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Risks posed by nurses' working hours in the intensive care unit: a systematic review

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Abstract

Background Nurses in intensive care units often work long shifts, leading to significant physical and mental strain. This strain can negatively impact their well-being and the quality of care they provide to patients.

Aim To evaluate the associations between nurses' working hours in intensive care units and outcomes related to risk identification, nurse well-being, patient safety, and institutional performance.

Methods This systematic review was conducted under the methodological guidance of the Joanna Briggs Institute, grounded in a theoretical framework based on the Donabedian Model, and reported in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses 2020 statement. Literature searches were conducted from 2014 to 2024, with the assistance of an expert librarian, across the databases of Scopus, Medline/PubMed, CINAHL, Web of Science, Cochrane Library, and Google Scholar. Peer-reviewed empirical or primary studies, published in English or Turkish, focused on nurses working in adult intensive care units, addressed risks related to working hours, utilized experimental, quasi-experimental, cross-sectional, or longitudinal designs, and regression analysis methods to explore associations and predictive outcomes were included. Publications not in English or Turkish, lack of full-text access, grey literature, studies on official sections of the intensive care units, and studies not focusing on the risks of growth along with the working hours of officials in the intensive care units were excluded.

Results A total of 902 articles were identified, and 16 studies met the inclusion criteria. The analysis suggests that extended working hours in intensive care units pose significant risks, particularly related to sleep disturbances, increased burnout, and medication errors. These risks affect nurses, patients, and institutions alike.

Conclusion The review highlights the importance of addressing the risks associated with long working hours in intensive care units. The primary risks identified include nurse-focused issues such as the development of sleep disturbances and increased burnout, as well as patient-focused risks like medication errors. These risks, along with their frequency and impact, underscore the need for improved scheduling and working conditions to ensure patient safety and nurse well-being.

Joanna Briggs Institute (JBI) review registration This systematic review was registered with the Open Science Framework proposed by the Joanna Briggs Institute Collaboration on August 10, 2024 and is available at https://doi.org/10.17605/OSF.IO/FTQBK.

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Relevance to clinical practice Healthcare organizations can use these findings as a resource in creating evidence-based programs to create a healthy work environment and ensure patient safety, and to minimize existing risks in institutions.

Keywords Critical care, Intensive care, Nursing, Risk, Work hours

Background

Patient safety is the cornerstone of effective healthcare and involves minimizing unnecessary harm associated with the delivery of care [1, 2]. Nurses, who represent nearly half of the global healthcare workforce, play a critical role in ensuring safe and high-quality care. Their contributions directly influence clinical outcomes through the provision of individualized care, timely interventions, and close patient monitoring [3, 4].

Intensive care units (ICUs) represent high-risk environments due to the complexity and intensity of care required for critically ill patients. These units demand constant vigilance, rapid decision-making, and collaboration within multidisciplinary teams, making them particularly susceptible to adverse events [1]. ICU nurses are responsible for continuous patient monitoring and are trained to make high-stakes clinical decisions, often under pressure [2, 4]. However, staffing shortages frequently result in extended work hours, which may compromise both staff well-being and patient safety [5]. Long working hours and overtime due to understaffing in nursing are linked to higher rates of medical errors and higher patient morbidity and mortality. Studies are showing that nurses who work more than 40 hours per week have a two-fold increased risk of making medical errors [6–8], and that patients' mortality rates from acute myocardial infarction are related to nurses' weekly working hour load [9].

Working time arrangements in healthcare significantly impact not only the safety and health of nurses but also patient outcomes and institutional performance. These arrangements often involve schedules that exceed conventional working hours, including extended shifts, rotating night duties, and mandated overtime [10, 11]. Research has shown strong associations between such demanding schedules and negative consequences such as burnout, fatigue, sleep disturbances, and reduced job satisfaction among nurses [11].

In response, international organizations have recommended standardized limits on daily and weekly working hours to safeguard health professionals. The 2012 European Working Conditions Survey reported that healthcare professionals work between 34 and 55 hours per week, with some exceeding 90 hours in extreme cases [12]. In ICUs, 8-, 12-, and even 24-hour shifts are routinely practiced, with a growing trend toward 12-hour models in Europe and the U.S. [13, 14]. However, working more than 40 hours per week has been linked to impaired sleep quality, diminished alertness and decision-making capacity, and overall declines in work performance [6, 7, 15].

In addition to these effects, long work hours increase the risk of occupational injuries, stress-related disorders, and professional burnout. Prolonged exposure to physical and emotional stressors has been shown to have an adverse effect on nurses' health, morale, and patient care outcomes [5, 16]. Furthermore, Folkard and Tucker [17]. demonstrated that the risk of workplace accidents rises progressively across consecutive workdays, particularly during night shifts, with cumulative fatigue playing a key role. Dong et al. [18] found that long working hours and irregular work schedules were significantly associated with higher rates of occupational injury. Another study by Dembe et al. [19] found that working 12 or more hours per day was associated with a 37% increased risk of injury, while working 60 hours per week was associated with a 23% increased risk. It also reveals that factors such as high workload, burnout, staff shortages, and inadequate institutional support negatively affect the quality of care and play a significant role in influencing the stability of the nursing workforce by affecting nurses' intention to leave their jobs [20, 21].

