executive function.	True
H3a: Expressive suppression may play a mediating role between perceived stress and executive function.	True
H3b: Cognitive reappraisal may play a mediating role between perceived stress and executive function.	False
H4a: Sleep quality can positively predict executive function.	False
H4b: Sleep quality may play a mediating role between perceived stress and executive function.	False

Table 5 shows that perceived helplessness (PSS1) has a significant positive effect on expressive suppression (WE2) ($\beta = 0.419$, $p < 0.001$). Perceived self-efficacy (PSS2) has a significant negative effect on cognitive reappraisal (WE1) ($\beta = -0.714$, $p < 0.001$) and expressive suppression (WE2) ($\beta = -0.407$, $p < 0.001$). Nurses with higher self-efficacy use positive emotion regulation strategies more. In the sleep quality model, perceived helplessness (PSS1) predicts Pittsburgh Sleep Quality Index (MPSQI) ($\beta = 0.554$, $p < 0.001$). Higher stress links to poorer sleep quality. The path from self-efficacy (PSS2) to MPSQI is not significant ($p > 0.05$). For Dysexecutive Questionnaire (YDEX), expressive suppression (WE2) ($\beta = 0.304$, $p < 0.001$) and perceived helplessness (PSS1) ($\beta = 0.458$, $p < 0.001$) are significant positive predictors. Stress and negative emotion regulation strategies both cause executive function problems. The paths

from MPSQI, WE1, and PSS2 to YDEX are not significant. The model shows that perceived helplessness in operating room nurses directly affects executive dysfunction. It also indirectly affects cognitive performance through negative emotion regulation strategies like expressive suppression.

Figure 2. Circles represent latent variables (PSS1, PSS2, WE1, WE2, MPSQI, and YDEX, which correspond to perceived helplessness, perceived self-efficacy, cognitive reappraisal, expressive suppression, Pittsburgh Sleep Quality Index, and Dysexecutive Questionnaire, respectively). Rectangles represent observed variables. The numbers on the arrows indicate standardized path coefficients; double-headed arrows represent correlations between latent variables, and single-headed arrows indicate causal paths. All path coefficients are standardized estimates.

Hypotheses & Results

Table 6 shows a list of hypotheses (H1, H1a, H1b, H2a, H2b, H3a, H3b, H4a, H4b). It also shows if the data or analysis supported each hypothesis (True) or not (False)

Discussion

This study examined the relationships among perceived stress, emotion regulation, sleep quality, and executive function. It used a structural equation model. The model fits well. Several research hypotheses are supported. The findings show some useful implications.

Perceived Helplessness in Operating Room Nurses Increases Expressive Suppression but Has Little Effect on Cognitive Reappraisal

Our findings show a strong positive link between perceived helplessness and expressive suppression. The link to cognitive reappraisal is not significant. OR nurses who feel more "uncontrollable and unmanageable" stress use expressive suppression more as an emotion regulation strategy. They use re-evaluating the situation less. OR nurses tend to choose expressive suppression under high pressure.

Consistent with previous research (38, 39), this finding implies that when OR nurses perceive greater stress, they tend to adopt relatively passive and defensive emotion regulation approaches like expressive suppression, rather than more active and constructive cognitive reappraisal. This inclination is a significant contributor to the increased psychological health risks among nurses (40). We were surprised to find that perceived self-efficacy was significantly negatively correlated with both cognitive reappraisal and expressive suppression. This suggests that as nurses possess a greater capacity to cope with stress, their overall emotion regulation ability is enhanced. This outcome aligns with some existing research that posits a positive correlation between high self-efficacy and cognitive reappraisal (41). Operating room nurses with higher self-efficacy believe in their ability to handle various challenges and exhibit more proactive behavioral orientations when facing stress, thereby making them more likely to favor positive emotion regulation strategies (cognitive reappraisal) over negative ones (expressive suppression).

Perceived Helplessness in Operating Room Nurses Affects Sleep Quality

In the relationship between perceived stress and sleep, this study found a strong positive effect of perceived stress on the PSQI score. Higher levels of perceived stress link to poorer sleep quality. This finding matches a large body of research on the link between stress and sleep problems (27, 42). But perceived self-efficacy showed strong correlations. Its direct effect on sleep quality was not strong. This means that in the operating room (OR) nurse group, sleep quality comes mainly from perceived stress.

