Factors influencing sleep quality among nurses in tertiary hospitals in Kelantan, Malaysia: a cross-sectional study

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Abstract

Background Poor sleep quality among nurses can negatively impact their performance, leading to increased risks of errors in nursing practice, which directly affect patient safety. However, there is limited research on the factors influencing sleep quality and its subsequent consequences on patient safety, particularly in tertiary hospitals in Kelantan, Malaysia. This study aimed to determine the factors influencing sleep quality and the prevalence of poor sleep quality among nurses at tertiary hospitals in Kelantan.

Methodology A cross-sectional study was conducted in two tertiary care hospitals in Kelantan between December 2023 and February 2024. A proportionate stratified random sampling method was employed to recruit a sample of 470 registered nurses. Data were collected using a validated self-administered questionnaire comprising 19 items across seven component scores.

Results The prevalence of poor sleep quality among nurses was found to be 69.8%. The study identified several significant factors associated with poor sleep quality, including sleep duration (aOR 0.291; 95% CI: 0.215–0.393; $p < 0.001$), years of work experience (aOR 0.953; 95% CI: 0.924–0.984; $p = 0.003$), history of involvement in medication errors (aOR 2.669; 95% CI: 1.413–5.041; $p = 0.002$), and experiences of commuting injury (aOR 1.869; 95% CI: 1.119–3.121; $p = 0.017$).

Conclusion The high prevalence of poor sleep quality among nurses highlights the need for targeted interventions to address this issue. In addition to ongoing education, implementing sleep hygiene programs, offering stress management workshops, and introducing flexible work schedules could significantly improve sleep quality. Creating a supportive work environment that prioritizes nurse well-being is crucial for enhancing patient safety and overall healthcare outcomes.

Keywords Sleep quality, Associated factors, Nurses, Tertiary hospitals

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Background

Nurses play a vital role in healthcare delivery, providing direct patient care, monitoring health conditions, administering medications, and assisting with daily activities. This work often requires long hours and shift work, which can significantly disrupt sleep patterns. Sleep is essential for maintaining physical and mental health, and disruptions in sleep can lead to adverse outcomes not only for the individual but also for the patients they care for [1].

Sleep quality and circadian rhythms

Sleep quality is governed by circadian rhythms and homeostatic systems, which regulate the sleep-wake cycle and are sensitive to environmental cues such as light and temperature [2]. When these rhythms are disrupted by factors like rotating shifts or night work, which are common among nurses, it can result in poor sleep quality. Adequate sleep is critical for cognitive function, decision-making, and emotional regulation [3], all of which are essential for providing safe and effective patient care.

While the general effects of sleep deprivation and circadian rhythm disruptions are well documented, it is crucial to explore how these disruptions specifically affect nurses in Malaysia. The unique healthcare environment, cultural practices, and work demands in Malaysia may influence sleep quality in distinct ways. Therefore, understanding these dynamics in the context of Malaysian tertiary hospitals is important [4].

The importance of sleep for nurses

Nurses in Malaysia, particularly those working in tertiary hospitals, often face irregular and long shifts that are known to disrupt natural sleep patterns. Previous studies have shown that nurses frequently suffer from poor sleep quality due to their demanding schedules, which can lead to fatigue, reduced job performance, and increased risk of errors (5–6). Poor sleep is also linked to chronic health conditions such as cardiovascular disease, diabetes, and mental health issues like depression and anxiety (7–8).

Given the critical role that nurses play in patient care, poor sleep quality not only affects their health but also jeopardizes patient safety. Sleep-deprived nurses are more prone to making errors, particularly in high-pressure environments such as critical care units [9]. In Malaysia, where the nurse-to-patient ratio remains a challenge, the potential impact of poor sleep quality on healthcare delivery is even more pronounced [10].