Despite the existence of national and institutional policies to regulate shift work, ICU nurses continue to experience challenges related to overtime, frequent rotation between shifts, and inadequate recovery periods. While general studies have explored the relationship between shift work and nursing outcomes, specific risks associated with nurses working in ICU settings remain insufficiently examined [22, 23]. Considering this gap, the current systematic review aims to synthesize current findings on the risks associated with ICU nurses' working hours and assess their relationship to nurse well-being, patient safety, and the overall healthcare system.

This review is guided by the following research questions:

> *What is the association between nurses' working hours in intensive care units and the identification of risks and outcomes associated with nurses, patients, and healthcare organizations?*

Methods

Aim

This systematic review aims to evaluate the relationship of nurses' working hours in the ICU on outcomes related

to risk identification, nurse well-being, patient safety, and organizational performance.

Study design

This systematic review protocol was registered with the Open Science Framework database and has been conducted under the methodological guidance of the Joanna Briggs Institute (JBI) Manual for Evidence Synthesis [24]. The reporting of the review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 statement to ensure transparency and completeness [25]. The search strategy was developed in accordance with established systematic review practices and informed by expert consultation. To ensure reproducibility and methodological rigor, the entire search process, including database selection, time period, keyword formulation, screening tools, and adherence to PRISMA 2020 guidelines, has been summarized in Appendix A (page 1). This appendix provides a concise overview of all critical elements used in the search process, including Boolean operators, languages included, software employed, and screening procedure. The review adhered to the PRISMA 2020 guidelines, which were used for reporting, and the PRISMA 2020 flow diagram illustrating the study selection process is presented in Appendix B (page 2).

Research strategy

This systematic review followed the PICOS (Population, Intervention, Comparison, Outcome, Study Design) framework to ensure a structured and comprehensive approach (Appendix C, page 3):

- Population (P): Nurses working in intensive care units
- Intervention (I): Working hours
- Comparison (C): Different working time conditions
- Outcome (O): Risks associated with working hours, particularly nurse-related outcomes such as burnout, sleep disturbances, and medication errors
- Study Design (S): Experimental, quasi-experimental, cross-sectional, and qualitative studies

Search strategy development

The search strategy was developed in collaboration with four nursing researchers specializing in intensive care and occupational risks. Two additional experts reviewed and refined the keyword list. This list was also informed by previous systematic reviews: Di Muzio et al. [26], Wagstaff et al. [22].

2.3.3. Keywords development

Keywords were structured using Boolean operators (OR, AND) and included following search terms: (nurse OR nursing) AND (intensive care OR critical care) AND (night shift OR shift work OR overtime OR work hour OR work schedule OR work time OR extended hour OR weekend work) AND (risk OR implication OR impact OR effect OR well-being OR personal life OR family life OR health status OR quality OR safety).

Databases and search period

The search strategy was independently conducted by two independent nursing researchers (BO & FC) using the following databases: Scopus, Medline/PubMed, CINAHL, Web of Science, Cochrane Library, and Google Scholar. Google Scholar was used as a resource to identify potentially relevant studies not indexed in primary databases and to perform a "backward search" through citations and bibliographic references.

Studies published between August 1, 2014, and August 31, 2024 were included. The last search was performed on August 31, 2024. This time frame was chosen due to the growing body of literature on shift work and working conditions in the last decade, reflecting significant developments in healthcare and nursing research.

Software and documentation tools

To ensure accurate screening and prevent duplication, Zotero v6.0.30 was used. Additionally, the reference lists of included articles were manually screened for further eligible studies.

Inclusion and exclusion criteria

Inclusion criteria:

- Peer-reviewed empirical or primary studies,
- Published in English or Turkish,
- Focused on nurses working in adult intensive care units,
- Addressed risks related to working hours (e.g., burnout, errors, sleep issues),
- Utilized experimental, quasi-experimental, cross-sectional, or longitudinal designs,
- Included regression analysis methods to explore associations and predictive outcomes.

Exclusion criteria:

- Studies not published in English or Turkish (due to limited translation opportunities),
- Studies without accessible full texts,
- Grey literature (e.g., dissertations, books, conference papers) was excluded due to potential methodological heterogeneity, lack of peer review, and increased risk of bias,
- Studies on non-ICU nursing populations (e.g., pediatric, obstetric, or gynecologic units),

- Studies with irrelevant outcomes not related to the risks associated with ICU nurses' working hours.

Screening process

The study reporting process was structured following the PRISMA 2020 framework. It consisted of four main stages: identification of potential studies, initial screening of titles and abstracts, eligibility assessment based on predefined criteria, and final selection of studies for inclusion (Appendix B, page 2). These steps were meticulously executed to ensure the systematic and rigorous inclusion of relevant literature in the review.

Quality appraisal

To assess the methodological robustness and bias risk in the 16 studies reviewed, the review utilized the National Institutes of Health (NIH) Quality Assessment Tool for Observational Cohort and Cross-Sectional Studies [27]. This tool provides a structured approach for evaluating the studies' quality and potential biases. The NIH Quality Assessment Tool is comprised of a 14-question checklist. This checklist is specifically designed to evaluate the internal validity of cohort and cross-sectional studies, focusing on identifying the potential risk of biases such as selection, information, measurement biases, or confounding factors. For each criterion in the NIH Quality Assessment Tool, responses were categorized as "yes," "no," "not applicable," or "not reported." The quality classification into Good, Fair, or Poor was based on the total number of "yes" answers from the NIH Quality Assessment Tool (Appendix D, page. 4). A study was classified as good if it met the majority of the criteria, as fair if it met some criteria but had some limitations, and as poor if it did not meet the majority of the requirements or presented significant risks of bias. This process was independently conducted by two researchers (BO and FC), with discussions held to resolve disagreements until consensus was reached.