Objective factors like irregular working hours, shift work, heavy workloads, and night duty for nursing staff may cause sleep quality issues in nurses (42). This seems different from our results. Our findings show that OR nurses all have sleep quality problems. But these problems do not link directly to night duty. Still, the hard environment and work needs in the operating room cause strong work-related stress for OR nursing staff(2, 39). This high stress then worsens sleep problems among OR nurses(2, 27). It also raises the risk of decision-making errors

Perceived helplessness among operating room nurses may diminish executive function and, by amplifying expressive suppression, further impair executive function

In terms of executive function, this study found a significant positive association between perceived helplessness and executive dysfunction, such that stronger perceived helplessness corresponded to more pronounced impairments in executive function. This suggests that operating room nurses experience relatively high levels of stress, and high stress can compromise executive function, thereby affecting work quality and surgical safety. In this study, perceived self-efficacy showed a significant negative correlation with executive function, but the direct path within the model was not significant, indicating that among the two dimensions of perceived stress, the helplessness dimension is the key factor contributing to reduced executive function. Regarding emotional regulation, expressive suppression had a significant positive effect on executive dysfunction, meaning that greater suppression of emotion was associated with more pronounced executive function problems; the direction of the effect for cognitive reappraisal was negative but did not reach statistical significance. This finding is partly consistent with prior literature(43), suggesting that expressive suppression requires continued expenditure of self-control resources after emotional experience to inhibit outward emotional responses; long-term use may increase cognitive load and impair executive control. These results imply that when faced with stress, operating room nurses are more likely to interpret the current situation negatively(14), thereby tending to employ suppression as an emotion regulation strategy(40), which in turn further negatively impacts executive function.

However, this study did not find a significant mediating effect of sleep quality on the relationship between stress and executive function; that is, the pathway from sleep quality to executive function was not statistically significant. This finding is inconsistent with some prior studies that have suggested an interactive relationship between sleep and executive function(36, 44), or that sleep can modulate the

negative impact of stress on executive function (45). Correlation analyses in this study showed moderate associations between overall PSQI scores (and all but sleep efficiency) and executive function. Yet, in the structural equation model, the use of the overall sleep quality score attenuated this effect, implying that the contributions of stress and emotional regulation to explaining executive function may be more critical. Another possible explanation is that the total PSQI score lacks the sensitivity and specificity of its individual components, making it difficult to distinguish differential effects of distinct sleep dimensions on cognition. Moreover, our measure of executive function primarily assessed subjective everyday functioning, which may differ in sensitivity from objective neuropsychological tests, potentially attenuating sleep's apparent effect. Additionally, this SEM only considered sleep quality as a mediator and did not examine potential moderating effects of sleep quality; it is also possible that stress mediates the impact of sleep on executive function.

Limitations and Recommendations for Further Research and Practice

This study has several limitations. First, the cross-sectional design relied entirely on self-report questionnaires for all variables, which may introduce subjective bias and prevents causal inferences. Future research could employ longitudinal cohort or intervention designs, incorporate objective sleep monitoring as well as assessments of executive function and emotion, and thereby further validate the causal pathways among stress, emotion regulation, and executive function. Second, the sample was limited to operating room nurses from a single region; cultural background and institutional contexts may restrict the generalizability of the findings. Subsequent studies should replicate the work in diverse regions and across hospitals of different levels. Nevertheless, this study, by using structural equation modeling within the same framework, jointly examined the relationships among two dimensions of perceived stress, two emotion regulation strategies, sleep quality, and executive function, providing new evidence for understanding how nurses perform executive functions under high-stress conditions. Future research could build on these results by designing integrated interventions aimed at reducing perceived stress and expressive suppression, with the goal of improving nurses' executive function and thereby enhancing nursing quality and patient safety.

Conclusion

In summary, this study yields the following main findings:

First, perceived stress among operating room (OR) nurses plays a more central role in sleep problems and executive function impairment than perceived self-efficacy. This means nursing managers should focus on reducing nurses' helplessness. They can use crisis intervention, psychological support, and resource allocation to address stress. They should not only emphasize building self-efficacy(46).

Second, the OR environment links closely to expressive suppression and executive function dysfunction. This shows that suppressing emotional expression may cause cognitive weariness and worsen executive function. Nurse managers should create ways for nurses to express stress and negative

emotions in daily management. They should also use cognitive-behavioral and mindfulness-based training to reduce emotional suppression(47, 48).

Third, these findings show that when evaluating sleep and executive function among OR nursing staff, assessments should go beyond objective workload. They should also check subjective stress experiences and emotion regulation patterns. This helps build a more complete occupational health intervention framework.

