SYSTEMATIC / NARRATIVE REVIEW ARTICLE

Hospital noise exposure: A systematic review of levels, sources, and effects on patients and staff

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ABSTRACT

Introduction: Noise is often underestimated as a hospital-related hazard. This systematic review aimed to assess noise levels in hospitals, their sources, and the associated physiological and psychological impacts on the hospital community.

Materials and Methods: A literature search was conducted through PubMed, ProQuest, Ovid, and Scopus without language or date restrictions. Studies in all languages were considered, non-English articles were assessed using machine translation, although none met the inclusion criteria. This review was registered in PROSPERO under registration number CRD42025112689. Quantitative, qualitative, and mixed-method study designs that assessed hospital noise levels, sources, or effects were included. Risk of bias was appraised using the Joanna Briggs Institute (JBI) critical appraisal tools based on study designs, and the data were synthesised narratively.

Results: Eighteen studies were included in the qualitative synthesis, which consisted of cross-sectional (n=10), cohort (n=7), and qualitative (n=1) designs conducted across various countries. Noise levels frequently exceeded World Health Organization (WHO) limits, with mean equivalent levels (LAeq) ranging from 43 to 75.8 dB(A) and peak levels (LAFmax) reaching 100 dB(A). Intensive Care Units (ICUs) and Emergency Departments (EDs) were consistently reported as the noisiest departments. The physiological and psychological impacts experienced by the hospital community included stress, sleep disturbances, annoyance, elevated heart rate, and headaches. In chronic cases, noise-induced hearing loss (NIHL) was diagnosed particularly in hospital staff from the maintenance and service department. The principal noise sources were medical equipment alarms and staff communication.

Conclusion: Hospital noise levels consistently exceed recommended limits, posing both clinical and occupational risks. Noise should be considered a health and safety concern requiring institutional management. An integrated approach combining acoustic engineering, administrative policies, staff behavioural training, and continuous monitoring is essential to foster a safer hospital environment.

KEYWORDS:
Hospital noise, occupational exposure; psychological stress; noise-induced hearing loss; healthcare environment; acoustic management

INTRODUCTION

Hospital noise pollution is one of the most ubiquitous and underestimated environmental stressors in healthcare settings, adversely affecting both patient recovery and staff performance.[1] Noise is defined as any undesirable or distressing sound that interferes with human comfort, communication, healing, or occupational function. The World Health Organization's Guidelines for Community Noise recommend that hospital sound levels not exceed 35 dB(A) during the day and 30 dB(A) at night to promote patient relaxation, recovery, and staff concentration.[2]

Yet empirical studies consistently show that actual noise levels far surpass these thresholds across diverse units, including neonatal and adult intensive care units (ICUs), emergency departments (EDs), and general wards.[3-4] Primary contributors include monitoring alarms, ventilators, infusion pumps, mobile equipment, door closures, staff conversations, paging systems, and visitor interactions.[5-6] Together, these sources create a dynamic and persistent acoustic environment. The physiological and psychological effects are substantial, affecting both patients and hospital workers. For patients, particularly vulnerable populations in neonatal and adult ICUs, noise disrupts sleep architecture, elevates heart rate and blood pressure, suppresses melatonin production, precipitates delirium, disturbs circadian rhythms, and impairs neurocognitive function.[7-9]

Hospital staff experience comparable burdens, as chronic noise exposure contributes to fatigue, tension, elevated cortisol levels, reduced concentration, communication errors, and an increased risk of clinical mistakes, including medication dosing errors. The persistent interplay of these sounds undermines overall well-being, safety, and efficiency. Despite the accumulating evidence, the literature remains inconsistent, hampered by methodological variability, heterogeneous settings, and differing outcome measures. This systematic review synthesizes extant research to comprehensively evaluate hospital noise levels, predominant sources, and their physiological, psychological, and

This article was accepted: 08 June 2026
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occupational impacts on patients and staff, ultimately informing targeted mitigation strategies.

MATERIALS AND METHODS

This systematic review was prepared in accordance with the Preferred Reporting Items for Systematic Review and Meta-Analyses (PRISMA) 2020 statement.[10] The review protocol was registered with the International Prospective Register of Systematic Reviews (PROSPERO) (ID: CRD42025112689). The review adopted the PEO (Population, Exposure, Outcome) framework defining the population as hospital staff and patients, the exposure as noise in the hospital, and the outcomes as effects of hospital noise on hospital staff and patients. Studies were categorized based on the type of outcomes measured, including noise levels, psychological and physiological effects on hospital staff and patients, and identified noise sources.