Data extraction

This systematic review thoroughly analyzed the risk factors related to the working hours of nurses in intensive care units. The study aimed to determine and analyze risk outcomes and risk cause variables and reveal the nature of the relationships. The variables included in the regression analyses, the direction of the relationships between them, and their statistical significance (p-values) were meticulously tabulated. To systematically interpret these relationships, a unique theoretical framework (Fig. 1) based on categories developed by Oner et al. [28] was used. A model based on the Donabedian model [29] was created. The Donabedian Model, which is frequently used to conceptualize and evaluate healthcare quality, was defined by Donabedian in 1980 [29]. This model summarizes three basic measures of quality: structure, process, and outcome. This model follows a linear perspective that includes a dynamic cycle. This study intentionally excluded the process measure from the theoretical framework while examining the linear relationship between structure and outcome. This selective approach aims to identify and understand the direct relationship between the health service structure and the resulting outcomes.

In the theoretical framework, the working hours of nurses in the intensive care unit emphasize structural factors (shift system, night/weekend/holiday shift work, long working hours, break work, etc.). In turn, the results are the risks that arise for nurses, patients, and the organization due to structural factors. According to this framework, dependent variables (risk outcomes) were examined in three main groups: nurse-focused, patient-focused, organizational-focused. Independent variables (risk causes) constitute the structure phase of the framework (a comprehensive list and definitions of risk outcome/cause variables are presented in Appendix E (pages 5–9), and their frequencies according to the number of articles are presented in Appendix F (page 10) and Appendix G (page 11).

Two researchers (BO and FC) independently extracted the data collected between August 2014 and August 2024. They collaborated to resolve the inconsistencies that arose during data extraction. For this purpose, coding worksheets with drop-down menu options were created in Microsoft Excel 2016 for data analysis. Basic information about the relevant articles was recorded in the data extraction table. This table includes the author's name, year of publication, country of study, research design, sample characteristics, risk outcome and risk cause variables, and summary of findings of 16 studies (Appendix H, pages 12–17, and detailed tables are available from the relevant author). This theoretical framework guided the overall research process and was systematically used during the data extraction and analysis phases.

Statistical analysis

Within the scope of this systematic review, variables from 16 studies were examined in detail, resulting in the identification of 104 statistical relationships. This number emerged from the analytical approach applied in the included studies, which often utilized multiple independent variables and, in some cases, several dependent variables. For coding, separate lists of statistically significant dependent and independent variables were generated. Each variable was grouped under broader conceptual categories (e.g., nurse-focused, patient-focused, organizational-focused), based on a theoretical framework developed through a comprehensive review of the literature. Additionally, some variables were further broken

