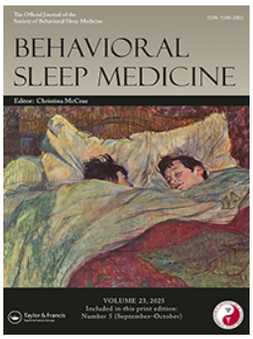

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A Mixed-methods Systematic Review of Sleep Duration and Quality in Healthcare Workers: Impacts on Patient Safety and Quality of Care

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ABSTRACT

Objectives: The aim of this systematic review was to synthesize evidence on the impacts of sleep duration and quality in healthcare workers on patient safety and quality of care. A secondary aim was to understand the impact of shiftwork and workload characteristics alongside sleep duration and quality.
Methods: A systematic search of Scopus, PubMed, Embase, APA PsycINFO, and CINAHL databases was completed in May 2023 and updated in December 2024. Only studies published in English from 2013 onwards were considered for inclusion in the review. Quality appraisal of included studies was conducted via the McMaster tools for quantitative and qualitative studies, respectively, and results were synthesized and presented as a narrative summary.
Results: Database searching revealed 7,422 results, with 30 studies eventually included in the review. Studies consistently showed that short sleep duration in healthcare workers was associated with worse patient safety (increased errors and poorer cognitive functioning). There was also a clear link between shiftwork and long shifts with reduced patient safety.
Conclusions: The majority of included studies revealed that patient safety and quality of care are worse where HCWs experience short duration and/or low-quality sleep or are working long and/or irregular shifts.

Introduction

Frequent sleep disturbances can have considerable negative impacts on the physical and mental health of individuals. Health care workers (HCWs) are a key group of people who are particularly vulnerable, owing to a variety of factors including long hours, shift work, being on call and high-stress work roles leading to sleep which may be low-quality, interrupted, and/or of short duration. Over the last decade, the higher prevalence of sleep disturbances in HCWs compared to the general population has been documented (Ghalichi et al., 2013). For example, in a systematic review which included studies published until mid-2018, the pooled prevalence of poor sleep quality in nurses was 61% (Zeng et al., 2020). Although sleep disturbances in HCWs were already more prevalent than in one general population (currently <30% in the general population; Hakami et al., 2023), this issue has been exacerbated in recent years following the

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COVID-19 pandemic (Salari et al., 2020), with sleep disturbances reported in up to 75% of HCWs in 2021 (Jahrami et al., 2021). Accordingly, these sleep disturbances place HCWs at risk of negative psychological consequences such as distress, burnout, and depression (Pappa et al., 2022).

In addition to the impact poor sleep can have on the health and wellbeing of HCWs, it may also impact the quality of their work, whereby sleep disturbances are shown to negatively impact cognitive functioning such as reaction time (Saadat et al., 2017), memory (Chang et al., 2013), psychomotor vigilance (Whelehan et al., 2021), attention (Johnson et al., 2010), and concentration (Johnson et al., 2010). Furthermore, HCWs experiencing sleep disturbances are likely to have more absences (Gillet et al., 2020) and lower productivity (Park et al., 2018) and career satisfaction (Landel & Dasgupta, 2018). In combination, the consequences of insufficient and/or low-quality sleep in HCWs, exacerbated by the stress of shiftwork and long working hours, may lead to poor employee health and wellbeing, a strained workforce (as a consequence of absenteeism and staff turnover), and a lower standard of care provided to patients. As such, it is important to understand how sleep in HCWs impacts both the employee and patients they treat so that strategies can be implemented to ensure a safe environment for HCWs and patients.

Although some reviews have previously assessed how sleep in HCWs impacts patient safety, a comprehensive investigation is lacking with previous reviews only capturing data from nurses (Cho & Steege, 2021; DiMuzio et al., 2019), or physicians (Gates et al., 2018) in isolation. Furthermore, while patient safety is of crucial importance, the patient experience and quality of care they receive is also a key outcome but has not yet been reviewed in relation to how it is impacted by sleep of HCWs. In this regard, an earlier systematic review suggested that outcomes such as patient satisfaction be explored in relation to HCW sleep and fatigue (Cho & Steege, 2021). However, a comprehensive understanding of the impact that sleep disturbances in HCWs has on patient safety and quality of care is important to develop to fully elucidate the extent of the problem and to be able to propose solutions and implement strategies to mitigate potential risks. Therefore, the aim of this systematic review was to synthesize evidence on the impacts of sleep duration and quality in HCWs on patient safety and quality of care. A secondary aim was to understand the impact of shiftwork and workload characteristics alongside sleep duration and quality.

Materials and methods

This review is reported in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines (Supplementary Table S1) (Page et al., 2021). The protocol was registered on the National Institute for Health research: PROSPERO international prospective register of systematic reviews database (Registration number: CRD - 42,023,427,846; Fox et al., 2023). No changes were made to the review protocol following registration.