Abbreviations

PSS

Perceived Stress Scale

PSS1

perceived self-efficacy

PSS2

perceived helplessness

ERQ

Emotion Regulation Questionnaire

E1

cognitive reappraisal

E2

expressive suppression

WE1

cognitive reappraisal

WE2

expressive suppression

PSQI

Pittsburgh Sleep Quality Index

MPSQI

Pittsburgh Sleep Quality Index

DEX

Dysexecutive Questionnaire

YDEX

Dysexecutive Questionnaire

Declarations

Ethics approval and consent to participate

This study was designed as a **non-clinical, cross-sectional investigation** with no anticipated physical or psychological risks. The study was designed and conducted in full compliance with the principles of the

Declaration of Helsinki. Prior to completing the questionnaires, participants were fully informed about the significance and objectives of the study. They were also informed of their right to withdraw at any time during the questionnaire completion process. Strict confidentiality principles were followed, ensuring that all participant information was kept secret, and the collected data were used solely for this research. Every participant signed the consent. This study was approved by the Ethics Committee of the First Affiliated Hospital of Army Medical University, with the ethics approval number A KY2026013.

Consent for publication

All authors agree to publication. All participants have provided informed consent for the publication of any images or other personal details that may affect their anonymity.

Availability of data and materials

All data and materials supporting the findings of this study are available from the corresponding author upon reasonable request.

Competing Interests

There is no competing interests as defined by BMC, or other interests that might be perceived to influence the results and/or discussion reported in this paper.

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Authors' contributions

Q.L and L.Z wrote the main manuscript text, M.K, S.L, C.H, S.Y prepared table 1-4, Q.L, W.Z, Z.Z prepared the rest table. All authors reviewed the manuscript.