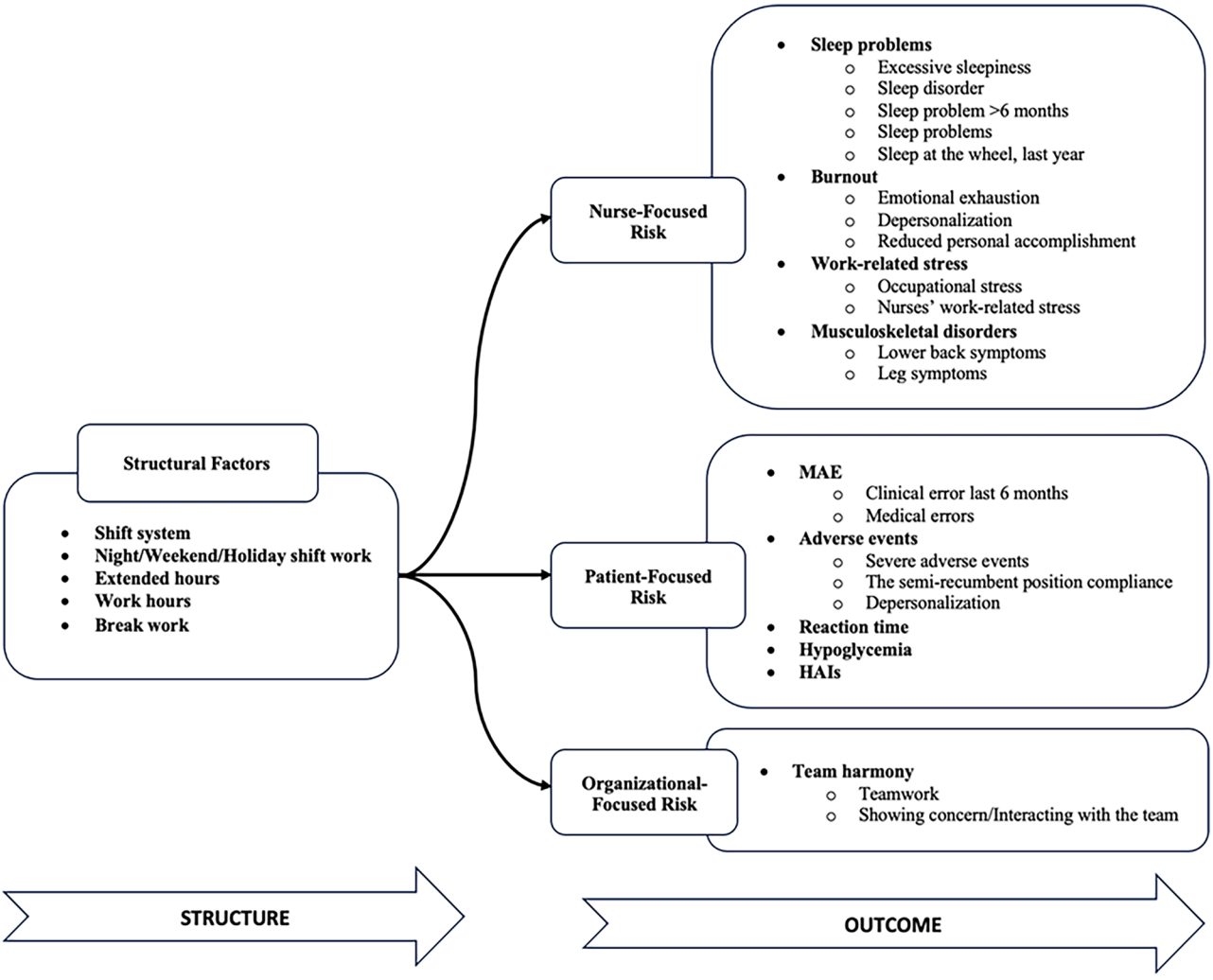


Fig. 1 Theoretical framework [28]. This framework was developed based on the model proposed by Oner et al. (2021) [28], which in turn was adapted from Donabedian's Model (1980) [29]. MAE: medication administration error, HAIs: healthcare-associated infections

down into sub-dimensions to enhance interpretability. This structured coding approach was essential for analyzing and reporting the relationships identified across studies.

Due to the high heterogeneity across study designs, outcome measures, and statistical approaches, a quantitative meta-analysis was not feasible. Instead, regression analysis results reported in the included studies were systematically coded and synthesized using a vote-counting approach to capture the direction and strength of associations. The regression analysis results were reviewed in detail, using a significance threshold of $p \leq 0.05$ to identify meaningful associations. A positive relationship was interpreted as a directly proportional association between the variables, while a negative relationship indicated an inverse association. To enhance the presentation of findings, frequency distributions were used to illustrate the prevalence of relationships across the dataset, and the vote-counting method was applied to capture trends. Data extraction and initial coding were performed using Microsoft Excel (2016), and Tableau Software (version 2023.2) was utilized for visualizing patterns and trends across categories and variables. The first author (BO) conducted the primary data coding, which was subsequently verified and audited by the second researcher (FC).

Results

In this systematic review, the study reporting process was structured according to the PRISMA 2020 framework [25]. The process involved four main stages: identification of potential studies, initial screening of titles and abstracts, assessment of eligibility based on predefined criteria, and final inclusion (Appendix B, page. 2). A total of 902 articles were initially retrieved from the database searches. After removing 327 duplicates, 575

titles and abstracts were screened using Zotero 2 Version 6.0.30, and 575 articles were assessed for eligibility. Two independent researchers (BO, FC) evaluated the articles against the review questions and inclusion/exclusion criteria, each using their own Zotero account to ensure accuracy and minimize selection bias. Disagreements regarding eligibility were resolved through discussion, with the assistance of a third researcher (NC) when necessary. Following this comprehensive selection process and the application of exclusion criteria, 92 studies were selected for full-text review. After an in-depth review of the full-text articles, a total of 76 studies were excluded because they did not meet the PICOS criteria (e.g., wrong population, irrelevant outcomes, inappropriate study design, or insufficient data reporting). The 16 included studies were all empirical and met the inclusion criteria based on design (e.g., experimental, quasi-experimental, cross-sectional, or longitudinal) and content (addressing risks related to nurses' working hours in ICUs). Detailed breakdowns of excluded and included studies are presented in Appendix B (page. 2). 16 studies that met al.l criteria were included in this review. Descriptive statistics for these studies are presented in Appendix I (page. 18). Notably, over 60% of the included studies were published after 2019, with 43% originating from Asia and 31% from Europe. Furthermore, 68% of the studies were conducted across multiple hospital units, and 87% utilized a cross-sectional design. The results are presented in alignment with the Donabedian model, focusing on the direct relationship between structural factors (working hours and shift characteristics) and outcome variables (nurse-, patient-, and organization-related risks).

Frequency of relationships explored and the most consistent findings

Table 1 presents the countries, sample sizes, relationship sizes, and relationship types between the risk outcome variables and the risk cause variables, according to the study's risk focus. Notably, the most intense relationships were observed in nurse-focused studies. The research indicates a significant positive relationship between night/weekend/holiday shift work, specifically shift system, extended hours, and work hours, with increased risks of developing sleep disturbances and increased risk of burnout among nurses. The analysis of the reviewed studies suggests that the shift system variable has a notably positive correlation with patient-focused risks, particularly medication administration errors (MAE). It shows that working hours also affect teamwork.

In terms of study distribution, primarily presents the findings based on nurse-focused and selected patient-focused studies, where the most significant relationships were identified. Tables 2 and 3, in Appendix J (p. 19) and Appendix K (p. 20), provide detailed breakdowns of the relationship results between variables in the reviewed articles [30, 44].