Search strategy

An electronic search of Scopus, PubMed, Embase (Elsevier), APA PsycINFO (EBSCOhost), and CINAHL databases was conducted using three groups of search terms (sleep, healthcare worker, and patient safety or quality of care). Search terms were developed and refined by drawing on prior research and via piloting the search within the relevant databases. Each group of keywords were independently searched with search terms separated by the Boolean operator "OR", before combining the search strings using the Boolean operator "AND". The search terms used and the complete search strategy for each database are provided in Supplementary tables S2 and S3, respectively. All identified articles were imported to Covidence (Covidence systematic review software, Veritas Health Innovation, Melbourne, Australia) which was used for de-duplication, screening, and data extraction. Duplicates not detected by Covidence were manually identified. A title search of gray literature was also conducted using Google Scholar to further ensure no relevant articles were missed. Only one

source of gray literature was searched as we were seeking only original, peer-reviewed research which are most likely to be retrieved via scholarly databases rather than other sources. The searching was completed on 19 May 2023 and updated on 12 December 2024.

Screening and data extraction

Studies were screened based on the inclusion and exclusion criteria outlined in Table 1. These criteria were chosen based on definitions in related reviews also looking at patient safety and quality of care as their outcomes of interest. Studies were limited to those published in the last 10 years to ensure findings were as relevant as possible to the current work environment for HCWs, particularly following the COVID-19 pandemic. All authors initially screened a selection of articles as a group ($N \approx 10$) to establish consistency. Next, all titles and abstracts were screened by two authors (drawn from GC, DC, RL, RY); any disagreement was discussed, and the final decision made by JF or PM. Full texts were then screened via the same process. Reference lists of included articles were screened but did

Table 1. Inclusion and exclusion criteria.

PICO element	Inclusion criteria	Exclusion criteria
Population	Healthcare workers – nurses, doctors, and allied health professionals including: • Nutritionists/dietetics • Occupational therapists • Physiotherapists • Psychologists • Podiatrists • Social workers • Speech pathologists • Exercise physiologists (Turnbull et al., 2009) Shift workers are included as a subpopulation of interest due to a number of previous studies having found that HCWs doing shift work are more vulnerable to sleep disturbances and its associated effects (Alshahrani et al., 2017; DiMuzio et al., 2019)	Administration staff (i.e. receptionists) Health professional trainees or students (i.e. medical students, nursing students, allied health students) Carers HCWs not active in clinical practice
Investigated phenomena	Sleep health measured through: • Objective sleep measures (e.g. activity monitors, etc.) • Subjective sleep measures (e.g. sleep diaries, questionnaires, etc.) • Global sleep measures (e.g. Pittsburgh Sleep Quality Index, etc.)	Shift/work patterns only Measures of fatigue or burnout only
Context	Public and private healthcare settings including hospitals, community health settings (i.e. primary care)	Settings not primarily associated with healthcare (e.g. schools, prisons, detention centers)
Outcome	Patient safety (Snowdon et al., 2016) • Adverse events/complications • Mortality • Failure to cure • Reoperations/readmissions • Medication errors (DiMuzio et al., 2019) Quality of care (Snowdon et al., 2017) • Objective (e.g. patient outcomes, body function, activity) Subjective (e.g. health-related quality of life, measures of patient experience)	Physician health and well-being only Any other patient safety and quality of care measures not included within inclusion criteria Any other patient outcomes
Study design	Primary studies (Clarke, 2011) • Quantitative study designs (including RCTs, cohort studies, cross-sectional etc.) • Qualitative study designs (including interviews, focus groups) • Mixed methods designs	Secondary research such as reviews Case reports Editorials, opinion pieces Conference abstracts Theses Research protocols
Other	Published from 2013 onwards (10 years from the original search date) Peer-reviewed sources	Non-English literature Non-human studies

HCWs = healthcare workers, RCT = Randomised Controlled Trials.

not reveal any additional studies for inclusion. Data extraction utilized a customized template within the Covidence platform, which was piloted as a group before GC, DC, RL, or RY extracted the data from each article.

Quality appraisal

Quantitative and qualitative studies were assessed for methodological quality using the McMaster tools for quantitative (Law et al., 1998) and qualitative studies (Letts et al., 2007), respectively. This was completed independently by two authors (drawn from GC, DC, RL, RY) before being compared for consensus; disagreements were resolved by JF or PM.

Results

Study selection

The PRISMA flowchart showing article screening and inclusion outcomes is provided in Figure 1. A total of 7,422 articles were identified via database searching (Scopus: $N = 2{,}288$; PubMed: $N = 2{,}426$;

