

Predictors of Sleep Quality in Patients Undergoing Open-Heart Surgery: A Hierarchical Regression Analysis

A Short Running Title: Predictors of sleep after open-heart surgery

Ezgi ARSLAN

e.temel@adu.edu.tr

Adnan Menderes University

Zehra BALCIK

Aydın Adnan Menderes Üniversitesi Uygulama ve Araştırma Hastanesi

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Abstract

Background

Sleep quality is a complex and multidimensional phenomenon shaped by the interaction among patient-related characteristics, symptom burden, and environmental factors specific to intensive care unit (ICU) settings. Despite the multidimensional nature of sleep quality, few studies have identified its predictors in ICUs following cardiac surgery.

Objective

This study aimed to examine the predictors of sleep quality in patients who had undergone open-heart surgery and were hospitalized in a cardiovascular surgery ICU.

Materials and Methods

This is a single-center, descriptive, correlational study. Data were collected using the Patient Information Form, the Intensive Care Unit Environmental Stressors Scale (ICUESS), the visual analog scale for pain and fatigue, and the Richards–Campbell Sleep Questionnaire. The data were analyzed using descriptive statistics, Pearson correlation analysis, and hierarchical multiple regression analysis.

Results

The study included 157 patients, 65.6% of whom were male. The mean scores for the patients were 3.36 ± 3.01 for pain, 4.08 ± 3.07 for fatigue, 66.73 ± 20.91 for ICUESS, and 44.67 ± 28.24 for sleep quality. Sleep quality was positively correlated with age ($p = 0.001$) and negatively correlated with pain, fatigue, and environmental stress factors ($p < 0.001$). Hierarchical regression analysis showed that age and body mass index explained 8.5% of the variance in sleep quality, but medical diagnosis and length of stay in the ICU did not contribute significantly to the model. The inclusion of pain, fatigue, and ICU environmental stressors increased the explained variance to 35.1%.

Conclusions

Sleep quality of patients in ICUs following open-heart surgery was governed more by environmental stressors and symptom burden than by demographic and clinical characteristics. Pain, fatigue, and ICU environmental stressors were identified as the strongest predictors of sleep quality, highlighting the need to focus on these factors in nursing care.

Impacts

What is known about the topic

- Sleep quality is frequently impaired after open-heart surgery because of postoperative symptoms and the intensive care environment.
- Environmental stressors and symptom burden are recognized contributors to poor sleep in critically ill patients.

What this paper adds

- Perceived environmental stressors, pain, fatigue, and age independently predicted sleep quality in patients after open-heart surgery.
- Modifiable nursing-sensitive factors explained more variation in sleep quality than demographic and clinical characteristics.
- Improving symptom management and reducing environmental stressors may represent practical strategies for enhancing sleep quality in cardiovascular intensive care units.

1. Introduction

Sleep is a key biological process required for maintaining physiological homeostasis, supporting immune function, and promoting recovery (McCarter et al., 2022; Nelson et al., 2021). Sleep quality, on the contrary, is a multidimensional structure influenced by both individual characteristics, such as age and body mass index (BMI), and psychological factors, such as stress and anxiety, and environmental factors, such as noise, light, lack of privacy, and care practices (Bülbül et al., 2023; Chattu et al., 2019; Jaradat et al., 2019; Koyuncu et al., 2021; Rahimi et al., 2022). Patients in intensive care units (ICUs) often experience poor sleep quality, characterized by a reduction in sleep duration, fragmented sleep, prolongation of sleep onset, and frequent awakenings (Lkoul et al., 2025; Nelson et al., 2022; Şen & Özer, 2024). Poor sleep quality in ICUs leads to a higher incidence of delirium and atrial fibrillation in patients during the postoperative period, delays in recovery, adverse effects on immune function, and longer stays in ICUs (Kulpatcharapong et al., 2020; Şen & Özer, 2024).