Nurse-focused risk outcomes

Table 2 provides an in-depth summary of studies examining the relationship between nurses' work schedules and nursing-focused risk outcomes. Across multiple studies; Dong et al. [44], Han et al. [30] and Gander et al. [8] a significant positive relationship was consistently found between the frequency of night shifts and sleep-related problems, indicating that as night shifts increase, so do sleep disturbances. The sample sizes in these studies also played a key role in the strength of these findings. One study by Gander et al. [8]; identified a significant correlation between the total hours worked, the number of night shifts, and the risk of sleepiness while driving, emphasizing the impact of demanding work schedules on nurses' safety and well-being. The findings further indicated that factors such as the number of days worked, extended shifts, and changes in shift schedules had a positive association with increased risk of sleep disturbances and excessive sleepiness. Additionally, another study by Welp et al. [31] demonstrated a positive relationship between working night shifts and emotional exhaustion and depersonalization, while a negative relationship was found between night shifts and personal accomplishment. This suggests that night shifts not only affect physical health but also contribute to emotional and psychological strain among nurses.

Patient-focused risk outcomes

Table 3 summarizes the most striking results showing the effects of nurses' working hours on patient-focused risk outcomes. Studies have analyzed the relationship between various shift work patterns and MAE and appear to find significant associations between these work patterns and clinical errors. Increased days worked, night shifts, extended shifts of ≥30 minutes, and breaks between shifts of ≥24 hours are positively and significantly associated with clinical errors in the last six months. Specifically, the long intervals between shifts may disrupt the continuity of rest or sleep patterns, leading to fatigue or cognitive decline, which increases the likelihood of clinical errors. In addition, a positive association was observed between total extended hours and clinical errors in the previous six months. However, it is noteworthy that the number of nights sleeping from 11 p.m. to 7 a.m. and sleeping enough to feel fully rested is negatively associated with clinical errors in the last six months.

Table 1 Relationship results of risk outcome and risk cause variables regarding risks related to nurses' working hours ($n = 16$)

Focused Risk	Risk Outcomes	Risk Causes	Country	Sample Size	Relationship Type			Grand Total	Source Study*
					Positive	Negative	None		
Nurse (10 studies)	Sleep Problems	Shift system	New Zealand	3,133 nurses	2	2	2	6	[8]
		Night/weekend/ holiday shift work	New Zealand	3,133 nurses	3	6		9	[8]
			China	4,951 nurses	1			1	[18]
				2,003 nurses	2			2	[30]
		Extended hours	New Zealand	3,133 nurses	3		3	6	[8]
		Work hours	New Zealand	3,133 nurses	3		3	6	[8]
		Break work	New Zealand	3,133 nurses			3	3	[8]
	Burnout	Shift system	Swiss	1,148 nurses	2	1		3	[31]
			Turkey	594 nurses	2		2	4	[32]
			Asian Countries	3,100 nurses			2	2	[33]
		Night/weekend/ holiday shift work	Asian Countries	3,100 nurses		1	1	2	[33]
		Extended hours	Turkey	594 nurses			8	8	[32]
		Work hours	Asian Countries	3,100 nurses	1		1	2	[33]
	Work-Related Stress	Shift system	Ethiopia	398 nurses	1			1	[34]
			Iran	17,414 nurses			2	2	[35]
		Night/weekend/ holiday shift work	Iran	17,414 nurses			2	2	[34]
	Musculoskeletal Disorders	Shift system	Turkey	323 nurses			4	4	[36]
							Total	**63**	
Patient (7 studies)	MAE	Shift system	Spain	28 patients	3	3	4	10	[37]
			New Zealand	3,133 nurses	1	1		2	[8]
			Taiwan	42 nurses			2	2	[38]
		Night/weekend/ holiday shift work	New Zealand	3,133 nurses	1	2		3	[8]
		Extended hours	New Zealand	3,133 nurses	2			2	[8]
		Work hours	New Zealand	3,133 nurses	1		1	2	[8]
		Break work	New Zealand	3,133 nurses	1			1	[8]
	Adverse Events	Shift system	Spain	276 patients		2		2	[39]
		Night/weekend/ holiday shift work	France	498 patients			3	3	[40]
		Work hours	France	498 patients			1	1	[40]
	Reaction Time	Shift system	Taiwan	42 nurses	1		3		[38]
	Hypoglycemia	Shift system	Canada	165 patients	3			3	[41]
	HAIs	Night/weekend/ holiday shift work	USA	27 patients			1	1	[42]
				15 patients			1	1	[42]
							Total	**37**	
Organizational (2 studies)	Team Harmony	Shift system	Swiss	1,148 nurses		3		3	[31]
		Work hours	Italy	308 nurses	1			1	[43]
							Total	**4**	
Grand Total					**34**	**21**	**49**	**104**	

MAE: Medication Administration Error, HAIs: Healthcare-Associated Infections

*The numbers in this column refer to the studies in the reference list. Each number corresponds to a specific article that contributed data to the relationship shown in the respective row of the table. Because several studies are first cited in this table, they are numbered consecutively [31–43] here; subsequent in-text citations continue from [44]

Table 2 Nurse-focused risk outcomes ($n = 16$)