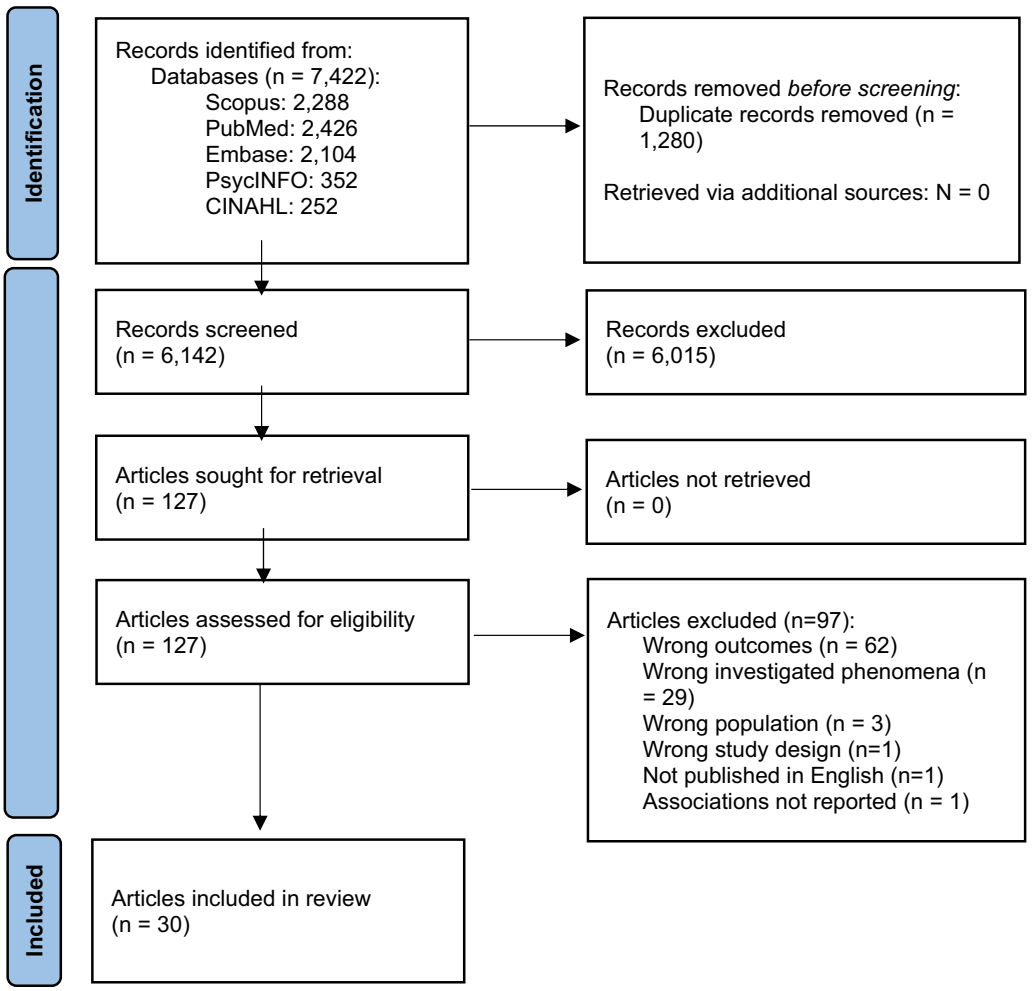

Figure 1. Flowchart of screening and study selection.

Embase: $N = 2{,}104$; PsycINFO: $N = 352$; CINAHL: $N = 252$), of which 1,280 were duplicates. After screening 6,142 titles and abstracts, 127 articles were deemed relevant and progressed to full-text screening. 31 articles were included at full-text screening, after which one article (Desai et al., 2013) was excluded during data extraction as no data relating to the associations between sleep and patient safety/quality of care were reported. As such, 30 articles were included in the review. The gray literature search yielded no additional relevant studies.

Characteristics of included studies

The characteristics of included studies and study participants are provided in Tables 2 and 3, respectively. All studies ($N = 30$) utilized descriptive study designs, the majority of which were quantitative ($N = 27$, 90%) and were most commonly conducted in the United States ($N = 13$; 43%). Participants in the included studies were nurses ($N = 16$; 53%), doctors ($N = 9$; 30%), an aggregation of many types of healthcare workers ($N = 3$; 10%), a combination of doctors and nurses ($N = 1$; 4%), or midwives ($N = 1$; 4%), and sample size ranged from 30 to 3,654. Participants' gender, age, experience, and workload/shift characteristics varied considerably across studies (Table 3); however, the majority of studies did not have similar proportions of males and female participants.

Quality appraisal

Results of the quality appraisal for each included quantitative and qualitative study are provided in supplementary Tables S4 and S5, respectively. Of the quantitative studies ($N = 27$), all scored yes for clearly outlining the study purpose, reviewing the literature, describing the sample in detail, reporting the results in terms of statistical analysis, and utilizing appropriate analysis methods. Only nine quantitative studies (33%) scored yes for justifying the sample size, and 16 (59%) for reporting clinical importance.

Of the qualitative studies ($N = 3$), all scored yes on all items except having a clear and complete description of the site ($N = 2$ answered yes; 67%), data analysis being inductive ($N = 2$; 67%), evidence for dependability ($N = 2$; 67%), evidence for confirmability ($N = 2$; 67%), sampling until redundancy was reached ($N = 1$; 33%), identifying the role of researchers and relationships with participants ($N = 1$; 33%), evidence for transferability ($N = 1$; 33%), identifying a theoretical perspective ($N = 0$; 0%), and identifying assumptions and biases of the researcher ($N = 0$; 0%).

Data synthesis

Due to the considerable variation in outcome measures and descriptive and inferential statistics used, a meta-analysis of the data was not possible. Therefore, a narrative summary of the results is presented (Popay et al., 2006). Risk of bias due to missing results was not assessed and we did not formally assess confidence in the body of evidence (Page et al., 2021).

Study findings

Overall, findings indicate that insufficient sleep duration and low sleep quality are commonly related to more frequent medical errors and poorer quality of patient care. A description of sleep-related outcomes, patient safety and quality of care-related outcomes, and relationships between these elements for each included article is presented in supplementary table S6. While most studies revealed some level of association between sleep and patient safety/quality of care, the sleep-related variables significantly associated with patient safety and quality of care varied between studies. Poor sleep quality, assessed subjectively using PSQI (where higher scores indicate worse sleep), was significantly associated with more medical errors (Demir & Karadag, 2023) and medication errors (Abbas et al., 2021) as well as reduced motivation, low job efficiency, failure to take emergency actions, reduced

Table 2. Characteristics of included studies.