Eligibility Criteria for Studies

Type of studies

Eligible study designs included quantitative, qualitative and mixed-methods research such as randomized controlled trials (RCTs), cohort studies, cross-sectional studies, case-control studies, and quasi-experimental designs that reported the noise levels, noise sources, and the effects of noise exposure to patients and hospital staff. Editorials, commentaries, reviews and conference abstracts were excluded. RCTs, case-control studies, and quasi-experimental studies were included in the eligibility criteria, however, none were retrieved through the systematic search.

Participants and Study Setting

The population of interest included patients and hospital staff within hospital environments. Hospital workers were defined as all personnel working in hospital settings who may be exposed to occupational noise. This includes both clinical staff, such as physicians, nurses, radiographers, and allied health professionals, as well as non-clinical staff, including administrative personnel, maintenance and engineering staff, and cleaning and support service workers.[11] Studies were included if they assessed noise exposure levels, noise sources, or associated health and occupational outcomes among these groups within hospital settings.

Exposure (Validity of Instrument used)

Eligible exposures included noise measurements in decibels collected using calibrated sound level meter (SLM) conforming to IEC61672:2013 or personal noise dosimeters (IEC61252), as well as validated subjective assessments of noise perceptions. Included studies were required to use SLMs compliant with IEC 61672:2013 to ensure a consistent and accurate measurement standard across studies, and traceability to national standards via approved calibration was required.[12]

Outcomes measured

The outcomes of interest in patients and hospital staff included physiological outcomes (heart rate and sleep quality), psychological outcomes (stress, fatigue, and burnout), and NIHL. Additionally, outcomes from subjective perceptions of noise such as annoyance and communication quality, were also assessed.

Language and publication criteria

Studies published in all languages were considered. Non-English articles were screened and assessed for eligibility using machine translation (Google Translate). Full-text articles were translated where necessary to facilitate evaluation. However, no non-English studies met the inclusion criteria and were not included in the final analysis.

Search Strategy

The search was conducted through PubMed, ProQuest, Ovid, and Scopus without language or date restriction. The search terminology used and full search strategy are presented in Table I. The final search was conducted on 17 June 2025. Medical Subject Headings (MeSH) terms used for PubMed included tinnitus, hypertension, noise-induced hearing loss, stress, anxiety, and heart rate.

Data Extraction

Two review authors (AR, NN) independently extracted the data from each selected study. After the extraction, the data were cross-checked by each reviewer. Any discrepancy was resolved through discussion leading to consensus. The characteristics of the data extracted from each study included study details such as authors, year of publication, and country. Information on study design, study setting, and locations of noise level measurements was also collected. In addition, data on the sample population were extracted, including the number of patients, hospital workers, or both, as well as participant characteristics and job designations. Measurement methods, exposure duration, and noise levels were recorded. Outcome measures included identified noise sources and all reported health or occupational outcomes.

Quality Assessment

Two review authors (AR, NN) independently assessed the quality of the selected studies using the Joanna Briggs Institute (JBI) Critical Appraisal Tools (CATs) for cross-sectional, cohort, and qualitative studies. Any disagreement between reviewers was resolved by discussion. The methodological quality and risk of bias of the included studies were critically appraised to ensure transparency and reliability of the review findings. JBI Critical Appraisal Tools were used, as they are appropriate for a variety of non-intervention and non-randomized research designs.[1] Studies were judged to have a low risk of bias when they reached the minimum score set for each study type, namely at least six "Yes" answers out of eight for cross-sectional studies, seven out of eleven for cohort studies, and six out of ten for qualitative studies.

Data Synthesis

A meta-analysis was not performed due to substantial heterogeneity among the included studies. The studies varied considerably in terms of design, participant populations, clinical settings, noise measurement methods, and outcome measures, including psychological, physiological, and auditory impacts assessed using different instruments and scales. A narrative synthesis was therefore conducted to summarise the findings across the included studies.