Author, Year, Country	Sample Size	Risk Outcomes	Risk Outcome Sub-dimensions	Risk Causes	P Value	OR*/β**	Relationship Type
Dong et al., 2017, China	4,951 nurses	Sleep Problems	Sleep problems	Night shift frequency per month	< 0.001	1.40	Positive relationship
Han et al., 2016, China	2,003 nurses	Sleep Problems	Sleep disorder	Times of night shift per month - general (Ref: Few)	< 0.001	1.550	Positive relationship
				Times of night shift per month - many (Ref: Few)	< 0.000	1.800	Positive relationship
Gander et al., 2019, New Zealand	3,133 nurses	Sleep Problems	Sleep at the wheel, last year	Total hours worked	< 0.01	1.017	Positive relationship
				Number of night shifts	< 0.01	1.116	Positive relationship
				Number of nights able to sleep 11pm-7am	< 0.01	0.942	Negative relationship
				Number of nights enough sleep to feel fully rested	< 0.01	0.926	Negative relationship
				Total extended hours	> 0.05	NS	No relationship
				Number of days worked	> 0.05	NS	No relationship
				Number of breaks between shifts ≥24 h	> 0.05	NS	No relationship
				Roster change both weeks versus no changes	> 0.05	NS	No relationship
				Number of shifts extended ≥30 min	> 0.05	NS	No relationship
				Shift choice	> 0.05	NS	No relationship
			Sleep problem > 6 months	Number of days worked	< 0.05	1.118	Positive relationship
				Number of night shifts	< 0.001	1.170	Positive relationship
				Number of shifts extended ≥30 min	< 0.001	1.117	Positive relationship
				Roster change both weeks versus no changes	< 0.001	1.648	Positive relationship
				Number of nights able to sleep 11pm-7am	< 0.001	0.893	Negative relationship
				Number of nights enough sleep to feel fully rested	< 0.001	0.744	Negative relationship
				Shift choice	< 0.001	0.750	Negative relationship
				Total hours worked	> 0.05	NS	No relationship
				Total extended hours	> 0.05	NS	No relationship
				Number of breaks between shifts ≥24 h	> 0.05	NS	No relationship
			Excessive sleepiness	Number of days worked	< 0.05	1.156	Positive relationship
				Number of night shifts	< 0.01	1.124	Positive relationship
				Number of shifts extended ≥30 min	< 0.001	1.149	Positive relationship
				Total extended hours	< 0.05	1.041	Positive relationship
				Roster change both weeks versus no changes	< 0.001	1.543	Positive relationship
				Number of nights able to sleep 11pm-7am	< 0.001	0.929	Negative relationship
				Number of nights enough sleep to feel fully rested	< 0.001	0.820	Negative relationship
				Shift choice	< 0.001	0.837	Negative relationship
				Total hours worked	> 0.05	NS	No relationship
				Number of breaks between shifts ≥24 h	> 0.05	NS	No relationship
Welp et al., 2019, Swiss	1,148 nurses	Burnout	Emotional exhaustion	Predominant shift - night (Ref: Day)	< 0.01	0.09**	Positive relationship
			Depersonalization		< 0.01	0.09**	Positive relationship
			Personal accomplishment		< 0.01	–0.10**	Negative relationship

Table 2 (continued)

Author, Year, Country	Sample Size	Risk Outcomes	Risk Outcome Sub-dimensions	Risk Causes	P Value	OR*/β**	Relationship Type
Elay et al., 2019, Turkey	594 nurses	Burnout	Emotional exhaustion	Alternate-day shift/other	< 0.001	3.93	Positive relationship
				Weekly working hours ≤40/≥ 80	> 0.05	NS	No relationship
				Weekly working hours 41–79/≥ 81	> 0.05	NS	No relationship
			Depersonalization	Alternate-day shift/other	< 0.05	2.22	Positive relationship
				Weekly working hours ≤40/≥ 80	> 0.05	NS	No relationship
				Weekly working hours 41–79/≥ 81	> 0.05	NS	No relationship
			Reduced personal accomplishment	Alternate-day shift/other	> 0.05	NS	No relationship
				Weekly working hours ≤40/≥ 80	> 0.05	NS	No relationship
				Weekly working hours 41–79/≥ 81	> 0.05	NS	No relationship
				Doing extra work off the clock	> 0.05	NS	No relationship
				Weekly working hours	> 0.05	NS	No relationship
				Shift work	> 0.05	NS	No relationship
See et al., 2018, Asian Countries	3,100 nurses	Burnout		Work days per month (Ref: Non-intensive care medicine)	0.01	1.03	Positive relationship
				Stay-home night calls per month (Ref: No)	0.04	0.98	Negative relationship
				Average of each ICU rotation: > 2 weeks (Ref: 0–2 weeks)	0.93	NS	No relationship
				Shift work - yes (Ref: No)	0.62	NS	No relationship
				Stay-in night calls per month (Ref: No)	0.43	NS	No relationship
				Work hours per day (Ref: Non-intensive care medicine)	0.32	NS	No relationship
Baye et al., 2020, Ethiopia	398 nurses	Work-Related Stress		Rotating shift (Ref: Fixed shift)	< 0.05	2.5	Positive relationship
Kazemi et al., 2022, Iran	17,144 nurses	Work-Related Stress		Working shift - fixed	NA	NS	No relationship
				Working shift - rotation	NA	NS	No relationship
				Working in holiday days - yes	NA	NS	No relationship
				Working in holiday days - no	NA	NS	No relationship
Sezgin & Esin, 2014, Turkey	323 nurses	Musculoskeletal Disorders	Lower back symptoms	Monthly (Ref: Weekly)	> 0.05	NS	No relationship
				Irregular (Ref: Weekly)	> 0.05	NS	No relationship
			Leg symptoms	Type 2 (08–16/16–08) (Ref: Type 1 (08–18/18–08))	> 0.05	NS	No relationship
				Type 3 (08–20/20–08) (Ref: Type 1 (08–18/18–08))	> 0.05	NS	No relationship

OR: Odds Ratio, β: Standardized Regression Coefficients, ICU: Intensive Care Unit, NA: Not Applicable, Ref: Reference, NS: not significant

*An odds ratio > 1.0 indicates a direct (positive) relationship, and an odds ratio < 1.0 indicates an inverse (negative) relationship