Study	Country	Aims	Description	Type	Population
Abbas et al. (2021)	Kuwait	To assess sleep quality among healthcare workers on the front line of COVID-19 management at Kuwait Ministry of Health hospitals and its relationship to experiencing medical errors	Quantitative	Cross-sectional survey	Healthcare workers in public hospitals
Abdalla et al. (2022)	United States	To assess the correlation between the frequency and burden of neurointerventional surgery calls and sleep deprivation with physician burnout, physical and driving safety, and fatigue-related medical errors.	Quantitative	Cross-sectional survey	Neurointerventionalists who were members of the Society of Neurointerventional Surgery and Society of Vascular and Interventional Neurology boards
Abdulah and Suleman (2021)	Iraqi Kurdistan	To examine the interactive effect of insomnia and perceived time pressure on safety events to patients in nurses of general public hospitals.	Quantitative	Cross-sectional survey	Nurses in public hospitals who were nonalcoholic, worked full-time and did not self-report any mental disorders
Alyahya et al. (2021)	Jordan	To investigate the association of cognitive medical errors with hospitals' organizational factors and workload, stress, sleep and fatigue.	Quantitative	Correlational cross-sectional survey	Registered nurses and physicians working in clinical departments of three hospitals (University hospital, public hospital, and a private hospital)
Andreassen et al. (2018)	Norway	To investigate the relationship between workaholism and negative work-related incidents in a large sample of nurses.	Quantitative	Cross-sectional survey	Nurses who were members of the Norwegian nurses organisation
Arbour et al. (2020)	United States	To describe midwives experiences related to sleep and sleep deprivation as a result of their work and call-shift schedules.	Qualitative	Survey (open-ended questions)	Midwives who were members of the American College of nurse midwives
Arslanian-Engoren and Scott (2014)	United States	To examine decision regret among critical care nurses, with an emphasis on clinical decisions made when nurses were most sleepy.	Qualitative (from a larger study)	Survey (open-ended questions)	Critical care nurses who were members of the American Association of Critical Care Nurses and working full-time (≥36 hours/week)
Balogun et al. (2023)	Nigeria	To investigate the prevalence of the "second victim" phenomenon among residents in surgical specialties and to determine the impact of the adverse event on the second victim, identify the coping strategies employed and explore the possibility of improving on the coping strategies.	Qualitative	Phenomenology study: Semi-structured interviews	Resident doctors completing postgraduate training in surgery or a surgery sub-specialty
Bayoumi et al. (2020)	Egypt	To evaluate the impact of nurses' poor sleep hygiene on patients' care at intensive care units.	Quantitative	Cross-sectional study	ICU nurses working in a public hospital

(*Continued*)

Table 2. (Continued).

Study	Country	Aims	Description	Type	Population
Booker et al. (2024)	Australia	To explore if there are differences in shift patterns and work-related factors between metropolitan and regional/rural healthcare shift workers and their risk of poor sleep and mental health. A secondary aim was to explore whether these factors impact on medical errors, workplace and car accidents/near car accidents.	Quantitative	Cross-sectional survey	Nurses, midwives, and paramedics working shiftwork in Australia
Chaiard et al. (2018)	Thailand	To discern if inadequate sleep duration increases the risk of fatigue, excessive daytime sleepiness, and occupational errors	Quantitative	Cross-sectional survey	Registered nurses who had worked in a tertiary hospital for ≥1 year and were employed full-time
Crincoli et al. (2024)	United States	To identify and understand the interrelationships among organizational characteristics (unsupportive practice environments, high registered nurse workloads, and high staffing ratios), individual nurse characteristics (years of experience, level of education, sleep between work shifts), and occupational fatigue increase levels of missed care at night.	Quantitative	Cross-sectional survey	Licensed registered nurses in New Jersey who completed the board of nursing annual workforce survey
Demir and Karadag (2023)	Turkey	To examine the relationship between the sleep quality of nurses working shifts and their tendency to commit medical errors.	Quantitative	Cross-sectional study	Nurses working in a state, private, and university hospital in a single province in Turkey.
Dollarhide et al. (2014)	United States	To assess the real-time influence of emotional stress, workload, and sleep deprivation on self-reported medication events by physicians in academic hospitals.	Quantitative	Cross-sectional study	Physicians from four large academic hospitals
Ghorbani et al. (2023)	Iran	To examine the association between sleep quality, chronotype and medication errors among nurses who are working in critical care units.	Quantitative	Cross-sectional study	Nurses working in critical care (Intensive Care Unit, Cardiac Care Unit, Emergency department) in three teaching hospitals.
Hassinger et al. (2024)	United States	To investigate the link between sleep health and self-reported medical errors	Quantitative	Secondary analysis from a prospective cohort study	Interns who completed the Intern Health Study between 2017 and 2019.

(*Continued*)

Table 2. (Continued).