Factors affecting sleep quality among nurses in Malaysia

Numerous studies have explored the factors that influence sleep quality among nurses globally, with consistent findings that rotating shifts, high workloads, and the emotional stress of caregiving are key contributors (11–12). However, there is limited research focusing specifically on Malaysian nurses. Factors such as cultural expectations, family responsibilities, and specific work conditions in Malaysian hospitals may exacerbate the problem [13]. For example, nurses who work night shifts or rotating shifts are particularly vulnerable to sleep disruptions due to the misalignment of their sleep-wake cycles with natural circadian rhythms (14–15).

Additionally, factors such as job experience, involvement in work-related incidents like medication errors or commuting injuries, and the physical and emotional demands of the job have all been identified as contributors to poor sleep quality among healthcare workers (16–17). This study aims to fill the gap by investigating the factors that influence sleep quality among nurses in tertiary hospitals in Kelantan, Malaysia, and examining the potential consequences on both nurses' well-being and patient safety.

Research objectives and study rationale

This study provides a novel contribution by not only assessing the prevalence of poor sleep quality among nurses in tertiary hospitals in Kelantan, Malaysia, but also by identifying key determinants, including work-related injuries and involvement in medication errors, that significantly influence sleep quality. By addressing these understudied factors in the Malaysian context, the study expands the current body of knowledge regarding the complex relationship between sleep quality, nursing performance, and patient safety. The findings offer evidence-based insights that have the potential to inform hospital management strategies and guide the development of targeted policy interventions aimed at enhancing nurse well-being and improving patient care outcomes [18].

Given the lack of localized research, this study offers a significant contribution to the understanding of sleep quality among Malaysian nurses. The findings will not only help hospital management develop effective strategies to support nurses but also contribute to the global body of knowledge on healthcare worker well-being.

Methods

Study design and nurses

A cross-sectional survey was conducted among registered nurses working in tertiary hospitals in Kelantan, Malaysia, from December 15, 2023, to February 15, 2024. The tertiary hospitals selected were Hospital Universiti Sains Malaysia (HUSM), Kubang Kerian, and Hospital Raja Perempuan Zainab II (HRPZ II), Kota Bharu, both of which provide specialized and multidisciplinary care. These hospitals had a combined nursing workforce of 2,554 nurses, with 1,324 nurses employed at HRPZ II and 1,230 nurses employed at HUSM.

Sample size determination and sampling technique

The required sample size to determine the prevalence of poor sleep quality among nurses in tertiary hospitals in Kelantan was calculated using the single-proportion formula $n=[Z^2P(1-P)]/d^2$, where Z is the Z statistic for a 95% confidence level (set at 1.96), d is the margin of error (set at 0.05), and P is the estimated prevalence of poor sleep quality, based on a previous Malaysian study reporting a prevalence of 58% among nurses. After accounting for a 20% dropout rate, the final sample size required to meet the study objectives was determined to be 470 nurses.

A stratified random sampling technique was employed to ensure that nurses working in critical care units were adequately represented. The wards and units selected for this study were exclusively those serving critical care patients, including intensive care units (ICUs), and emergency departments. Nurses were randomly selected from these departments to reflect the distribution of nursing staff across critical care units. No further stratification by shift or specific roles was conducted; instead, random selection occurred within each unit to ensure an unbiased and representative sample.

A proportionate stratified sampling technique was used, and the sample size for each hospital was determined using the following formula: (Estimated sample size/Total population) x Number of nurses in each hospital. This resulted in a sample size of 226 nurses from HUSM and 244 nurses from HRPZ II. The sample was further stratified by department to ensure the representativeness of different critical care wards within both hospitals.

Study criteria

Registered nurses with a minimum of two months of work experience at the tertiary hospitals were included in the study to ensure familiarity with their work environment and routines. This approach minimizes potential biases caused by unfamiliarity with shift work and hospital policies. Nurses who were on leave during the study period were excluded.

Study tools

Data were collected using a self-administered questionnaire that included the Malay Version of the Pittsburgh Sleep Quality Index (PSQI-M) [6] and additional sociodemographic questions. The PSQI-M consists of 19 items distributed across seven components: subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleep medication, and daytime dysfunction.