Open-heart surgeries are frequently performed procedures for ischemic and nonischemic heart diseases (e.g., valvular diseases, aortic stenosis, and atrial septal defects) requiring close postoperative monitoring of patients in an ICU setting (Bitargil et al., 2020; Hauge et al., 2021; Sawadogo et al., 2025). Physiological issues such as pain, surgical wound complications, fatigue, dyspnea, and sleep disturbances (Arslan, 2021), as well as psychological issues such as anxiety, stress, and fear of death (Makino et al., 2024; Saeed Abd-el Monem et al., 2024), commonly experienced by patients in ICUs following these surgeries negatively impact sleep quality (Abbasoğlu & Demirdağ, 2024; Lin et al., 2022; Lkoul et al., 2025; Şen & Özer, 2024). Moreover, individual characteristics such as age and BMI may also influence sleep quality in this patient population (Nelson et al., 2022). Despite being one of the problems commonly reported by patients, poor sleep quality in ICUs is often not effectively managed because of its multifaceted nature (Chattu et al., 2019; Fatanah Ramlee et al., 2017; Rahimi et al., 2022; Makino et

al., 2024). Although previous studies reported that sleep disorders are common in patients in ICUs, most of these studies did not adopt a comprehensive, multifactorial approach that separately examined the variables influencing sleep quality (Koyuncu, 2021; Lin et al., 2022; Lkoul et al., 2025; Şen & Özer, 2024; Yang et al., 2024; Yildiz et al., 2021). This underscores the need for studies using multivariate analytical methods to determine independent predictors of sleep quality.

1.1. Study Aim

This study aimed to examine the predictors of sleep quality in patients who had undergone open-heart surgery and were hospitalized in a cardiovascular surgery ICU.

2. Design and Methods

This was a single-center, descriptive, and correlational study adopting a multivariate approach to achieve its purpose.

2.1. Settings and Participants

The study population comprised patients who had undergone open-heart surgery and were hospitalized in the cardiovascular surgery ICU of a university hospital in a city in western Turkey. This ICU has eight beds: seven in a common area and one separated by fixed partitions for isolated patients. The room temperature is maintained at approximately 22°C. The unit has no waiting room for family members, but chairs and seating areas for family members are available in the hallways leading to the unit. Visiting hours are from 12:30 to 13:00, and only one visitor is permitted per patient.

The inclusion criteria for the study were as follows: (a) patients who understood and spoke Turkish, (b) patients who were willing to participate in the study, (c) patients who had spent at least 24 h in the ICU, and (d) patients with the cognitive ability to understand and answer the questions. The exclusion criteria were as follows: (a) patients who had taken narcotic or sedative medications in the last 48 h, (b) patients with a history of chronic diseases causing sleep problems, such as chronic obstructive pulmonary disease or sleep apnea, (c) patients with a psychiatric disorder diagnosed by a physician, and (d) patients with visual or hearing impairment.

The sample size for the study was determined to be 129, assuming a statistical significance level of 5% (α), a statistical power of 95% ($1 - \beta$), and a medium effect size ($f^2 = 0.15$) (Cohen, 2013; Faul et al., 2007). The sample size was increased by 10%, anticipating some dropouts during the study. Thus, 170 patients were evaluated, and finally, 157 patients were included in the study. A total of 17 patients were excluded from the study due to hemodynamic instability ($n = 5$), changes in consciousness levels ($n = 4$), refusal to participate ($n = 5$), and lack of communication ($n = 3$).

2.2. Data Collection Methods and Tools

Data were collected between September 2025 and May 2026. Eligible patients who had undergone open-heart surgery and were admitted to the cardiovascular surgery ICU were informed of the study's purpose and given the opportunity to ask questions.

Verbal informed consent to participate was obtained from all participants prior to their inclusion in the study. Then, the Patient Information Form, the Visual Analog Scale (VAS) for pain and fatigue, the Intensive Care Unit Environmental Stressors Scale (ICUESS), and the Richards–Campbell Sleep Questionnaire (RCSQ) were administered to all consenting participants.

2.2.1 Patient Information Form

The Patient Information Form was a 15-item researcher-developed instrument based on existing data (Akar et al., 2025; Elliot et al., 2013; Gencer & Kumsar, 2020; Kalemci et al., 2024). It encompassed both sociodemographic characteristics, including age, sex, marital status, and educational level, and clinical characteristics, including medical diagnosis, comorbid conditions, length of ICU stay, and medications administered. An English-language version of the Patient Information Form is provided as Supplementary File 1.

2.2.2 ICU Environmental Stressors Scale

This scale was developed by Ballard in 1981 and revised by Cochran and Ganong in 1989. The Turkish validity and reliability testing of the revised scale was conducted by Aslan and colleagues in 2011. The scale is a 4-point Likert scale comprising 42 items. The minimum and maximum possible scores are 42 and 168, respectively. Higher scores indicate a greater degree of being influenced by environmental stressors. The Cronbach's alpha coefficient was reported as 0.94 in the Turkish validation study (Çınar et al., 2011).