Study	Country	Aims	Description	Type	Population
Johnson et al. (2014)	United States	To investigate the relationship between sleep deprivation and occupational and patient care errors among staff nurses who work the night shift.	Quantitative	Cross-sectional survey	Nurses working on medical-surgical, obstetric, critical care, emergency, pediatric, psychiatric, and orthopedic units in three urban hospitals with ≥1 year of experience as a registered nurse or licensed and no untreated sleep disorders
Kalmbach et al. (2017)	United States	To prospectively characterize the risk of depression and medical errors based on pre-internship sleep disturbance, internship-related sleep duration, and duty hours.	Quantitative	Prospective cohort study	Interns from 10 specialties across 33 institutions who screened negative for depression at baseline
Karahan et al. (2020)	Turkey	To determine sleep quality, fatigue, and concentration in nurses according to their shifts and chronotype.	Quantitative	Cross-sectional survey	Nurses working in hospitals
Kwak et al. (2024)	South Korea	To assess the rate of near-miss error experiences and its related factors, as well as to examine the association of job stress, quality of sleep, and the experiences of near-miss error incidents.	Quantitative	Cross-sectional survey	Nurses working in general hospitals in a province in South Korea
Morelock (2016)	United States	To better understand the relationship between fatigue and error in the clinical practice environment; to better quantify the relationships between factors that affect safety and quality such as stress, skill level, and practice environments.	Quantitative	Cross-sectional survey	Critical care nurses in five critical care units and two emergency departments in two medical centers affiliated with a large metropolitan hospital system
Prabath et al. (2022)	Sri Lanka	To assess intern medical officers' level of burnout, associated factors and the effects on self-reported patient care in comparison to post-intern Relief House Officers.	Quantitative	Cross-sectional survey	Internal medical officers and relief house officers attached to general medical and general surgery wards in two teaching hospitals
Quan et al. (2023)	United States	To determine whether there would be more medical errors, adverse events, and operating room communication and teamwork issues after a night on call with at least 2 hours of hospital clinical duties	Quantitative	Prospective, within subjects, repeated measures observational study	Attending surgeons from eight hospitals with surgical and/or obstetric services
Saleh et al. (2014)	Egypt	To explore the extent of nurses' circadian rhythm sleep disorders, fatigue, and depression and their impact on medication administration errors.	Quantitative	Descriptive cross-sectional study	Full time nurses at an oncology facility (2 medical and 4 surgical units) affiliated with a university hospital

(*Continued*)

Table 2. (Continued).

Study	Country	Aims	Description	Type	Population
Scott et al. (2014)	United States	To examine the association between selected sleep variables, impairment due to fatigue, and clinical-decision self-efficacy and regret among critical care nurses.	Quantitative	Cross-sectional survey	Full-time critical care nurses who were members of the American Association of critical-Care Nurses
Senol et al. (2014)	Turkey	To identify the sleep quality of emergency health workers and to determine its effects on professional and social life	Quantitative	Cross-sectional survey	Emergency health workers from emergency aid stations
Stimpfel et al. (2020)	United States	To describe sleep duration and work characteristics among registered nurses across health care settings and unit types; to determine the association between sleep duration and quality of care and patient safety	Quantitative	Two parallel cross-sectional surveys (data aggregated).	Newly licensed nurses working as a staff or general duty nurse at the time of survey administration
Weaver et al. (2016)	United States	To determine if sleep quality (uninterrupted sleep) or sleep quantity (number of hours of sleep), prior to working a 12-hour shift in an ED, affects the perceived error rate of RNs in a critical care setting	Quantitative	Prospective, observational, self-administered survey coupled with wrist actigraphy	Registered nurses working in the emergency department of a university hospital
Westbrook et al. (2018)	Australia	To assess the relative contributions of interruptions and multitasking by emergency physicians to prescribing errors, while also considering a range of individual, physician and contextual characteristics such as working memory capacity, preference for multitasking, age, seniority, workload and fatigue/sleep.	Quantitative	Prospective, direct observation study, combined with sleep survey	Emergency department physicians in a teaching hospital
Zupancic et al. (2021)	Slovenia	To understand how perceived work safety and exposure to risk, such as working at COVID-19 entry points, could have impacted physician sleep and psychological functioning at work and whether sleep and safety could have worked as protective factors in ensuring resilient healthcare system by decreasing the likelihood of compromised safety and medical errors.	Quantitative	Cross-sectional survey	Registered physicians from all medical specialties

ICU = Intensive Care Unit; RCT = Randomised Controlled Trial; PGY = Postgraduate Year; ED = Emergency Department; RN = Registered Nurse.

Table 3. Characteristics of study participants.