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Figures

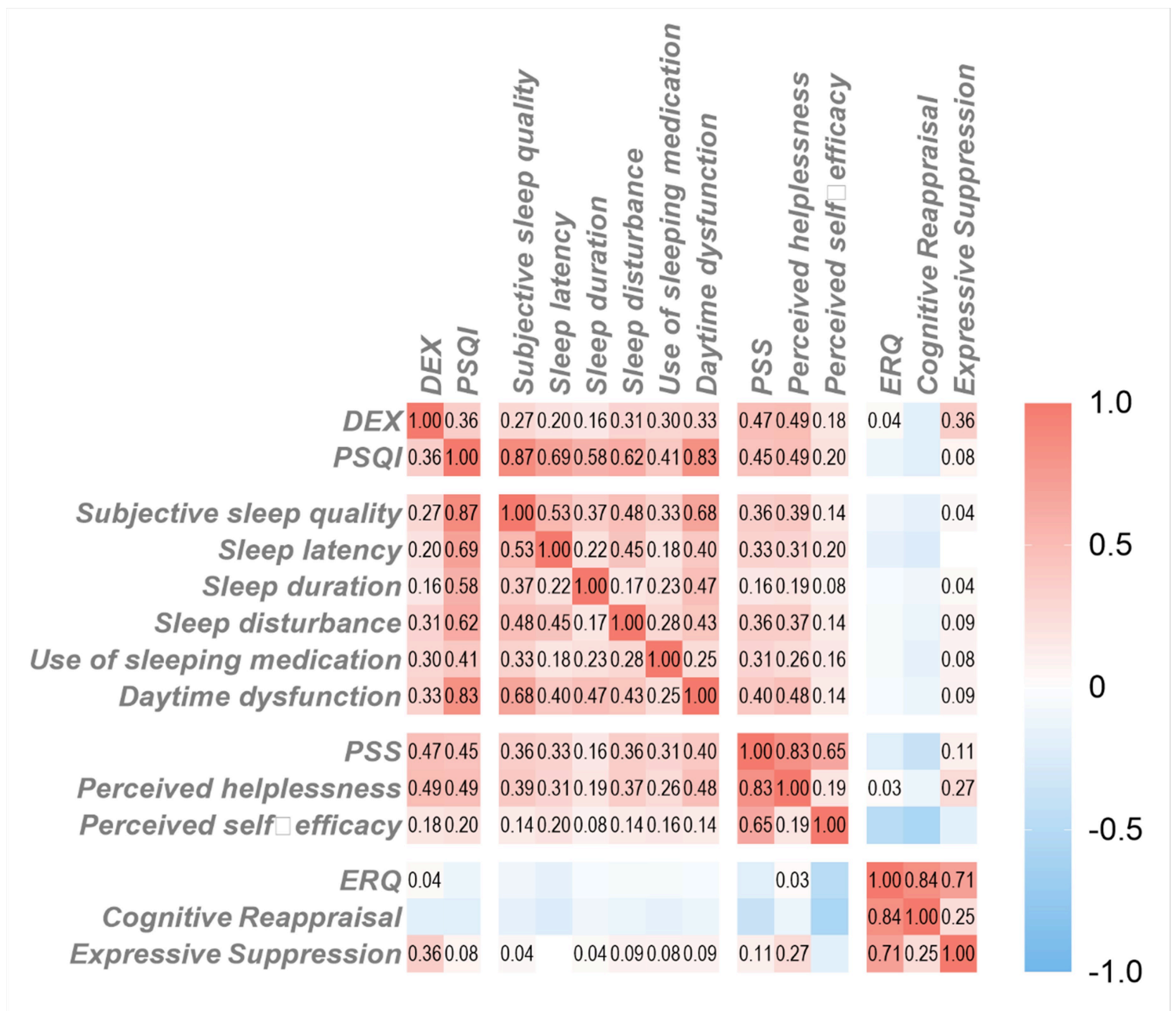


Figure 1

Heatmap representing Pearson correlation coefficients

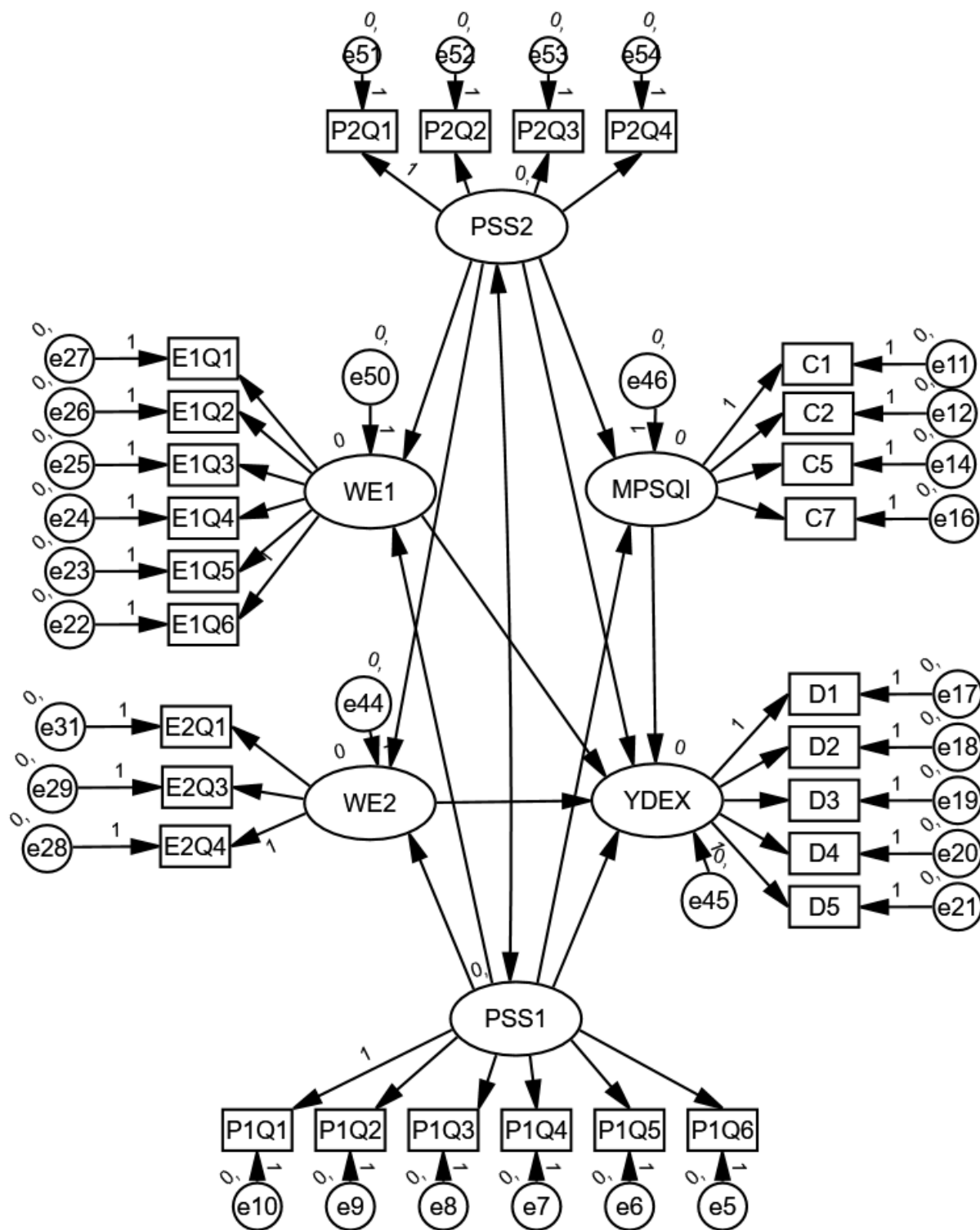


Figure 2

Structural Equation Model (SEM) of the relationships among variables.

Supplementary Files

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