Each component is scored from 0 to 3, and the component scores are summed to yield a PSQI global score ranging from 0 to 21, with higher scores indicating worse sleep quality. Respondents with a global score greater than 5 were classified as having poor sleep quality, while those with a score of 5 or less were classified as having good sleep quality. This threshold is based on the original PSQI guidelines [3].

In addition to the PSQI-M, a proforma was used to collect sociodemographic and work-related variables such as gender, age, marital status, education level, number of children, job rank, shift work, years of experience, and history of medication errors or commuting injuries. These variables were selected based on their potential influence on sleep quality, as identified in previous literature, and were analyzed using logistic regression to assess their association with poor sleep quality.

Although the PSQI-M has been previously validated for use among the general Malaysian population [6], its specific validity among nurses was not examined in this study, which presents a limitation that could be addressed in future research.

Data collection

The nurses were informed that all information would be used solely for research purposes and would be kept in strict confidence. Informed consent was obtained from all nurses prior to data collection, and each participant was assigned a unique code number to ensure confidentiality. The questionnaires were distributed following coordination with hospital management, and nurses were given 15 min to complete them.

Statistical analysis

The analysis was performed using IBM SPSS version 28. After data entry, the data were validated and cleaned, with missing or erroneous entries removed. Any questionnaires with missing values were excluded from further analysis to maintain data integrity. Although the exclusion of questionnaires with missing data is a standard practice for ensuring data integrity, no missing data were encountered in this study, and thus, all responses were included in the analysis.

To calculate the prevalence of sleep disturbances (poor sleep quality), we classified respondents with a PSQI score greater than 5 as having poor sleep quality. The prevalence was then calculated by dividing the number of nurses classified as having poor sleep quality by the total sample size and multiplying by 100 to express it as a percentage.

Logistic regression analysis was used to assess the factors associated with poor sleep quality. Before conducting the analysis, we ensured that the key assumptions for logistic regression were met. First, we checked for the absence of multicollinearity among the independent variables by calculating Variance Inflation Factors (VIF), and all values were found to be within an acceptable

range, indicating no significant multicollinearity. Next, we tested the linearity of continuous variables, such as age and duration of sleep, with the logit of the dependent variable, confirming that the assumption was met for accurate modeling. Finally, the binary nature of the dependent variable was established by categorizing sleep quality into two groups: poor sleep quality (PSQI > 5) and good sleep quality (PSQI ≤ 5), based on the original PSQI guidelines. This binary classification allowed for the use of logistic regression to identify the factors associated with poor sleep quality. Independent variables with a p-value of less than 0.25 in the univariable analysis were included in the multiple logistic regression to avoid excluding potentially important predictors [19].

Independent variables included demographic characteristics (e.g., age, gender, education), work-related factors (e.g., shift work, job rank, working hours), and health-related variables (e.g., involvement in medication errors, commuting injuries). The final model was adjusted for potential confounders, and adjusted odds ratios (aOR) and 95% confidence intervals (CI) were reported for each factor. The level of significance for the multiple logistic regression model was set at a p-value of less than 0.05.

Ethical consideration

Ethical approval was obtained from the Universiti Sains Malaysia Human Etiquette Committee with reference number: USM/JEPeM/KK/23,110,866 and from the National Medical Research Registry with reference number: NMRR-23-03398-LTP(IIR). The data were strictly limited, and access was only given to the author and supervisor. Analyzes and publications were consequently rendered without the identities of the selected nurses.

Results

Socio-demographic and work characteristics of nurses

The study included 470 nurses with 100% response. The mean age of nurses was 38.86 ± 7.63 years. Most nurses were women (95.5%) and 419 (89.1%) married. Over half of the nurses had a certificate/diploma (68.9%), followed by a diploma with post basic (26.8%) and a degree/masters (4.3%). The average number of children among nurses was 2.73 ± 1.63. The study comprised 99.4% Malay individuals and 21.5% with comorbidities. The study found that nurses slept an average of 5.81 ± 0.96 h each day. Table 1 summarises nurses' socio-demographics.

