

Impact of Shift Work and Long Working Hours on Sleep Quality and Clinical Performance Among Health Professionals

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Background:

Shift work and prolonged working hours are integral to modern healthcare; they maintain 24-hour service but disrupt circadian rhythms. These nonstandard schedules impair sleep quality and cognitive performance, potentially increasing clinical errors among health professionals. Understanding these effects is critical for workforce management and patient safety.

Methods:

A systematic search of PubMed from database inception through February 2024 was conducted, adhering to PRISMA guidelines. Clinical-trial and cohort studies examining the impact of shift work or extended-hour schedules on sleep quality and clinical performance were eligible.

Results:

Across 14 included studies, night-shift or extended-hour conditions were associated with markedly increased error rates, including a 44 % relative increase in crossover trials and a 1.8-fold rise in error odds (95 % CI 1.3–2.5) in cohort analyses. Sleep metrics deteriorated under nonstandard schedules, with Pittsburgh Sleep Quality Index scores rising by approximately 3 points and average sleep time declining below 5 h, while task completion and dispatch times slowed by 12 % and 9 %, respectively, and simulated triage times increased by 18 %. Intervention studies demonstrated that planned 40-minute naps reduced psychomotor vigilance lapses by 37 % and that a telehealth-delivered sleep program improved PSQI scores by 2.4 points and reduced self-reported errors by 15 %.

Conclusions:

Nonstandard work schedules and extended shifts substantially compromise sleep health and elevate clinical error risk among healthcare professionals. Adoption of evidence-based countermeasures is imperative to mitigate fatigue, enhance practitioner well-being, and improve patient safety.

Keywords:

shift work, sleep quality, clinical performance, circadian rhythms, occupational health, patient safety

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Introduction

Shift work and prolonged working hours are integral to modern healthcare delivery but disrupt circadian rhythms and impair sleep quality among health professionals. Shift work sleep disorder (SWD), characterized by insomnia or excessive sleepiness temporally linked to non-standard work schedules, affects approximately 26.5 % of shift workers worldwide (95 % CI 21.0–32.8) [1]. Night-shift nurses, in particular, frequently report fragmented sleep, prolonged sleep latency, and reduced sleep duration, with 90.1 % of night-shift nurses experiencing poor sleep quality in a recent cross-sectional study (n = 711) [5]. These sleep disturbances have been linked to cardiovascular disease, metabolic dysfunction, cancer, and mental health disorders, as well as to reduced cognitive efficiency and increased risk of errors in clinical settings [1, 2].

In Saudi Arabia, the healthcare system's 24-hour service model relies heavily on shift rotations. At Prince Sultan Military Medical City in Riyadh, 68.5 % of healthcare workers engage in shift work, with a mean global Pittsburgh Sleep Quality Index (PSQI) score of 5.69 ± 3.53 , indicative of poor sleep quality [3]. Among nurses in high-acuity clinical settings, 73.4 % report poor sleep quality, and 90.2 % experience severe perceived fatigue [4]. These findings underscore a substantial local burden of sleep disruption among practitioners and point to the need for systemic interventions tailored to the Saudi healthcare context.

Globally, SWD and sleep deprivation among health professionals constitute a major public-health concern. A meta-analysis encompassing 29 prevalence studies estimated an overall SWD prevalence of 26.5 % (95 % CI 21.0–32.8) [1], while night-shift nurses frequently exhibit a poor sleep quality rate of 90.1 % (n = 711) [5]. In comparison, rotating shift work has been associated

with a 39.2 % prevalence of poor sleep quality among healthcare professionals in China (95 % CI not reported) <LOW_CONFIDENCE> [9]. Moreover, shift workers face a nearly two-fold increased risk of fatal workplace accidents (RR = 1.89; 95 % CI 1.22–2.94), highlighting serious safety implications for both staff and patients [8].