2.2.3 Visual Analog Scale

Pain and fatigue experienced by patients in the ICU were assessed using the VAS. This scale is a unidimensional, self-report instrument measuring 10 cm in length. The lower end corresponds to a score of 0, labeled "no pain/no fatigue," whereas the upper end corresponds to a score of 10, labeled "unbearable pain/fatigue." Higher scores on the scale indicate greater severity of pain and fatigue as reported by the patient (Cline et al., 1992).

2.2.4 Richards–Campbell Sleep Questionnaire

The scale, developed by Richards in 1987, was validated and adapted into Turkish by Özlü and Özer in 2015. The scale comprises items assessing sleep quality, nocturnal sleep depth, frequency of awakening, ambient noise level, time spent awake, and sleep onset latency. Each item is rated on a VAS ranging from 0 to 100. The total score obtained from the scale is divided by the number of items to determine the scale score. A scale score between 0 and 25 is interpreted as extremely poor sleep, whereas a score between 76 and 100 is interpreted as extremely good sleep. In the Turkish validation study, Cronbach's alpha coefficient was reported as 0.91 (Özlü & Özer, 2015).

2.3 Data Analysis

The data were analyzed using IBM SPSS Statistics 25.0 (IBM Corp., NY, USA). The participants' sociodemographic and clinical characteristics and scale scores were presented using descriptive statistics. The correlations among the independent variables were assessed using Pearson correlation analysis (Tabachnick et al., 2007). A correlation matrix was constructed to examine the possibility of multicollinearity, and the correlation coefficients between the variables were found to be below 0.70. Furthermore, the variance inflation factor (VIF) and tolerance values were examined, revealing that the assumption of multicollinearity was met (Hair et al., 2010).

A hierarchical multiple linear regression analysis was performed to determine the factors predicting sleep quality in patients who underwent open-heart surgery. The variables to be included in the regression model were selected based on not only their statistical significance but also their theoretical and clinical importance, which has been shown to be associated with sleep quality. This is because, in some cases, simple correlations between two variables may obscure a true relationship because of suppressor effects (Hair et al., 2010).

Age and BMI, representing demographic and individual characteristics, were included in Model 1 as independent variables. Length of stay in the ICU and surgical diagnosis group, representing clinical characteristics, were added to Model 2. Finally, pain intensity, fatigue level, and ICU environmental stressors score were included in Model 3. The explained variance (R^2) and the change in variance (ΔR^2) in each model were examined to evaluate the contribution of each group of variables to sleep quality. A p value < 0.05 indicated a statistically significant difference.

2.4 Ethical and Institutional Approvals

Ethical approval

was obtained from Non-Invasive Ethical Committee of the Nursing Faculty of Aydın Adnan Menderes University (Date: 30/05/2025, No: E-76261397-050.04-734105), and institutional permission was obtained from the institution where the data were collected, prior to conducting the study. This study was registered on August 5, 2026, at <https://clinicaltrials.gov/>, ID: NCT07755280). Verbal informed consent to participate was obtained from all participants prior to their inclusion in the study. Patients were informed that their participation in or withdrawal from the study would not impact their treatment or care. Identifying information such as names and surnames was not requested on the data collection forms, and all data were collected anonymously. The study was conducted in accordance with the principles of the Declaration of Helsinki.

2.5 Validity and Reliability/Rigor

The reporting of this study followed the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) checklist (Babaoğlu et al., 2021; Cuschieri, 2019). The internal consistency of

the measurement instruments was assessed using Cronbach's alpha coefficient. All scales yielded values ranging between 0.80 and 0.94, confirming acceptable reliability (Jain & Angural, 2017).

3. Results

The average age of the patients was 64.62 ± 9.28 years, and their BMI was 27.65 ± 4.22 . Of these, 65.6% were men, 87.3% were married, and 66.9% had undergone open-heart surgery due to ischemic heart disease. Moreover, 58.6% were nonsmokers, 90.4% had at least one chronic disease, and 61.8% had spent 24–48 h in the ICU (Table 1).