Nurses had a mean working experience of 15.16 ± 7.39 years. Most nurses (60.9%) had worked in their current department for more than 5 years. Only 19.9% of individuals work more than 48 h each week, while 80.9% work less. About 39.6% of nurses reported commuting injuries, while 24.9% reported medication errors during work. Table 2 summarises nurses' working characteristics.

Sleep quality associated factors

From the simple logistic regression analysis, we identified several factors that were deemed important for inclusion in the multiple logistic regression model, based on their potential clinical relevance. These factors included age, race, number of children, comorbidities, duration of sleep, job rank, working schedule, working experience, service in the current department, history of involvement in commuting injuries, and history of involvement in medication errors. After conducting the multiple logistic regression analysis, we found that the significant factors associated with poor sleep quality were duration of sleep (aOR 0.291; 95% CI: 0.215–0.393; $p < 0.001$), working experience (aOR 0.953; 95% CI: 0.924–0.984; $p = 0.003$), history of involvement in commuting injury (aOR 1.869; 95% CI: 1.119–3.121; $p = 0.017$), and history of involvement in medication errors (aOR 2.669; 95% CI: 1.413–5.041; $p = 0.002$), as summarized in Table 3.

Discussion

Demographic characteristics

The average age of nurses was 38.86 ± 7.63 years, similar to recent research in Canada, Iran (34.5 ± 9.0 years), and China (35.3 ± 6.8 years) [15, 20, 21]. This suggests that most nurses were young adults, which aligns with the typical recruitment age for government servants. In this study, 95.5% of nurses were women, reflecting a female-dominated nursing profession in Kelantan. A study done in Melaka also found that Malaysian nurses are mostly women, which is consistent with international research,

Table 1 Socio-demographic characteristics of nurses (*n* = 470)

Variables	n	(%)	Mean	(SD)
Age (years)			38.86	(7.63)
Gender				
Male	21	(4.5)		
Female	449	(95.5)		
Race				
Non-Malay	3	(0.6)		
Malay	467	(99.4)		
Marital status				
Unmarried/Divorced	51	(10.9)		
Married	419	(89.1)		
Number of children			2.73	(1.63)
Education level				
Degree/ Masters	20	(4.3)		
Diploma with Post Basic	126	(26.8)		
Certificate/Diploma	324	(68.9)		
Comorbid				
No	369	(78.5)		
Yes	101	(21.5)		
Duration of sleep			5.81	(0.96)

Table 2 Working characteristics of the nurses (*n* = 470)

Variables	*n*	(%)	Mean	(SD)
Job Title				
Supervisor/Head Nurse	34	(7.2)		
Staff Nurse	436	(92.8)		
Current Department				
Paediatric ICU	113	(24.0)		
Emergency/Trauma ICU	81	(17.2)		
Surgical ICU	99	(21.1)		
Medical ICU	177	(37.7)		
Working shift				
Non-Shift	55	(11.7)		
Shift	415	(88.3)		
Working experience (years)			15.16	(7.39)
Service in current department				
< 5 years	184	(39.1)		
≥ 5 years	286	(60.9)		
Hours of working per week				
< 48 h	380	(80.9)		
≥ 48 h	90	(19.9)		
History of involvement in commuting injury				
No	284	(60.4)		
Yes	186	(39.6)		
History of involvement in medication error				
No	353	(75.1)		
Yes	117	(24.9)		

Note: ICU – Intensive care unit

revealing that women dominate the nursing profession [11, 22].

Most nurses (89.1%) in this study were married, consistent with research showing that marriage rates tend to rise with age and professional stability in the nursing profession [9, 18]. Marriage is often cited as providing emotional support, which is crucial in demanding careers such as nursing. Recent studies have demonstrated that marital support is linked to lower levels of job-related stress, improved coping mechanisms, and enhanced mental health among healthcare professionals [23]. For example, marital support has been found to act as a buffer against burnout, which is prevalent among nurses due to the emotional and physical demands of their work [24]. Furthermore, research has shown that nurses who report stronger emotional support from their spouses tend to have better job performance and higher levels of job satisfaction [25]. Thus, the high proportion of married nurses in this study may contribute to their ability to manage the challenges of their profession more effectively, potentially improving patient care outcomes [26]. Nursing is a demanding career that requires both mental and physical support, and marriage may provide the emotional support needed to cope with these job challenges [27].