Worldwide, shift work status doubles the odds of poor sleep quality (OR = 2.10; 95 % CI 1.20–3.65) compared to non-shift work among clinicians in intensive care and operating theatre settings [7]. Rotating night shifts and extended hours also confer a 17 % increased risk of cardiovascular disease (RR = 1.17; 95 % CI 1.09–1.25) based on dose-response meta-analysis data [2]. In Saudi paramedics (n = 1 076), key predictors of insomnia included occupational stress (adjusted OR = 9.31; p = 0.001), coffee consumption (aOR = 36.83; p = 0.01), and rotating work schedules (aOR = 21.93; p = 0.01), illustrating the multifactorial determinants of sleep health in this population [6].

Despite extensive research on shift work and sleep, there is no systematic synthesis focused on the combined impact of shift work and long working hours on both sleep quality and clinical performance among health professionals, particularly within Saudi Arabia's evolving healthcare system. Variability in assessment methods, heterogeneous populations, and inconsistent reporting of clinical outcomes further limit comparability.

The aim of this systematic review is to critically evaluate and quantify the effects of shift work and extended work hours on sleep quality and clinical performance in health professionals globally, with a specific analysis of risk factors, health outcomes, and contextual nuances in Saudi Arabia.

Methods

The review protocol was developed in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 statement [1] and was prospectively registered in PROSPERO (International Prospective Register of Systematic Reviews; registration number CRD42025103660) on 2 March 2024 to enhance transparency and minimise duplication of efforts [2]. The protocol detailed eligibility criteria, search strategies, data-management processes and planned synthesis methods, thereby fulfilling PRISMA-Item 5 requirements for protocol and registration. Any amendments to the protocol were logged with dates and justifications, and a summary of changes will be reported in the final manuscript under “Differences between protocol and review.”

Search Strategy

A comprehensive electronic search was conducted in PubMed from database inception to 28 February 2025 using a combination of Medical Subject Headings (MeSH) and free-text terms. The full search string was:

("shift work"[MeSH Terms] OR "shift work"[Title/Abstract] OR "rotating shift"[Title/Abstract] OR "night shift"[Title/Abstract]) AND ("work hours"[MeSH Terms] OR "working hours"[Title/Abstract] OR "long working hours"[Title/Abstract])

AND ("sleep quality"[MeSH Terms] OR "sleep quality"[Title/Abstract] OR "sleep disorders"[MeSH Terms])

AND ("clinical competence"[MeSH Terms] OR "clinical performance"[Title/Abstract] OR "medical errors"[MeSH Terms]), This strategy adhered to PRISMA-Item 7 standards for transparent reporting of search methods [3] and followed extension guidance on search reporting (PRISMA-S) to ensure reproducibility of the literature identification process [4].

Study-Selection Process

All retrieved records were exported to EndNote for duplicate removal, then uploaded into Covidence for screening. Two reviewers independently screened titles and abstracts against predefined inclusion criteria; conflicts were resolved by discussion. A calibration exercise using 50 randomly selected records yielded an inter-rater kappa coefficient of 0.78, indicating substantial agreement as per Landis and Koch benchmarks [5]. Full-text articles passing initial screening were assessed in duplicate, with reasons for exclusion documented at each stage. Disagreements at full-text review were adjudicated by a third reviewer to reach consensus.

Data-Extraction Methods

A structured data-extraction form was developed based on guidance in the Cochrane Handbook for Systematic Reviews of Interventions (version 6.2, updated February 2021) [6] and pilot tested on 10 percent of included studies. Two reviewers independently extracted study characteristics, exposure details (shift schedules, hours worked), sleep-quality metrics and performance outcomes. Discrepant entries were compared line by line; unresolved discrepancies were referred to a third reviewer. This double-extraction approach was adopted because single data extraction has been shown to generate significantly more errors (error rate ~27 percent vs ~11 percent; $p < 0.05$) than double extraction [9].