Study	Sample size	Gender of HCWs	Age of HCWs (years)	Experience of HCWs	Workload/shift characteristics of HCWs
Abbas et al. (2021)	217	122 (56%) males; 95 (44%) females	36 ± 7 (mean ±standard deviation)	<10 years: 118 (54%); >10 years: 99 (46%)	<48 hours/week: 80 (37%); >48 hours/week: 137 (63%)
Abdalla et al. (2022)	164	male to female ratio of 9:1	<30: *N* = 2; 30–39: ~20%; 40–49: 50%; 50–59: 20%; 60–69: 10%; >69: *N* = 1	>5 years: 78%; >20 years: 18%	Not reported
Abdulah and Suleman (2021)	111	57 (51%) males; 54 (49%) females	30 ± 5	Not reported	Morning shift (8am-2pm): 41 (37%); evening (2pm-8pm): 21 (19%); night (8pm-8am): 17 (15%); rotating (multiple shift types): 32 (29%)
Alyahya et al. (2021)	400	190 (48%) males; 210 (53%) females	20–30: 169 (42%); 31–40: 196 (49%); 41–50: 30 (8%); 51–60: 4 (0.01%); >60: 1 (0.002%)	<1 year: 39 (10%); 1–5 years: 110 (28%); 6–10 years: 122 (31%); 11–15 years: 77 (19%); 16–20 years: 35 (9%); >20 years: 17 (4%)	Not reported
Andreassen et al. (2018)	1781	177 (10%) males; 1595 (90%) females	36 ± 9	Not reported	Percentage of full time equivalent: >90% FTE: 55%; 76–90% FTE: 18%; 50–74% FTE: 23%; <50% FTE: 4%
Arbour et al. (2020)	268	4 (2%) males; 264 (99%) females	52 ± 11	Not reported	Not reported
Arslanian-Engoren and Scott (2014)	157	81% females	46 ± 10	Not reported	Dayshift: 49%; Night shift: 35%; additional employment (>12 hours/week beyond full-time employment): 17%
Balogun et al. (2023)	31	21 (68%) males; 10 (32%) females	32 ± 2.8	2–3 years in residency training: 14 (45%); >3 years in residency training: 17 (55%)	Not reported
Bayoumi et al. (2020)	40	12 (30%) males; 28 (70%) females	26 ± 4	6 ± 4 years (range: 1–16)	68 ± 9 hours/week (range: 48–72)
Booker et al. (2024)	403	44 (11%) males; 359 (89%) females	39 ± 12 metropolitan HCWs 45 ± 14 rural/ regional HCWs	1–5 years: 104 (26%) >5 years: 298 (74%)	Hours worked per week: 35 ± 9 metropolitan; 37 ± 11 rural/ regional Shift pattern: 61 (15%) fixed; 340 (85%) rotating Night shifts in the past two weeks: 2.1 ± 2.2 metropolitan; 2.6 ± 2.5 rural/ regional Consecutive night shifts worked normally: 2.6 ± 1.6 metropolitan; 2.6 ± 1.7 rural/ regional
Chaiard et al. (2018)	220	17 (8%) males; 203 (92%) females	≤40: 144 (66%); 41–49: 76 (35%)	≤20 years: 172 (78%); >20 years: 48 (22%)	Day only: 42 (19%); Rotating: 178 (81%); 115 (52%) had 10 + nightshifts per month
Crincoli et al. (2024)	228	23 (10%) males; 205 (90%) females	34 ± 11	Not reported	7pm-7am shift: 218 (96%); 3pm-11pm shift: 5 (2%); 11pm-7am shift: 5 (2%) Number of consecutive shifts normally worked per week: 58 (25%) <2; 138 (61%) ≥3; 31 (14%) other

(*Continued*)

Table 3. (Continued).

Study	Sample size	Gender of HCWs	Age of HCWs (years)	Experience of HCWs	Workload/shift characteristics of HCWs
Demir and Karadag (2023)	378	69 (18%) males; 309 (82%) females	29 ± 8	Not reported	8am-4pm shift: 78 (21%); 8am-8pm shift: 11 (3%); 4pm-8am shift: 23 (7%); permanent night shift: 44 (12%); shiftwork: 222 (59%)
Dollarhide et al. (2014)	185	85 (46% males); 100 (54%) females	30 ± 5	Not reported	Not reported
Ghorbani et al. (2023)	173	26 (15%) males; 147 (85%) females	33 ± 7	9 ± 6	Fixed shift: 7 (4%); rotating shift: 166 (96%)
Hassinger et al. (2024)	3654	1598 (44%) males; 2056 (56%) females	28 ± 3	Not reported	Average weekly duty hours: 64 ± 19
Johnson et al. (2014)	289	56 (18%) males; 233 (82%) females	39 ± 10	≤5 years: 104 (39%)	On night shifts for >5 years: 133 (49%)
Kalmbach et al. (2017)	1215	624 (51%) males; 591 (49%) females	28 ± 3	Not reported	3 months into internship: 67 ± 16hrs/week 6 months internship: 65 ± 18 hrs/week
Karahan et al. (2020)	285	25 (9%) males; 260 (91%) females	28 ± 8	Not reported	Not reported
Kwak et al. (2024)	195	21 (11%) males; 174 (89%) females	33 ± 8	7 ± 7	Day work: 42 (22%); 2 or 3 shifts/week: 131 (67%); fixed day or night shifts: 22 (11%) Night shifts/month: 5 ± 4 Overtime work hours/week: 1.5 ± 2.5
Morelock (2016)	45	18 (40%) males; 25 (55%) females; 2 n/a	20–30: 45%; 31–40: 24%; 41–50: 9%; 51–60: 13%; >60: 4%; n/a: 5%	Not reported	Am shift: 43%; pm shift: 55%; did not answer: 2%
Prabath et al. (2022)	114	male to female ratio of 1:1.3 (intern medical officers) and 1.6:1 (relief house officers)	Both groups: 27 ± 1	Not reported	Not reported
Quan et al. (2023)	60 (362 cases)	65% males	48 ± 10	15 ± 10 years post-residency	Not reported
Saleh et al. (2014)	52	1 (2%) male; 51 (98%) females	23.5 ± 3	Nursing experience: 5 ± 3 years	56 ± 12 hours per week
Scott et al. (2014)	546	79 (15%) males; 465 (85%) females	46 ± 10	Not reported	12 hour shifts: 475 (87%); 8 hour shifts: 53 (10%); Other shifts: 16 (3%) Day shift: 311 (58%); night shift: 156 (29%); evening shift: 15 (3%); rotating shift: 59 (11%)
Senol et al. (2014)	121	53 (44%) males; 68 (56%) females	18–27: 92 (76%); 28–37: 26 (22%); 38–46: 3 (3%)	≤1–5 years: 96 (79%); 6–10 years: 20 (17%); 16–20 years: 5 (4%)	Day shift (8am-5pm): 5 (4%); night shift (5pm-8am): 14 (12%); evening shift (5pm-11:59pm): 17 (14%); 24-hour shift (8am-8am): 85 (70%)
Stimpfel et al. (2020)	1568	181 (12%) males; 1377 (88%) females	32 ± 9	Not reported	Full time employee: 1275 (82%); part time employee: 285 (18%)

(*Continued*)

Table 3. (Continued).