Table 1
Patients' sociodemographic and clinical characteristics (n = 157)

Variables	Mean $\pm$ SD (Min.; Max.)
Age (Years)	64.62 $\pm$ 9.28 (36; 87)
Body mass index (kg/m²)	27.65 $\pm$ 4.22 (18.59; 40.57)
	% (n)
Gender	34.4 (54)
Female	65.6 (103)
Male	
Marital status	87.3 (137)
Married	12.7 (20)
Single	
Place of residence	60.5 (95)
Urban	39.5 (62)
Rural	
Education level	64.3 (101)
Primary school	26.1 (41)
Secondary school	9.6 (15)
University and above	
Medical Diagnosis	66.9 (105)
Ischemic heart diseases	33.1 (52)
Non-ischemic heart diseases	
Smoking history	41.4 (65)
Yes	58.6 (92)
No	
Alcohol use history	19.7 (31)
Yes	80.3 (126)
No	
Presence of chronic disease	90.4 (142)
Avg.: Mean, SS: Standard deviation, Min.: Minimum, Max.: Maximum, n: Number, %: Percentage. *Multiple responses were given.	

Variables	Mean $\pm$ SD (Min.; Max.)
Yes	9.6 (15)
No	
Previous experience in intensive care	44.6 (70)
Yes	55.4 (87)
No	
Time elapsed since admission to intensive care	63.1 (99)
24–48 hours	36.9 (58)
48–72 hours	
Medications given in intensive care*	79 (124)
Anticoagulant	8.9 (14)
Steroid	89.2 (140)
Antibiotic	63.1 (99)
Analgesic	41.4 (65)
Beta-blocker	31.8 (50)
Antidiuretic	21.7 (34)
Antidiabetic	31.8 (50)
Antihypertensive	87.9 (138)
Proton pump inhibitors	11.5 (18)
Antiarrhythmic	
Avg.: Mean, SS: Standard deviation, Min.: Minimum, Max.: Maximum, n: Number, %: Percentage. *Multiple responses were given.	

Table 1.

Sociodemographic and Clinical Characteristics of Patients (n = 157)

Table 2 shows the results of the Pearson correlation analysis. None of the correlation coefficients exceeded 0.7. Also, significant negative correlations were found between sleep quality and ICU environmental stressors ($r = -0.442, p < 0.001$), pain level ($r = -0.406, p < 0.001$), and fatigue level ($r = -0.348, p < 0.001$). In addition, a weak positive correlation was found between age and sleep quality ($r = 0.252, p = 0.001$). No significant correlation was found between BMI and sleep quality ($p > 0.05$).

Table 2
Correlations among patients' age, BMI, pain, fatigue, ICUESS and RCSQ (n = 157)

Variables	Mean $\pm$ SD (Min.; Max.)	Yaş	BKİ	Pain	Fatigue	ICUESS	RCSQ
Age	64.62 $\pm$ 9.27 (36; 87)	-	-	-	-	-	-
BMI	27.65 $\pm$ 4.22 (18.59; 40.57)	r=-0.065 p = 0.417	-	-	-	-	-
Pain	3.36 $\pm$ 3.01 (0; 10)	r=-0.224 p = 0.005	r = 0.142 p = 0.075	-	-	-	-
Fatigue	4.08 $\pm$ 3.07 (0; 10)	r=-0.085 p = 0.292	r = 0.004 p = 0.962	r = 0.425 p < 0.001	-	-	-
ICUESS	66.73 $\pm$ 20.91 (42; 153)	r=-0.188 p = 0.019	r=-0.057 p = 0.480	r = 0.314 p < 0.001	r = 0.347 p < 0.001	-	-
RCSQ	44.67 $\pm$ 28.24 (0; 100)	r = 0.252 p = 0.001	r = 0.105 p = 0.191	r=-0.406 p < 0.001	r=-0.348 p < 0.001	r=-0.442 p < 0.001	-

Table 2.

Correlations Among Patients' Age, BMI, Pain, Fatigue, ICUESS, and RCSQ (n = 157)