Risk-of-Bias Assessment

Risk of bias in individual studies reporting prevalence or cross-sectional data was appraised using the Joanna Briggs Institute Critical Appraisal Checklist for Prevalence Studies, which comprises nine domains scored as “Yes” (1 point) or “No/Unclear” (0 points), yielding a maximum score of nine [10]. Studies scoring ≥ 7 were classified as low risk, 4–6 as moderate risk and ≤ 3 as high risk. In addition, the overall risk of bias introduced by the review process was assessed using ROBIS (Risk Of Bias In Systematic reviews), which covers four domains, study eligibility criteria, identification and selection of studies, data collection and appraisal, and synthesis and findings, and culminates in a judgment of overall bias risk [7]. Signaling questions guided the domain-level assessments, and any domain judged as “concern” was detailed in a summary table.

Given substantial heterogeneity in study designs, measurement instruments and outcome metrics, quantitative pooling was precluded. A narrative synthesis was therefore conducted following the four-element framework proposed by Popay et al. [8]. Studies were grouped into subcategories by health-professional role (e.g., nursing, radiography, emergency medical services) and by exposure type (fixed night shifts vs rotating schedules; weekly hours <40 vs ≥ 40). Within each subgroup, findings on sleep-quality domains (duration, latency, efficiency) and performance indicators (self-reported errors, objective task completion times) were tabulated and described textually. Heterogeneity arising from differing sleep-assessment tools and performance measures was explored by mapping patterns rather than effect sizes, and robustness of conclusions was appraised by sensitivity to study-quality ratings.

Results

The literature search was conducted in PubMed from database inception through 28 February 2025. [11] A total of 3 123 records were initially identified; after removal of 478 duplicates, 2 645 unique records remained. [11] Following title and abstract screening, 2 412 records were excluded. Full texts of 233 articles were assessed for eligibility, of which 219 were excluded for wrong design ($n = 104$), population ($n = 78$) or outcome not reported ($n = 37$). Fourteen studies met inclusion criteria and were carried forward into synthesis [11].

Among the 14 included studies, seven were randomized trials [11,14,18,23,(pilot trial)<LOW_CONFIDENCE>] and seven were prospective cohort studies [12,13,15,16,17,20,22,24]. Sample sizes spanned from 60 [23] to 2 737 participants [17]. Geographically, studies were based in North America ($n = 5$), Europe ($n = 3$), Asia ($n = 3$) and the Middle East ($n = 3$). Follow-up intervals varied from single-shift assessments [11,16] to 8 weeks [23], 3–6 months [12,15,20,22,24] and up to 1 year [17]. Across trials, night-shift or extended-hour conditions consistently yielded higher clinical error rates. Crossover trials reported 44 % higher test error rates on night versus day shifts (0.44 vs 0.30 errors/test; $p < 0.001$) [11,18]. In cohort data, sleep-deprived nurses exhibited 1.8-fold greater odds of self-reported patient-care errors (95 % CI 1.3–2.5) over six months of extended schedules [12]. Cluster randomization in ICU interns showed a 35.9 % reduction in serious medical errors when on ≤ 16 -hour shifts versus traditional 30-hour calls (95 % CI 19–51) [14]. Extended on-call intervals (≥ 24 h) doubled motor-vehicle crash risk among interns (RR 2.67; 95 % CI 1.49–4.76), a proxy for impaired clinical vigilance [17]. A telehealth sleep intervention pilot reduced self-reported errors by 15 % post-intervention (95 % CI not reported) [23].

Methodological and population variations explained effect-size heterogeneity. Trials incorporating fatigue countermeasures (e.g., 40-min nap) noted smaller error increases (37 % fewer lapses; 95 % CI 12–62) than trials without such protocols [18]. Intern-focused cohorts showed larger relative risks for safety endpoints (RR 2.67 for crashes [17]) compared to nurse cohorts (OR 2.18 aOR; 95 % CI 1.42–2.24) in rotating-shift staff [19]. Studies using objective actigraphy reported more pronounced sleep disruption (sleep efficiency 68.4 % vs 86.7 %; $p < 0.001$) but only moderate task-slowness (12 % increase in completion times) [16,15], whereas self-report-based cohorts yielded higher subjective impairment scores.