Study	Sample size	Gender of HCWs	Age of HCWs (years)	Experience of HCWs	Workload/shift characteristics of HCWs
Weaver et al. (2016)	30	6 (20%) males; 24 (80.0%) females	Not reported	10 ± 9 years	2.6 ± 0.6 shifts worked per week
Westbrook et al. (2018)	36 (58 sessions)	Not reported	Not reported	Not reported	Not reported
Zupancic et al. (2021)	1189	287 (27%) males; 787 (73%) females	46 ± 12	Not reported	Full time employee: 994 (92%); part time/contract employee: 80 (8%) 0 night shifts/month: 620 (59%); 1–5 night shifts/ month: 370 (35%); 6–10 night shifts/month: 50 (5%); 11–15 night shifts/month: 9 (1%)

HCW = healthcare workers; FTE = full-time equivalent.

performance, and loss of attention/concentration (Senol et al., 2014). Poorer sleep efficiency was also significantly associated with more errors in one study (Hassinger et al., 2024), while another showed a significant association with more minor errors (e.g., documenting the wrong chart but correcting it), but not moderate (e.g., entering the patient's room without proper supplies) or severe errors (e.g., administering the wrong medication; Weaver et al., 2016). One study using PSQI found that higher subjective sleep quality, sleep duration, and sleep efficiency (indicating better sleep) were significantly associated with fewer professional errors, but also worse PSQI score and sleep latency were significantly associated with fewer professional errors (Bayoumi et al., 2020). In contrast, four studies found no statistically significant relationship between PSQI (global score and sleep quality) and medical errors (Ghorbani et al., 2023; Karahan et al., 2020; Morelock, 2016; Weaver et al., 2016) and one found no statistically significant association between PSQI and near-miss errors (determined via an 18-item questionnaire; Kwak et al., 2024).

In seven studies, low sleep duration was significantly associated with more medical errors (Abdalla et al., 2022; Dollarhide et al., 2014; Johnson et al., 2014; Kalmbach et al., 2017; Saleh et al., 2014; Westbrook et al., 2018; Zupancic et al., 2021) and one study found that longer sleep duration was significantly associated with lower quality patient care (Prabath et al., 2022). One study assessing both safety and quality of care found that increased sleep duration was significantly associated with better quality of care (non-technical skills [situational awareness, decision-making, communication, and teamwork]), though no change in incidence of errors was observed (Quan et al., 2023); a similar study found increased sleep duration to be significantly associated with improved patient safety and quality of care (Stimpfel et al., 2020). A further study which utilized a factor analysis revealed that of two overarching constructs, psychological and functional factors contributed to increased cognitive medical errors, of which sleep and fatigue were contributing factors (Alyahya et al., 2021).

Regarding shift characteristics, one study found that the number of night shifts completed, but not sleep duration, were significantly associated with "near miss (determined via an 18-item questionnaire)" harming incidents, but not actual harm (Andreassen et al., 2018). Similarly, daytime sleepiness and working 12-hour shifts were significantly associated with decision regret but sleep duration and quality were not (Scott et al., 2014). Shift characteristics including more evening shifts in the preceding two weeks (Booker et al., 2024) and working >8 hours/day, >40 hours/week, or > 10 night shifts/month (Chaiard et al., 2018) were significantly associated with more errors, as was fatigue and excessive daytime sleepiness (Chaiard et al., 2018). Shorter turnaround time between shifts (i.e., intershift recovery) also predicted missed patient care (Crincoli et al., 2024). A further study found that for every additional hour of work per week, the odds of making an error increased by 1% (Hassinger et al.,

2024). At a more extreme level, working ≥70 hours per week was also associated with more errors (Kalmbach et al., 2017). Lastly, irregular shiftwork and sleeping patterns were significantly associated with more medication errors (Saleh et al., 2014).

Within qualitative evidence, doctors reflected that loss of sleep, relating to long work hours and overnight on-call shifts, was the most common circumstance contributing to medical errors (Balogun et al., 2023). Similarly, midwives recounted serious consequences of their sleep deprivation, including missing labors/phone calls and providing lower quality care, with a participant commenting that the "*decisions [they] made at 4 am were not as good as the decisions made at 4pm*" (Arbour et al., 2020). In contrast, conflicting findings were reported by Arslanian-Engoren & Scott (2014), whereby nurses reported making similar clinical decisions while alert and while sleepy. However, compared to the larger mixed-methods study where data were drawn from, nurses who experienced decision regret were more likely to work nights and 12-hour shifts and experienced more fatigue, daytime sleepiness, and insufficient recovery between shifts.