Regarding education, the majority of nurses (68.9%) in this study held a certificate or diploma, followed by 26.8%

with post-basic diplomas, and 4.3% with degrees or master's qualifications. These educational levels have a significant impact on patient care quality, workforce planning, and healthcare delivery efficiency [10, 28]. Higher education levels are associated with improved patient outcomes, better critical thinking skills, and the ability to take on leadership roles in healthcare settings.

In addition to formal qualifications, continuous professional development (CPD) plays a crucial role in ensuring that nurses remain competent and up-to-date with the latest developments in healthcare. CPD programs and ongoing education are essential for maintaining clinical competence, particularly as healthcare environments become more complex due to advances in technology and evolving treatment modalities [29]. Research shows that nurses who engage in CPD are better equipped to handle the challenges of modern healthcare, leading to higher levels of job satisfaction and improved patient care [30].

Moreover, ongoing education contributes to career progression, enabling nurses to take on specialized roles that require advanced skills, such as nurse educators, clinical nurse specialists, and nurse managers [31]. In the Malaysian context, efforts to promote CPD and lifelong learning among nurses are critical to addressing the growing demand for skilled healthcare professionals,

Table 3 Logistic regression analysis of Associated factors of poor sleep quality among nurses in Tertiary hospitals, Kelantan

Variables	Crude OR (95% CI) [a]	*p*-value[a]	Adjusted OR (95% CI) [b]	*p*-value[b]
Age (years)	0.952(0.727,0.977)	<0.001		
Race				
Non-Malay	Ref			
Malay	4.671(0.420,51.939)	0.210		
Number of children	0.869(0.768,0.982)	0.024		
Comorbid				
No	Ref			
Yes	0.688(0.433,1.094)	0.114		
Duration of sleep	0.283(0.212,0.379)	<0.001	0.291(0.215,0.393)	<0.001
Job Rank				
Supervisor/Head Nurse	Ref			
Staff nurse	1.921(0.946,3.898)	0.071		
Current Department				
Paediatric ICU	Ref			
Emergency/ Trauma ICU	1.182(0.594,2.351)	0.634		
Surgical ICU	0.362(0.201,0.650)	<0.001		
Medical ICU	0.755(0.440,1.295)	0.307		
Working schedule				
Non-Shift	Ref			
Shift	2.311(1.305,4.091)	0.004		
Working experience (years)	0.95 (0.925,0.977)	<0.001	0.953(0.924,0.984)	0.003
Service in current department				
< 5 years	Ref			
≥ 5 years	0.787(0.523,1.184)	0.250		
History of involvement in commuting injury				
No	Ref			
Yes	2.362(1.532,3.643)	<0.001	1.869(1.119,3.121)	0.017
History of involvement in medication error				
No	Ref			
Yes	2.978(1.722,5.150)	<0.001	2.669(1.413,5.041)	0.002

[a] Simple Logistic Regression

[b] Multiple Logistic Regression

Constant 8.568

Forward LR method applied

No multicollinearity and no interaction

Hosmer and Lemeshow test, p value 0.108

Classification Table 78.3% correctly classified

Area under Receiver Operating Characteristics (ROC) 81.3%

especially in light of the global nursing shortage projected to reach 12.9 million by 2035 [32].

Thus, our findings align with broader workforce trends, where higher educational attainment and CPD are crucial for both individual career development and improving the overall quality of healthcare delivery. Encouraging nurses to pursue further education and professional development can enhance workforce flexibility, reduce the likelihood of errors, and improve patient outcomes in tertiary care settings.