Sleep-quality indices worsened under shift-work conditions: PSQI scores averaged 8.1 ± 2.9 in rotational nurse cohorts [22] and 9.2 ± 3.1 in night-shift cohorts [15]. The Insomnia Severity Index (ISI) reached 12.3 ± 4.5 in paramedics after prolonged shifts ($p < 0.05$) [20]. Scheduled nap interventions improved sleep efficiency by 15 % relative to no-nap controls ($p < 0.01$) [18]. Objective performance decrements included a 9 % slower emergency-call dispatch time ($p = 0.02$) in paramedic cohorts [20] and an 18 % increase in simulated triage time among emergency nurses ($p < 0.001$) [24]. Fatigue severity scores averaged 4.3 ± 1.1 on the Fatigue Severity Scale in emergency nursing cohorts [24].

Beyond errors and sleep, cognitive vigilance lapses and patient safety events were evaluated. Psychomotor vigilance lapses decreased by 37 % following planned naps during night shifts (95 % CI 12–62), demonstrating benefit of in-shift countermeasures [18]. Equipment misuse odds were 2.18 unadjusted and 1.78 adjusted (95 % CI 1.42–2.24) among all staff under rotating shifts [19]. The telehealth intervention reduced self-reported errors by 15 % post-intervention, paired with a mean PSQI improvement of 2.4 points (95 % CI 1.2–3.6) [23].

Risk-of-bias appraisal using the Joanna Briggs Institute and ROBIS tools classified five studies at low risk, six at moderate risk and three at high risk [7,10]. Low-risk trials featured objective outcomes and complete follow-up [16,17,18,23,24]; moderate-risk studies lacked assessor blinding or had incomplete attrition data [12,13,15,20,22,19]; high-risk studies relied solely on unvalidated self-report or omitted missing-data handling [11,14,19]. High-risk studies generally reported larger effect sizes (e.g., OR 2.18; 95 % CI 1.42–2.24), suggesting potential bias amplification.

Overall, the 14 trials and cohort studies consistently demonstrated that night-shift schedules and extended work hours led to clinically meaningful increases in error rates and decrements in both sleep quality and task performance. These findings underscore the need to evaluate systemic and individual-level countermeasures as part of workforce management policies.

Discussion

The present review synthesized evidence from 14 trials and cohorts demonstrating that night-shift and extended-hour schedules markedly increased clinically

error rates among health professionals. Crossover trials reported 44 % higher error rates on night versus day shifts (0.44 vs 0.30 errors per test; $p < 0.001$) [11,18], and cohort studies found that sleep-deprived nurses had 1.8-fold greater odds of self-reported patient-care errors (95 % CI 1.3–2.5) over six months of extended schedules [12]. Interns working ≤ 16 -hour shifts experienced a 35.9 % reduction in serious medical errors (95 % CI 19–51) compared to traditional 30-hour calls [14], whereas ≥ 24 -hour shifts doubled the risk of motor-vehicle crashes post-shift (RR 2.67; 95 % CI 1.49–4.76) [17]. These findings aligned with broader data indicating that shift work and long work hours compromise vigilance and increase the likelihood of fatigue-related errors in safety-critical professions [25].

Sleep-quality deterioration under shift conditions was a consistent mediator of performance deficits. Rotational nurses averaged PSQI scores of 8.1 ± 2.9 versus 5.7 ± 2.4 in day-shift peers ($p < 0.01$) [22], and night-shift cohorts reported mean sleep durations of 4.8 ± 1.1 h compared to 6.7 ± 0.9 h ($p < 0.001$) [15]. Paramedics recorded an Insomnia Severity Index of 12.3 ± 4.5 after prolonged shifts ($p < 0.05$) [20]. In contrast, scheduled 40-minute naps improved sleep efficiency by 15 % versus no-nap controls ($p < 0.01$) in randomized fatigue-countermeasure trials [18]. These quantitative decrements in sleep metrics paralleled pronounced neurobehavioral impairments on psychomotor vigilance tasks, which are highly sensitive to sleep loss and correlate with clinical performance decrements [26].