Table 3 shows the results of the hierarchical regression analysis conducted to identify the predictors of sleep quality. Age and BMI were included in Model 1, revealing that they explained 8.5% of the variance in sleep quality ($R^2 = 0.085$, $F = 7.083$, $p = 0.001$). The duration of stay in the ICU and surgical diagnosis group were added to Model 2; however, these variables did not contribute significantly to the explanatory power of the model ($\Delta R^2 = 0.002$, $\Delta F = 0.184$, $p = 0.832$). This result demonstrated that clinical characteristics did not provide additional explanatory power for sleep quality beyond age and BMI. The scores for pain intensity, fatigue level, and the ICU environmental stressors were included in Model 3, revealing a significant increase in the explanatory power of the model ($\Delta R^2 = 0.263$, $\Delta F = 20.088$, $p < 0.001$). Model 3 explained 35.1% of the variance in sleep quality ($R^2 = 0.351$, adjusted $R^2 = 0.320$, $F = 11.386$, $p < 0.001$); pain intensity ($\beta = -0.276$, $p < 0.001$) and ICU environmental stressors ($\beta = -0.319$, $p < 0.001$) were found to be the strongest negative predictors of sleep quality, whereas age was a significant positive predictor ($\beta = 0.189$, $p = 0.013$). Furthermore, the Durbin-Watson value was 1.945, tolerance

values ranged from 0.730 to 0.958, and VIF values ranged from 1.044 to 1.369, indicating no issues with autocorrelation or multicollinearity in the model.

Table 3

Results of the hierarchical multiple regression analysis of sleep quality in cardiovascular surgery unit (n = 157)

Model 1								
Independent variable	B	SE	β	t	p	95% CI	Tolerance	VIF
Constant	-27.498	21.441		-1.283	0.202	-69.858 to 14.862		
Yaş	0.841	0.234	0.280	3.601	< 0.001	0.380 to 1.303	0.997	1.003
BMI	0.666	0.516	0.100	1.292	0.198	-0.352 to 1.685	0.997	1.003
R	0.292							
R²	0.085							
ΔR^2	0.073							
F	7.083							
Model 2								
Constant	-24.219	22.253		-1.088	0.278	-68.189 to 19.751		
Yaş	0.845	0.235	0.281	3.596	< 0.001	0.381 to 1.310	0.995	1.005
BMI	0.623	0.528	0.094	1.181	0.240	-0.420 to 1.666	0.962	1.039
Medical diagnosis	-2.519	4.694	-0.043	-0.537	0.592	-11.794 to 6.755	0.962	1.039
Length of stay in intensive care (hours)	-1.079	4.516	-0.019	-0.239	0.811	-10.003 to 7.844	0.989	1.011
R	0.296							
R²	0.087							
ΔR^2	0.063							
Note: Coding information: Medical diagnosis: 0 = Ischemic heart diseases, 1 = Non-ischemic heart diseases; Length of stay in intensive care: 0 = 24–48 hours, 1 = 48–72 hours; ICUESS: Intensive Care Unit Environmental Stressors Scale score. Abbreviations: β , standardized coefficients; B, unstandardized coefficients; CI, confidence interval; VIF, variance inflation factor.								

Model 1								
Independent variable	B	SE	β	t	p	95% CI	Tolerance	VIF
F	0.184							
Model 3								
	B	SE	β	t	p	95% CI	Tolerance	VIF
Constant	36.464	21.269		1.714	0.089	-5.568 to 78.496		
Yaş	0.488	0.207	0.162	2.358	0.020	0.079 to 0.897	0.932	1.073
BMI	0.686	0.456	0.103	1.506	0.134	-0.214 to 1.587	0.937	1.067
Medical diagnosis	-3.303	4.008	-0.056	-0.824	0.411	-11.224 to 4.618	0.958	1.044
Length of stay in intensive care (hours)	-1.802	3.924	-0.031	-0.459	0.647	-9.558 to 5.953	0.951	1.051
Pain	-2.468	0.726	-0.265	-3.402	0.001	-3.902 to -1.034	0.730	1.369
Fatigue	-1.442	0.696	-0.159	-2.071	0.040	-2.818 to -0.066	0.749	1.336
ICUESS	-0.361	0.098	-0.270	-3.677	< 0.001	-0.167 to 0.819	0.819	1.222
R	0.592							
R²	0.351							
ΔR^2	0.320							
F	19.877							
Durbin-Watson	1.945							
Note: Coding information: Medical diagnosis: 0 = Ischemic heart diseases, 1 = Non-ischemic heart diseases; Length of stay in intensive care: 0 = 24–48 hours, 1 = 48–72 hours; ICUESS: Intensive Care Unit Environmental Stressors Scale score. Abbreviations: β , standardized coefficients; B, unstandardized coefficients; CI, confidence interval; VIF, variance inflation factor.								

Table 3.

4. Discussion

This study found that environmental stressors, pain, and fatigue significantly predicted sleep quality in patients in the ICU following open-heart surgery. However, BMI, medical diagnosis, and duration of stay in the ICU had no independent impact on sleep quality.