**β > 0 indicates a direct (positive) relationship, while a β < 0 indicates an inverse (negative) relationship. The larger the absolute value of β, the stronger the association

Discussion

This systematic review highlights that the most prominent risks associated with nurses' working hours in intensive care units are primarily nurse-focused. Specifically, the risk of developing sleep disturbances and increased burnout emerged as the most frequently reported adverse outcomes. These risks were most often linked to working conditions involving rotating shifts, extended working hours, and frequent night, weekend, or holiday duties. On the patient side, MAEs emerged as the most frequently studied outcome concerning nurse scheduling. Organizational risks, such as disruptions in team harmony, were addressed less frequently. Among all examined factors, insufficient rest and break times were found to have the least explored associations, indicating a notable gap in the literature. Addressing this gap through organization-focused research could contribute to more sustainable workforce models in critical care settings.

Relationship between nurses' work hours and nurses

In the studies analyzed, the consequences of extended and irregular working hours in intensive care units were most evident in nurses' sleep quality and psychological well-being. Their study also reported a significant negative relationship between sleep quality and prolonged sleep problems, suggesting that insufficient rest over time leads to excessive fatigue and persistent sleep issues. Our findings regarding the risk of developing sleep

Table 3 Patient-focused risk outcomes ($n = 16$)

Article Author, Year, Country	Sample Size	Risk Outcomes	Subdimensions of Risk Outcomes	Risk Causes	P Value	OR*	Relationship Type
Gander et al., 2019, New Zealand	3,133 nurses	MAE	Clinical error in the last 6 months	Number of days worked	< 0.001	1.308	Positive relationship
				Number of night shifts	< 0.05	1.086	Positive relationship
				Number of shifts extended ≥30 min	< 0.001	1.133	Positive relationship
				Total extended hours	< 0.01	1.055	Positive relationship
				Number of breaks between shifts ≥24 h	< 0.01	1.123	Positive relationship
				Roster change both weeks versus no changes	< 0.001	1.587	Positive relationship
				Number of nights able to sleep 11pm-7am	< 0.05	0.956	Negative relationship
				Number of nights enough sleep to feel fully rested	< 0.001	0.870	Negative relationship
				Shift choice	< 0.001	0.687	Negative relationship
				Total hours worked	> 0.05	NS	No relationship
Suclupe et al., 2020, Spain	28 patients	MAE	Preparation	Shift - morning (Ref: Night shift)	0.05	2.37	Positive relationship
				Shift - afternoon (Ref: Night shift)	< 0.01	4.07	Positive relationship
			Interruption	Shift - morning (Ref: Night shift)	0.02	2.15	Positive relationship
				Shift - afternoon (Ref: Night shift)	0.09	NS	No relationship
			Medication prepared by another professional	Shift - morning (Ref: Night shift)	0.01	0.27	Negative relationship
				Shift - afternoon (Ref: Night shift)	0.17	NS	No relationship
			Out of time or without prescription	Shift - morning (Ref: Night shift)	0.29	NS	No relationship
				Shift - afternoon (Ref: Night shift)	< 0.01	0.35	Negative relationship
			No information to patient	Shift - morning (Ref: Night shift)	0.59	NS	No relationship
				Shift - afternoon (Ref: Night shift)	0.03	0.09	Negative relationship
Lee et al., 2024, Taiwan	42 nurses	MAE		Shift - evening (Ref: Morning shift)	0.83	NS	No relationship
				Shift - night (Ref: Morning shift)	0.08	NS	No relationship

OR: Odds Ratio, MAE: Medication Administration Error, HAIs: Healthcare-Associated Infections, Ref: Reference, NS: not significant

*An odds ratio > 1.0 indicates a direct (positive) relationship, and an odds ratio < 1.0 indicates an inverse (negative) relationship

disturbances are consistent with previous research. Imes and Chasens [45] explored differences in sleep characteristics between day and night shift nurses in intensive care units, finding that rotating shift work contributed to disrupted sleep patterns. Similarly, Boughattas et al. [46] concluded that night shifts negatively affect sleep quality, often leading to sleep disorders and insufficient rest. Alaradi et al. [47] also reported a strong association between shift work and sleep disruption, with many ICU nurses experiencing poor sleep quality. Tucker et al. [48] identified a clear link between shift work and clinically significant sleep disorders. Zhang et al. [49] demonstrated that nurses working frequent night shifts are at greater risk of reduced sleep duration, difficulty initiating sleep, and overall poor sleep quality.

Given that shift work is an essential component of hospital operations and that nurses comprise a substantial portion of the healthcare workforce, creating a supportive environment to mitigate these consequences becomes imperative [50]. Improving rest periods, minimizing consecutive night shifts, and ensuring access to designated rest areas or opportunities for napping during long shifts may help enhance the quality of sleep and reduce fatigue among staff members [51]. Our findings on burnout also reflect previous evidence. Chuang et al. [52], in a systematic review of 25 studies, reported that the prevalence of burnout among intensive care professionals ranges between 6 and 47%, with a notable association between shift work and emotional exhaustion. Similarly, Di Muzio et al. [26] found that nurses working rotating shifts or extended hours were more likely to experience symptoms of fatigue and burnout. Our review supports these findings and highlights the urgent need for strategic planning and rest policies by ensuring healthy working conditions in this context, where increased burnout among nurses is associated with their intention to leave the institution [21].