Discussion

This review investigated how sleep duration and quality amongst HCWs impacts patient safety and quality of care. The majority of included studies revealed that patient safety and quality of care are worse where HCWs experience short duration and/or low-quality sleep or are working long and/or irregular shifts. It was particularly clear from the evidence that low sleep duration for HCWs compromises patient safety, including more medical and medication errors and worse cognitive functioning. These findings align with earlier systematic reviews where sleep deprivation, among other factors, was linked to worse patient safety (DiMuzio et al., 2019). As such, these data provide justification for strategies to be developed and implemented to support HCWs in achieving sufficient sleep before they come to work. This may include stricter rules around shift length and time between shifts (Landel & Dasgupta, 2018) or interventions such as those promoting better sleep hygiene (Bayoumi et al., 2020; Landel & Dasgupta, 2018).

Although the link between sleep duration and safety was clear, fewer studies assessed the relationship between sleep quality and patient safety. Data also revealed some conflicting findings whereby a mix of positive and negative correlations were reported, though not always significant. For one study, negative correlations were reported for global PSQI scores and sleep latency (whereby higher values indicate worse sleep) and errors (indicating that better sleep was associated with more errors), despite other sleep variables showing that worse sleep was associated with more errors (Bayoumi et al., 2020); as such, it is possible that all correlations were mistakenly labeled as negative when instead worse sleep was associated with more errors for all variables. While data were conflicting, one study showed an association between sleep quality and minor but not moderate or severe medical errors (Weaver et al., 2016). In addition to the limited data on sleep quality and patient safety, some studies also did not clearly define what they considered to be an error (Karahan et al., 2020; Morelock, 2016). As such, it is difficult to determine whether HCWs are able to handle some degree of reduced quality sleep without making errors in patient care that may cause significant harm, as some findings suggested (Weaver et al., 2016) and therefore, further research is needed. Nevertheless, any reduction in safety or quality of care should be avoided to the highest extent possible and HCWs should be working in an environment which allows them to work at their highest standard to maintain their own health and wellbeing as well as ensuring the best possible outcomes for patients they care for.

While this review was focussed on both patient safety and quality of care, quality of care data were limited, with the majority of studies focussing on patient safety. This lack of evidence persists despite earlier research calling for further investigation into HCW sleep and quality of patient care (Cho & Steege, 2021). Nevertheless, all included studies showed that lower sleep duration was linked to lower quality of care. Given these preliminary findings, we recommend more research be conducted to understand how sleep and shift characteristics impact patient care, going beyond patient safety.

A secondary aim of this review was to explore the impact of shiftwork and workload characteristics alongside sleep duration and quality. Evidence consistently showed that both

irregular shift patterns and long working hours lead to HCWs making more errors, as a consequence of poor sleep and/or fatigue. This finding also aligns with past research showing associations between shiftwork and worse patient safety (Weaver et al., 2023). In healthcare settings like hospitals, work patterns such as rotating and night shifts are largely unavoidable, with many additionally required to be available to work, if needed, during on-call periods; however, organizations may need to consider strategies such as reduced shift length, regular breaks, and appropriate rostering in negating some of the consequences of shiftwork and associated poor sleep. In addition, educational interventions teaching shift workers about sleep and counteracting fatigue or promoting sleep hygiene and other behavioral strategies (e.g., mindfulness) may be able to improve patient safety (Barger et al., 2018). As such, organizations should invest in strategies to manage sleep and fatigue-related outcomes for HCWs as they are likely to improve both the longevity of the workforce and organizational outcomes such as patient care and safety.

Strengths of this review include the use of PRISMA guidelines to inform the reporting of the review and the inclusion of quantitative and qualitative study designs which provides a broader range of evidence to draw from. While our review highlights important information about how sleep in HCWs impacts patient safety and quality of care, there are some limitations which should be considered when interpreting the results. First, there was considerable variation across studies in how data relating to sleep, patient safety, and quality of care were collected and reported. There was considerable use of surveys and self-reported instruments, many custom-made for the study rather than using validated instruments. This use of customized tools creates difficulties in evaluating the quality of the methodology and comparing results and trends between studies. Second, of the included studies, all utilized descriptive study designs, potentially offering a lower standard of evidence. Future research should consider undertaking more robust experimental research such as developing and evaluating interventions aiming to improve sleep amongst HCWs. Third, there were specific areas of the quality appraisal where included studies performed particularly poorly. Quantitative studies often did not justify their sample size and while data were reported in terms of statistical significance, many did not report clinical significance, often with significant results but only weak associations. Although the number of qualitative studies is low ($N = 3$), they did not report a theoretical perspective or identify the assumptions and biases of the researcher. As such, the variable quality and inconsistent reporting within the included studies mean that data should be interpreted cautiously. Fourth, in the present review we explored shift characteristics in relation to sleep duration and quality; however, it is important to note that shift-characteristics may impact patient safety and quality of care because of other related factors such as circadian disruption or HCW chronotype. Lastly, for practical reasons only studies published in English were included, which may exclude relevant results.

Conclusions

The majority of included studies focussed on relationships between sleep and patient safety. As such, more research is needed to fully ascertain how sleep duration and quality as well as shift and workload characteristics impact the quality of patient care provided by HCWs. Nevertheless, it is clear that HCWs are often not providing the highest standard of care possible, as a consequence of sleep disturbances. Strategies need to be developed and rigorously evaluated to ensure that HCWs have opportunities for sufficient sleep between shifts and can implement proper sleep hygiene.

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Data availability statement

A summary of extracted data from each included study is presented as supplementary online material.

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