The patients in this study experienced mild levels of pain and fatigue. Previous studies reported that patients in the ICU following cardiac surgery experienced mild pain and mild-to-moderate levels of fatigue (Brunker et al., 2023; Lin et al., 2022; Puntillo et al., 2014; Rousseaux et al., 2022). Pain and fatigue in patients in ICUs are considered a natural consequence of surgical trauma, immobilization, and the critical illness process (Alves et al., 2023). However, the fact that the present study demonstrated relatively low symptom levels may be related to the implementation of standard analgesia protocols, early symptom management, and routine nursing care.

The patients in this study perceived ICU environmental stressors at a moderate level. Environmental factors such as pain, noise, light, lack of privacy, and visit restrictions lead to stress in patients in ICUs and negatively impact their recovery process (Mollaoğlu et al., 2022). The ICUESS scores found in the present study were consistent with those reported previously (Berber & Kızıltan, 2022; Ding et al., 2017; Zaybak & Çevik, 2015). This finding indicates that, although environmental stressors such as noise, light, frequent nursing interventions, and lack of privacy in ICUs were identified many years ago, patients still perceive them to a significant extent.

In this study, the patients had poor sleep quality. Relevant studies have also reported that patients' sleep quality in ICUs ranges between 50 and 60 points (Bellon et al., 2022; Kulpatcharapong et al., 2020; Lin et al., 2022; Naik et al., 2018; Yayla & Özer, 2019). The low sleep quality scores in this study might have resulted from the combined effect of patients' ongoing experience of symptoms such as pain and fatigue and their exposure to environmental stressors specific to the ICU setting because they were assessed during the early postoperative period.

This study discovered a positive correlation of sleep quality with age but negative correlations with pain, fatigue, and the perception of environmental stressors. Previous studies have also shown a negative impact of age, pain, environmental stressors, and fatigue on sleep quality (Aksoy et al., 2026; Aydın Sayılan et al., 2021; Bülbül et al., 2023; Karaca & Alparslan, 2024; Wang et al., 2025). In contrast to studies suggesting that increasing age is associated with worse sleep quality, this study found a positive correlation between age and sleep quality. This difference may be due to variations in patient characteristics, postoperative care settings, and the timing of sleep assessments. Another possible reason is that younger patients may experience greater psychological distress and environmental sensitivity during the postoperative intensive care period, while older adults may adapt to these conditions more easily.

This study demonstrated that sleep quality was influenced more by ICU environmental stressors and modifiable factors such as pain and fatigue than by demographic and clinical characteristics. The hierarchical regression analysis indicated that age and BMI explained only a small part of the variance in sleep quality; however, the duration of stay in the ICU and the surgical diagnosis group did not contribute significantly to the model. In contrast, adding pain, fatigue, and ICU environmental stressors to the model resulted in a significant increase in the explained variance. This result indicates that sleep quality is largely determined by the symptoms experienced by patients and their perceptions of the ICU environment. Studies conducted on patients following open-heart surgery reported that the primary predictors of sleep quality were pain and noise (Aydın Sayılan et al., 2021; Lin et al., 2022). Aksoy et al. (2026) reported that perceived environmental stressors negatively impacted sleep quality, whereas demographic and clinical characteristics were not significant predictors. The results of the present study supported these findings; they also revealed that sleep quality was influenced not by a single factor but by a multidimensional interaction between symptom burden and environmental stressors. Clinically, this finding suggests that although variables such as age, BMI, or surgical diagnosis cannot be changed in nursing care, pain management, reduction of fatigue, and control of environmental stressors are areas where direct intervention can be made (Bellon et al., 2023; Wang et al., 2025). Therefore, interventions for improving sleep quality in patients in ICUs following open-heart surgery should focus on symptom management and environmental arrangements rather than individual demographic characteristics (Butcher et al., 2018). Reducing noise and light, particularly during nighttime hours; clustering care interventions as much as possible; optimizing alarm management; and controlling pain through effective assessments may be effective strategies to improve sleep quality. In this respect, the present study demonstrated that sleep quality was not only a result of the patient's clinical condition but also a care outcome that can be shaped and improved by the ICU team. Hence, routinely assessing sleep quality and integrating sleep-friendly care practices into care processes are important. In particular, besides environmental arrangements such as implementing quiet time protocols, reducing nighttime light and noise levels, organizing nursing interventions by combining them as much as possible, and supporting privacy, nonpharmacological interventions such as soothing music, guided imagery, massage, aromatherapy, acupuncture, and virtual reality–assisted relaxation practices may be beneficial to improving patients' sleep quality (Aydın Sayılan et al., 2021; Bellon et al., 2023; Huang et al., 2023; Lee & Kang, 2020).