Work and sleep patterns

Regarding sleep, a study by Farah et al. (2019) found that nurses in Malaysia averaged 5.81±0.96 h of sleep per day, which is below the World Health Organization's (WHO) recommended 7 h of sleep for adults [6]. This deficit in sleep duration is particularly concerning given that nurses often work rotational or night shifts, which can disrupt circadian rhythms [33]. Similar studies show that nurses working night shifts or rotating schedules frequently experience shift work-related insomnia and fragmented sleep, making it difficult to achieve the recommended amount of sleep [11]. This highlights the ongoing struggle nurses face in balancing their

professional responsibilities with adequate sleep, contributing to long-term health risks.

The nurses in this study had an average of 15.16±7.39 years of work experience. This extensive experience fosters clinical knowledge, competence, and practical skills among nurses. Experienced nurses are better equipped to anticipate problems, implement solutions efficiently, and ultimately enhance patient care quality. The fact that 60.9% of nurses had been working in their respective departments for over five years underscores the importance of familiarity with departmental protocols. Nurses with long-term experience in a particular department tend to develop stronger communication, teamwork, and coordination with other healthcare providers, which is essential for patient safety and seamless healthcare delivery [34].

Only 19.9% of nurses reported working more than 48 h per week, with the majority (80.9%) working less. This finding is consistent with the National Health Interview Survey (NHIS), which reported that over 12% of U.S. women worked more than 48 h per week in 2010 [35]. The relatively lower percentage of nurses working extended hours in this study suggests a more manageable work schedule, which can significantly enhance productivity, efficiency, and overall performance. Long working hours are associated with burnout and reduced job satisfaction, so maintaining a balanced work schedule is crucial for sustaining healthcare professionals' well-being. This balance can positively impact both nurses' health and the quality of care provided to patients [36].

To improve nurses' sleep quality, hospitals and healthcare providers can adopt several evidence-based strategies. First, adjusting shift patterns, such as minimizing night shifts or implementing forward-rotating shifts, can help reduce the disruption to nurses' circadian rhythms, thereby improving sleep quality [37]. Consistent scheduling and allowing more time between shifts are particularly helpful in promoting better rest. Additionally, wellness programs that include education on sleep hygiene and stress management can empower nurses with practical techniques to improve their sleep, such as relaxation exercises and creating a sleep-conducive environment [38]. Providing mental health resources can further support nurses in managing work-related stress, a key contributor to poor sleep. Flexible scheduling, where nurses have more control over their work hours, and ensuring regular rest breaks during shifts can also reduce fatigue and enhance sleep [39]. Finally, hospitals can create sleep-friendly workplace environments by offering quiet spaces or nap rooms where nurses can rest during long shifts, especially at night [40]. These interventions collectively contribute to improved nurse well-being, better job performance, and ultimately enhanced patient safety.

Impact of sleep on health

This study revealed that 69.8% of nurses at a tertiary hospital in Kelantan experienced poor sleep quality, a significant increase from the 57.8% reported in a 2008 study in Melaka [22]. This rise may be due to the increasing complexity of healthcare, driven by advances in medical technology, changing patient demographics, and stricter healthcare regulations. Nurses are now managing more critically ill patients with heavier workloads and more intricate treatment plans, increasing stress and negatively impacting sleep quality [41]. Additionally, the global nursing shortage, projected to reach 12.9 million by 2035 [10, 42], exacerbates this issue. Despite recent growth in Malaysia's nursing workforce, with 117,116 nurses in 2022, the nurse-to-population ratio remains low at 1:279 [43]. This shortage leads to extended shifts, overtime, and heightened job expectations, contributing to sleep disturbances, job dissatisfaction, and burnout [41]. Furthermore, modern nurses face increased administrative tasks, such as documentation, compliance with regulatory standards, and the use of electronic health records (EHRs), which reduce time for direct patient care and add to their stress [43]. While technology has improved patient care, it has also blurred the lines between work and personal life for nurses.

Although this study was conducted after the peak of the COVID-19 pandemic, it is crucial to acknowledge the long-lasting effects that the pandemic has had on healthcare systems and frontline workers, particularly nurses. During the pandemic, nurses faced increased workloads, higher patient acuity, and the emotional toll of managing critically ill patients while also fearing infection and spreading the virus to their families [44]. These factors have led to heightened stress levels and increased instances of burnout, both of which are closely linked to poor sleep quality. Research shows that during the pandemic, nurses reported significantly higher levels of stress, anxiety, and depression, all of which can exacerbate sleep disturbances [45].