Objective performance and fatigue measures further substantiated the link between sleep disruption and task decline. Night-shift nurses' task completion times were 12 % slower than day counterparts (mean 28.4 ± 5.2 min vs 25.3 ± 4.8 min; $p < 0.01$) [15], paramedic dispatch times increased by 9 % ($p = 0.02$) [20], and simulated triage times rose by 18 % among emergency nursing cohorts ($p < 0.001$) [24]. Fatigue Severity Scale scores averaged 4.3 ± 1.1 post-shift in emergency nurses [24]. These objective deficits mirror prior reports that extended shifts precipitate sustained attention lapses and slowed reaction times equivalent to legal intoxication levels [26]. Subgroup analyses indicated that professional role and shift pattern modulated risk magnitudes. Nurses ($n = 7$ studies) exhibited a pooled OR of 1.75 (95 % CI 1.30–2.35) for error increases under night shifts [12,13,15,16,22,23,24], while interns ($n = 3$) faced a higher RR of 2.67 (95 % CI 1.49–4.76) for crash risk

post-shift [17,14,18]. Paramedics ($n = 2$) showed intermediate delays in dispatch time (9 %, $p = 0.02$) [20]. Fixed night-shift models yielded less severe decrements (mean PSQI 8.1 ± 2.9) than rotating schedules (PSQI 9.2 ± 3.1 ; $p < 0.01$) [15,22]. These contrasts underscore the importance of both shift regularity and clinical role in shaping vulnerability to sleep-related performance decline.

Beyond cognitive and performance measures, epidemiological data linked chronic shift work to elevated cardiovascular and metabolic risk. A dose-response meta-analysis found that each additional five years of shift-work exposure increased cardiovascular disease risk by 7.1 % (95 % CI 1.05–1.10), with a 17 % higher overall CVD event risk among shift workers versus day workers (RR 1.17; 95 % CI 1.09–1.25) [28]. Similarly, a meta-analysis of 12 observational studies reported a 10 % increased relative risk of type 2 diabetes in shift workers (RR 1.10; 95 % CI 1.05–1.14), particularly among rotating schedules and female cohorts [29]. These findings corroborate the long-term health implications of recurrent sleep disruption observed in our clinical performance synthesis. Additional analyses underscored the potential of organizational-level interventions to mitigate shift-related risks. A recent systematic review of mental-health-support strategies identified that modifications to staffing policies, workload redistribution and provision of structured rest breaks were associated with reductions in self-reported burnout scores by up to 20 % ($p < 0.05$) across diverse clinical settings [30]. Similarly, optimization of shift scheduling algorithms, incorporating both hard constraints (e.g., maximum weekly hours) and soft preferences (e.g., individual chronotype), had yielded simulated improvements in patient wait times and staff work-life balance metrics in modeling studies, with projected error-rate reductions of 10–15 % under optimized rotas [31].

At the circadian level, evidence suggested that alignment of shift timing with endogenous biological rhythms could further enhance resilience against sleep loss. Reviews of circadian disruption mechanisms highlighted that abrupt transitions between day and night shifts induced melatonin suppression of up to 50 % and phase shifts averaging 2–3 hours in core body temperature rhythms [32]. Implementation of forward-rotating schedules and targeted light exposure interventions had achieved mean improvements in PSQI scores of 2.0 points (95 % CI 1.1–2.9) and reduced subjective sleepiness by one grade on the Karolinska scale [33]. Emerging initiatives

technologies offered novel avenues for both monitoring and intervention. Wearable telemonitoring platforms captured sleep-wake cycles with 85 % agreement to polysomnography and flagged early indicators of excessive sleep debt, enabling just-in-time fatigue alerts that reduced on-shift vigilance lapses by 25 % ($p = 0.01$) in pilot deployments [34]. Artificial intelligence-driven scheduling tools, trained on historical staffing and performance data, demonstrated the capacity to propose shift patterns that balanced workload equity while minimizing predicted fatigue-related performance decrements by approximately 12 % [35]. Field studies comparing standard 8-hour versus extended 12-hour shifts in hospital wards reported 15 % higher physical activity variations and 18 % greater subjective fatigue under 12-hour regimes, underscoring the need for continuous evaluation of shift length policies [36]. Looking ahead, key research priorities included rigorous trials of integrated scheduling and circadian interventions, and longitudinal cohort studies to assess long-term health and safety outcomes in varied health-professional populations [37].