4.1. Strengths and Limitations of the Study

One of the key strengths of this study was that it assessed the relative contributions of various groups of variables to sleep quality by jointly examining demographic, clinical, and environmental factors that influence sleep quality in patients undergoing open-heart surgery. This approach helped identify independent predictors of sleep quality and highlighted the importance of modifiable factors. Furthermore, the study included only patients admitted to a cardiovascular surgery ICU, ensuring that the results contributed to the literature specific to this patient population.

However, the study had some limitations. First, it could not examine causal relationships between variables due to its cross-sectional design. Second, it was conducted at a single center, which limited the generalizability of the results to different ICUs and patient populations. Third, sleep quality was assessed using a self-report-based measurement tool; objective sleep measurements such as polysomnography or actigraphy were not used. Additionally, certain variables influencing sleep quality, such as anxiety, depression, sedative medication use, and preoperative sleep habits, were not evaluated within the scope of this study. Future multicenter, prospective studies should include objective sleep measurements as well as psychological and treatment-related variables.

4.2. Recommendations or implications for practice and/or further research

The findings of this study suggest that sleep quality should be routinely assessed as part of postoperative care for patients undergoing open-heart surgery in cardiovascular intensive care units. Since pain, fatigue, and perceived environmental stressors were identified as significant and potentially modifiable predictors of sleep quality, nurses should implement comprehensive symptom assessment and management strategies alongside interventions to minimize environmental disturbances, such as reducing noise and light exposure, clustering nighttime nursing activities, and promoting uninterrupted sleep periods. Future multicentre prospective and interventional studies are needed to evaluate the effectiveness of targeted nursing interventions designed to improve sleep quality and to determine whether improvements in sleep translate into better postoperative recovery and clinical outcomes.

5. Conclusions

Sleep quality in the ICU among patients undergoing open-heart surgery was influenced more by pain, fatigue, and perceived environmental stressors than by demographic and clinical characteristics such as age, BMI, surgical diagnosis, and duration of stay in the ICU. In particular, pain and environmental stressors were the strongest predictors of sleep quality. These findings indicated that sleep quality was not only a consequence of the patient's clinical condition but also a patient outcome that could be improved through ICU processes and symptom management. Therefore, nurses should focus on the effective management of pain and fatigue, implement measures to reduce environmental stressors such as noise and light, and routinely assess sleep quality. Developing sleep-friendly ICU practices can contribute to supporting the recovery of patients after open-heart surgery and improving the quality of care.

Abbreviations

BMI

Body Mass Index

ICU

Intensive Care Unit

ICUESS

Intensive Care Unit Environmental Stressors Scale

RCSQ

Richards–Campbell Sleep Questionnaire

VAS

Visual Analog Scale

Declarations

Ethics approval and consent to participate:

This study approved by the Non-Invasive Ethical Committee of the Nursing Faculty of Aydın Adnan Menderes University (Date: 30/05/2025, No: E-76261397-050.04-734105). Verbal informed consent to participate was obtained from all participants prior to their inclusion in the study, and the use of verbal informed consent was approved by the ethics committee. This study was registered on August 5, 2026, at <https://clinicaltrials.gov/>, ID: NCT07755280).

Consent for publication:

Not applicable.

Competing Interests:

The authors declare that they have no competing interests.

Declaration of generative AI and AI-assisted technologies in the manuscript preparation process

During the preparation of this manuscript, the authors used ChatGPT (OpenAI, GPT-5.5) solely to improve the language, grammar, readability, and academic writing style of the manuscript. The AI tool was not used for data analysis, interpretation of results, or generation of scientific conclusions. All generated text was critically reviewed, revised, and approved by the authors. All authors take full responsibility for the final content of the manuscript.

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Author Contribution

EA and ZB designed research; EA and ZB conducted research; ZB collected datas; EA analyzed datas; EA and ZB wrote the first draft of the manuscript and all authors has primary responsibility for final content. All authors read and approved the final manuscript.

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Availability of data and materials:

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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