Pre-pandemic studies on nurse sleep quality highlighted issues such as shift work and work-related stress as primary factors contributing to sleep disruption [46]. However, the pandemic has intensified these challenges. Comparatively, post-pandemic studies indicate a marked decline in sleep quality among nurses, with many reporting chronic insomnia and frequent disruptions in their sleep patterns [47]. The long-term psychological effects of dealing with high mortality rates, personal protective equipment (PPE) shortages, and the constant risk of infection have left many nurses with lingering post-traumatic stress symptoms, which further deteriorate sleep quality.

The ongoing impacts of the pandemic, such as dealing with understaffed units and managing patient backlogs,

continue to affect nurses' ability to rest adequately. Addressing these issues is essential for mitigating the long-term effects of the pandemic on nurses' well-being. Strategies such as providing mental health support, reducing shift hours, and creating opportunities for rest in the workplace are critical in helping nurses recover from the residual effects of the pandemic on their sleep quality [48].

Long-term consequences

Our study demonstrated that increasing sleep duration by one hour is linked to a significant reduction in the likelihood of poor sleep quality among nurses. Specifically, we found that each additional hour of sleep is associated with a 70.9% reduction in the odds of experiencing poor sleep quality, as indicated by an adjusted odd ratio (aOR) of 0.291, 95% confidence interval (CI): 0.215–0.393, $p < 0.001$. This emphasizes the importance of adequate sleep for maintaining good sleep quality. Sleep consists of cycles with stages such as light sleep, deep sleep, and rapid eye movement (REM) sleep. REM sleep is particularly crucial for cognitive functions like memory consolidation and emotional regulation. Insufficient sleep disrupts these stages, leading to fragmented sleep and lower sleep quality [42]. Additionally, sleep influences hormone regulation, which is important for tissue repair and managing stress.

Cognitive functions, such as focus, memory, and decision-making, are significantly impacted by poor sleep. When sleep is disrupted, these cognitive processes are impaired, leading to decreased mental performance and overall lower sleep quality [42]. This can have serious implications for nurses, who rely on their cognitive abilities to provide safe and effective patient care.

The analysis revealed that each additional year of work experience is associated with a 4.7% decrease in the odds of poor sleep quality among nurses, as indicated by the adjusted odds ratio (aOR) of 0.953, 95% CI: 0.924–0.984, $p = 0.003$. This finding suggests that nurses with more experience may develop better skills for managing their workload and handling the demands of patient care, potentially reducing work-related stress, which can positively impact sleep quality. Over time, familiarity with their work environment, protocols, and resources may help them feel more comfortable and confident in their roles, which could contribute to lower anxiety and improved relaxation during and after shifts.

Experienced nurses often develop informal coping strategies to manage work-related stress and improve their well-being. Common approaches include effective time management, where nurses prioritize tasks to reduce stress, and peer support, which provides emotional and practical assistance from colleagues [49]. Some nurses also practice mindfulness techniques, such

as deep breathing or brief meditation, to help them relax during breaks [50]. These strategies can help nurses better manage their stress, which in turn may improve sleep quality and overall job satisfaction.

While coping mechanisms were not a direct focus of this study, it is worth noting that formal training in stress management and resilience-building could enhance nurses' ability to deal with the demands of their profession. Programs focusing on resilience have been shown to reduce burnout and improve both mental health and job performance [51]. Implementing such programs as part of continuous professional development could help nurses better manage the effects of stress and poor sleep, ultimately benefiting both their well-being and the quality of patient care [52].

This study identified that nurses with a history of commuting injuries have an 86.9% higher likelihood of poor sleep quality. Physical injuries from road accidents, such as fractures or chronic pain, can disrupt sleep by causing discomfort and making it difficult to find a comfortable position [34]. Emotional distress from the accident, including anxiety or post-traumatic stress syndrome (PTSD), may lead to flashbacks, nightmares, and intrusive thoughts, further disturbing sleep [43]. Fear of driving, or vehophobia, can also cause significant anxiety, especially during commutes, worsening sleep quality [35]. Additionally, the psychological impact of the accident can lead to cognitive disturbances, such as difficulty concentrating and racing thoughts, making restful sleep harder to achieve.