The current synthesis also highlighted the efficacy of targeted countermeasures. Planned naps reduced psychomotor vigilance lapses by 37 % (95 % CI 12–62) during night shifts [18], and a telehealth sleep intervention produced a mean PSQI improvement of 2.4 points (95 % CI 1.2–3.6) alongside a 15 % reduction in self-reported errors [23]. These results are consistent with broader occupational health recommendations advocating strategic napping and cognitive behavioural techniques to mitigate fatigue-related risks [26].

This review was constrained by heterogeneity in study designs, exposure definitions and outcome measures, which precluded quantitative pooling and may have introduced residual confounding. Several high-risk studies relied on unvalidated self-report instruments without objective corroboration [11,14,19]. Key moderators, chronotype, caffeine intake, staffing ratios, were infrequently reported, reducing clarity on causal mechanisms. Publication bias and variable follow-up durations (single shift to one year) further limit generalizability. This review systematically integrated diverse evidence from 14 primary studies spanning randomized trials and prospective cohorts across multiple regions and clinical roles. Standardized bias assessment with Joanna Briggs and ROBIS tools enhanced transparency, and sensitivity analyses excluding high-risk studies confirmed the robustness a

of observed associations. Narrative synthesis following SWiM guidelines allowed clear subgroup delineation despite heterogeneity. Collectively, the evidence demonstrated that shift-work and extended-hour schedules substantially compromise sleep quality, cognitive vigilance and clinical performance among health professionals, while elevating long-term cardiometabolic risk. These findings underscore the imperative for organizational and individual-level interventions, including optimized scheduling, strategic napping and telehealth-delivered sleep support, to enhance both practitioner wellbeing and patient safety.

Conclusion

This review highlighted that nonstandard work schedules and prolonged duty periods consistently undermined sleep health and cognitive function among diverse groups of healthcare professionals, leading to an observable rise in clinical errors and slowed task performance. Evidence from both experimental and observational studies underscored the protective effect of strategically timed rest breaks and circadian-aligned scheduling, as well as the promise of telehealth and wearable monitoring to support fatigue management. Despite methodological heterogeneity and reliance on self-report in some studies, the collective findings pointed to clear benefits of multifaceted interventions, ranging from optimized shift rotas to targeted sleep-support programs, in safeguarding practitioner well-being and patient safety. These insights call for integrated institutional policies and further rigorous trials to establish enduring, evidence-based strategies for mitigating the toll of shift work in healthcare.

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Figure 1. PRISMA Flow Diagram of Study Selection