Relationship between nurses' work hours on patients

This review identified several patient-related consequences associated with excessive and irregular nurse working hours, including MAEs, adverse events, hypoglycemia, and healthcare-associated infections (Table 3, Appendix J, p. 19). Among these, medication errors were

the most frequently reported outcome. Gander et al. [8] reported a positive association between prolonged working hours and an increased frequency of clinical errors. Similarly, Aiken et al. [53] found that nurses working more than 12 hours per day or more than 40 hours per week were more likely to contribute to adverse patient outcomes. These findings underscore the relationship between extended work schedules and patient safety.

Other reviewed studies reported that working night, weekend, or holiday shifts, as well as having insufficient rest between shifts, was positively associated with the risk of patient harm [32]. Notably, the frequency of nights slept between 23:00 and 07:00 and the number of nights slept sufficiently to feel fully rested demonstrated a negative relationship with clinical errors in the last six months. This highlights the importance of quality sleep in reducing the risk of clinical errors and underscores the complex interplay of several factors that influence patient safety [8]. In terms of timing, errors in medication preparation and administration were found to be more frequent during afternoon and night shifts. These include administering medication without a prescription, lack of patient communication, and errors introduced by staff other than the prescribing nurse [37]. By contrast, such errors were less frequently observed during morning shifts, due to better staffing ratios and supervision.

The systematic review by Di Muzio et al. [26] also supports the association between shift work and medication errors. They concluded that night shifts and rotations were significantly linked to an increase in error rates, notably when shift duration exceeded 12 hours. Additional studies similarly suggest that prolonged working hours—beyond 40 to 50 hours per week—elevate the risk of errors [54, 55]. Furthermore, adverse events linked to patient positioning (e.g., semi-recumbent position) were more frequently associated with non-morning shifts, implying better adherence to protocols during standard hours [39]. Overall, the literature consistently supports the conclusion that extended and irregular working hours among ICU nurses are associated with a greater risk of preventable clinical errors, particularly during night or prolonged shifts. Optimizing nurse scheduling may therefore directly contribute to improved patient safety. This review, based on the Donabedian model, demonstrates that structural components, such as long and irregular work hours and shift schedules, as discussed above, influence nurse well-being, patient safety, quality of care, and organizational functioning. Future research could examine the intermediary mechanisms through which structures influence outcomes, such as team communication or clinical decision-making processes. The effects of working hours on team harmony and the duration of rest breaks on work performance and patient safety should be examined through long-term studies, with any identified gaps in this area addressed.

Limitations of the study

This systematic review was limited to English/Turkish studies published between 2014 and 2024, which may have led to the exclusion of some earlier relevant research, potentially narrowing the scope of the literature covered. Additionally, the review focused on general nursing areas, excluding publications that concentrated on specific nursing fields, disease processes, or non-intensive care unit settings. The study further restricted its analysis to empirical research exploring relationships between risk cause and risk outcome variables, with a particular emphasis on studies using regression analysis to identify the direction and consistency of these relationships. Including only cases involving regression analysis poses a risk of excluding relevant definitions and distributions. This methodological focus was adopted to ensure a comprehensive and systematic examination of the variables. One of the limitations of the study is that the effects of working hours on health institutions cannot be discussed due to the lack of sufficient studies. The fact that the evaluation of qualitative evidence creates a broad limitation in the scope of the phenomenon was considered a limitation. Another limitation is that the majority of the included studies were cross-sectional, which may limit the ability to conclude temporal and directional relationships. The fact that the results of the studies included in this review could be influenced by geographical region and cultural differences in which they were conducted was considered a limitation.

Conclusion

This systematic review provides a comprehensive summary of research from the past decade on the risks associated with nurses' working hours in intensive care units and their effects on patients, nurses, and healthcare organizations. This review emphasizes the urgent need to optimize nurses' working hours in intensive care units, particularly to prevent sleep disturbances, increased burnout, and medication errors. Based on our findings, the most prominent challenges stem from night, weekend, and rotating shifts, which were strongly associated with sleep-related issues and emotional exhaustion. Healthcare institutions should therefore prioritize structured scheduling systems that minimize consecutive night shifts and ensure adequate rest periods between shifts. Optimizing scheduling through reduced overtime, adequate rest periods, and limits on consecutive night shifts may help create healthier work environments and lower nurses' intention to leave.

Targeted interventions such as regulated shift rotations, rest break policies, and designated rest areas

during long shifts could improve nurses' recovery and alertness. Organizational efforts to reduce nurse fatigue may also contribute to decreasing medication administration errors—a patient safety issue consistently linked with extended work hours in our analysis. The effects of working hours on team harmony and the duration of rest breaks on work performance and patient safety should be examined through long-term studies, with gaps in this area addressed. Furthermore, empirical investigation is necessary to assess the direct impact of addressing the nursing workforce shortage on nurse well-being and patient outcomes, considering the potential compounding effects of understaffing. Ultimately, optimizing nurses' working hours is not only a matter of workforce management but a critical requirement for safeguarding patient safety and sustaining a resilient healthcare system.

Abbreviations

β	Standardized Regression Coefficients
HAIs	Healthcare-Associated Infections
ICU	Intensive Care Unit
JBI	Joanna Briggs Institute
MAE	Medication Administration Error
NA	Not Applicable
NIH	National Institutes of Health
NS	not significant
OR	Odds Ratio
PICOS	Population, Intervention, Comparison, Outcome, Study Design
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
Ref	Reference

Supplementary Information

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Supplementary material 1

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Data availability
The data that support the findings of this study are openly available on request from the corresponding author.

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