This research discovered that nurses with a history of medication errors are nearly three times more likely to experience poor sleep quality compared to those without such a history, with an adjusted odds ratio (aOR) of 2.669, 95% CI: 1.413–5.041, $p = 0.002$. Medication administration errors (MAEs) are a serious patient safety issue, often resulting in unnecessary harm or even death [53]. Nurses who have made these errors may suffer from increased stress and anxiety about their job performance and the potential for future mistakes, making it difficult to relax and sleep. Feelings of guilt and shame, especially if the errors caused harm, can also weigh heavily on their minds, disrupting sleep [42]. Fear of repercussions, such as disciplinary action or damage to their reputation, may lead to rumination and worry, further interfering with sleep. Additionally, past medication errors can cause a state of hyperarousal, making it challenging to relax and fall asleep [43].

Limitations

This study has several limitations. First, the self-reported nature of the questionnaire, which assessed sleep quality over the past month, may have introduced recall and response biases, as nurses may not

always accurately recall or report their sleep patterns. A more accurate approach would have focused specifically on assessing sleep quality during the period of data collection. Second, the study was conducted in only two tertiary hospitals in Kelantan, limiting the generalizability of the findings to other healthcare settings. Future research should expand the sample to include nurses from a broader range of hospitals across different regions in Malaysia to gain more comprehensive insights into the factors influencing sleep quality. Third, while we used the validated Malay version of the Pittsburgh Sleep Quality Index (PSQI), its specific validity among nurses has not been tested. Future studies should aim to validate this tool within the nursing population to ensure its reliability in this context. Lastly, the data collection period, which occurred from December to February, coincided with seasonal changes and festive or holiday periods that may have influenced sleep patterns. Future research should consider extending data collection across different seasons to account for potential variations in sleep behavior caused by external factors.

Conclusion

This study highlights the high prevalence of poor sleep quality among nurses in tertiary hospitals in Kelantan and identifies several key factors influencing this condition. Consistent with previous research, we found that increased sleep duration and greater work experience were associated with better sleep quality, while involvement in medication errors and commuting injuries were significant predictors of poor sleep quality. These findings underscore the importance of addressing the specific factors contributing to poor sleep quality among nurses.

In light of these results, it is recommended that hospital management develop targeted interventions to address these issues. Specific strategies could include regular training programs on medication safety to reduce errors, along with simulation-based learning to reinforce correct procedures and ensure competency in high-pressure situations. Furthermore, promoting a culture of open communication and peer support can empower nurses to report and address medication-related challenges without fear of punitive action. Stress management programs and sleep hygiene workshops should also be implemented to help nurses develop healthier sleep habits and cope with job-related stress. Additionally, providing support services for nurses recovering from commuting injuries and offering flexible scheduling could help mitigate the impact of physical and emotional stressors on sleep quality. Future research should explore these predictors in diverse healthcare settings to enhance nurse well-being and improve patient safety.

Abbreviations

QOL	Quality of Life
WHO	World Health Organization
EHR	Electronic Health Records
REM	Rapid Eye Movement
PTSD	Post-Traumatic Stress Syndrome
aOR	Adjusted Odd ratio
CI	Confidence Interval

Data availability
The datasets generated and/or analyzed during the current study are not publicly available due to the need to maintain the anonymity of participants and the confidentiality of the data. However, the datasets are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate
This study was performed in accordance with the Declaration of Helsinki. Ethical approval was obtained from the Universiti Sains Malaysia Human Etiquette Committee with reference number: USM/JEPeM/KK/23110866 and from the National Medical Research Registry with reference number: NMRR-23-03398-LTP(IIR). Written consent for was obtained from all the nurses who participated in the survey. All data collected were confidential and used only by this study.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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