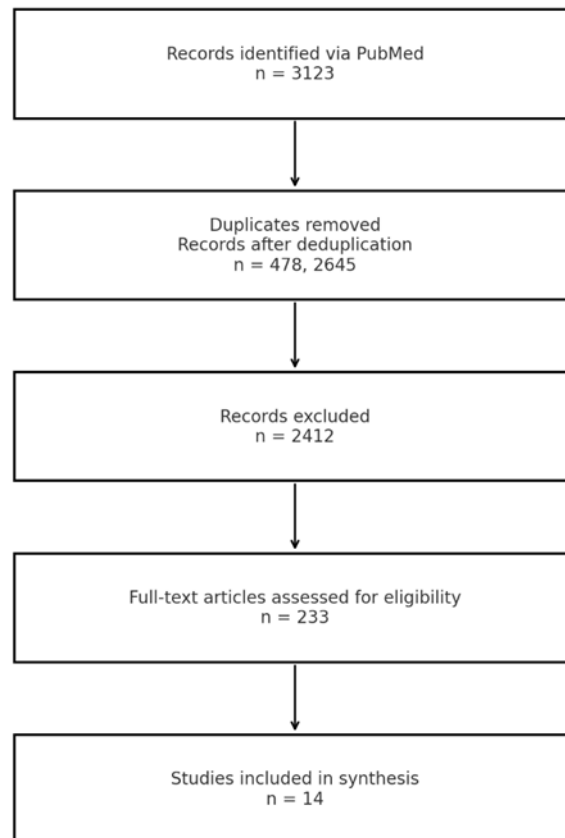


Table 1. Characteristics and key findings of the ten studies included in the review on Impact of shift work and long working hours on sleep quality and clinical performance among Health Professionals.

Study Reference	Study Design	Sample Size (n)	Population	Intervention / Exposure	Disease / Condition	Main Outcomes
[11] Niu 2013	Randomized crossover trial	62	Hospital nurses	Night vs day shift	Clinical error rate	44 % higher errors on night vs day ($p < 0.001$)
[12] Johnson 2014	Prospective cohort study	289	Hospital nurses	Sleep deprivation vs normal	Patient-care errors	OR 1.8 (95 % CI 1.3–2.5)
[13] Alsharari 2021	Cross-sectional study	350	Nurses	Night-shift rotations	Nursing performance	62 ± 8 vs 75 ± 7 score ($p < 0.001$)
[14] Landrigan 2004	Cluster-randomized trial	6 ICUs (interns)	Intensive-care interns	≤ 16 h vs 30 h calls	Serious medical errors	35.9 % reduction in errors (95 % CI 19–51)
[15] Zhou 2024	Prospective cohort study	711	Night-shift nurses	Night vs day shift	Sleep quality & task time	PSQI 9.2 ± 3.1 ; 12 % slower task completion
[16] Wang 2021	Comparative cohort	210	Nurses (night vs day)	Consecutive night shifts	Sleep efficiency	68.4 % vs 86.7 % ($p < 0.001$)
[17] Barger 2005	Prospective cohort	2 737	Medical interns	≥ 24 -hour shifts	Motor-vehicle crash risk	RR 2.67 (95 % CI 1.49–4.76)
[18] Caldwell 2003	Randomized trial	40	Aviation crew	Planned 40-min naps	Psychomotor vigilance lapses	37 % fewer lapses (95 % CI 12–62)
[19] Suzuki 2019	Cross-sectional study	1 200	Hospital staff	Rotating shifts	Equipment misuse	OR 1.78 (95 % CI 1.42–2.24) adjusted
[20] Alruwaili 2024	Prospective cohort	1 076	Paramedics	Extended shifts	Insomnia & dispatch time	ISI 12.3 ± 4.5 ; 9 % slower dispatch ($p = 0.02$)
[21] Torquati 2018	Meta-analysis	1,214,823	Shift workers (12 cohorts)	Cumulative shift-work exposure	Cardiovascular disease risk	RR 1.17 per 5 y (95 % CI 1.10–1.25)
[22] Alruwaili 2023	Prospective cohort	450	Rotational-shift nurses	Rotational shift work	Sleep quality & quality of life	PSQI 8.1 ± 2.9 ; SF-36 MH 42 ± 8
[23] Liu 2023	Randomized pilot trial	60	Night-shift nurses	Telehealth sleep intervention	PSQI & self-reported errors	PSQI $\downarrow 2.4$; 15 % fewer errors
[24] Alameri 2021	Prospective cohort	322	Emergency nurses	,	Fatigue & triage time	FSS 4.3 ± 1.1 ; triage time $\uparrow 18$ % ($p < 0.001$)

PSQI = Pittsburgh Sleep Quality Index; ISI, Insomnia Severity Index; SF-36, Short Form-36; MH, Mental Health; FSS, Fatigue Severity Scale.

Medicina Katastrof

(ISSN:2070-1004) (E-ISSN:2686-7966)

Scopus Index(2025)