Table I: Full search strategy

Search terminologies	Full search strategy with MeSH terms and filters
("noise pollution" OR "sound pollution" OR "noise exposure" OR "sound monitoring" OR "noise induced hearing loss" OR "noise level") AND ("hospital" OR "ward" OR "medical centre" OR "healthcare facility" OR "clinical setting" OR "medical setting" OR "health institution") AND ("nurse*" OR "doctor*" OR "healthcare staff" OR "hospital workers" OR "clinical staff" OR "medical staff") AND ("exposure" OR "source" OR "effect" OR "impact").	(("noise pollution" OR "sound pollution" OR "noise exposure" OR "sound monitoring" OR "noise induced hearing loss") AND ("hospital" OR "ward" OR "medical centre" OR "healthcare facility" OR "clinical setting" OR "medical setting" OR "health institution") AND ("nurses" OR "doctors" OR "healthcare workers" OR "hospital staff" OR "clinical staff" OR "medical staff" OR "patient") AND ("exposure" OR "source" OR "effect" OR "impact")) AND (("Article") AND ("English") AND (("hearing loss" OR "hearing protection" OR "tinnitus" OR "patients" OR "ears & hearing" OR "sound" OR "noise levels" OR "humans" OR "acoustics" OR "hospitals" OR "risk factors" OR "age" OR "exposure" OR "intensive care" OR "occupational exposure" OR "otolaryngology" OR "public health" OR "statistical analysis" OR "physiology" OR "quality of life" OR "speech" OR "cognitive ability" OR "nurses" OR "hearing aids" OR "epidemiology" OR "background noise" OR "older people" OR "male" OR "occupational health" OR "hearing" OR "cochlea" OR "anxiety" OR "adult" OR "medical personnel" OR "audiometry" OR "disease" OR "aging" OR "female" OR "heart rate" OR "middle aged" OR "health care" OR "mental depression" OR "noise pollution" OR "patient safety" OR "cohort analysis" OR "nursing" OR "perceptions" OR "audiology" OR "health risks" OR "workers" OR "cross-sectional studies" OR "aged" OR "listening" OR "noise control" OR "population studies" OR "speech perception" OR "stress" OR "auditory system" OR "medical screening" OR "medicine" OR "adults" OR "confidence intervals" OR "data collection" OR "environmental exposure" OR "intensive care units" OR "mental disorders" OR "occupational diseases" OR "otology" OR "pain" OR "paediatrics" OR "cochlear implants" OR "environmental health" OR "hearing loss, noise-induced") AND "noise" NOT ("studies" OR "questionnaires" OR "regression analysis" OR "air pollution" OR "outdoor air quality" OR "mortality" OR "traffic" OR "transportation noise" OR "aircraft" OR "trauma" OR "brain research" OR "dementia" OR "music" OR "roads & highways" OR "body mass index" OR "deafness")) AND ("Scholarly Journals" NOT ("Trade Journals" OR "Reports" OR "Working Papers")))

RESULTS

Study Selection

Searches of four databases (PubMed, Scopus, Ovid, and ProQuest) yielded 625 records. Two review authors (AR, NN) independently reviewed the results of the search and selected the studies for inclusion using the predefined eligibility criteria. The titles and abstracts were screened, and potentially relevant studies were then retrieved in full-text form and screened for eligibility. Any disagreement between two reviewers was resolved via discussion. Among them, 18 studies met the inclusion criteria and were included in the final review. The study selection process, including the reasons for study exclusion, is presented in the PRISMA flow diagram (Fig. 1).

Study Quality Assessment

Eighteen studies were assessed using the Joanna Briggs Institute (JBI) critical appraisal tools for cross-sectional, cohort, and qualitative study designs, as presented in Table II. Two reviewers independently evaluated methodological quality and risk of bias, and all included studies were classified as having low to moderate risk of bias. The methodological quality of the included studies was predominantly classified as low risk of bias, with only a small number of studies rated as having moderate risk. Most studies fulfilled key methodological criteria, particularly in clearly defining the study population and employing appropriate and objective measures of noise exposure and outcomes.

The studies classified as having moderate risk of bias were primarily limited by methodological constraints, including inadequate identification and control of confounding factors, insufficient reporting of strategies to address these confounders, lack of baseline outcome assessment, and absence of follow-up, which restricted causal inference.[13-14] Across the included studies, a consistent pattern was the limited control of confounding factors and the predominance of cross-sectional designs, which restricted the ability to establish causal relationships between hospital noise exposure and health outcomes.

The cross-sectional and cohort studies generally demonstrated consistent and reliable measurement of exposure and outcomes, although confounding was not adequately addressed in some cases. The qualitative study met all relevant JBI criteria, indicating minimal risk of bias. No studies were classified as having a high risk of bias. These methodological limitations should be considered when interpreting the findings.

Characteristics of the Included Studies

Eighteen studies were included in this review, comprising ten cross-sectional, seven cohort, and one qualitative study design. The studies spanned regions including Asia, Europe, the Middle East, Africa, Australia, and North America reflecting global concern regarding hospital noise exposure and its impact on both patients and hospital workers.[4,6-9,18] Across all studies, noise levels consistently exceeded the World Health Organization (WHO) recommended limits indicating non-compliance with recommended hospital noise standards. Most studies measured sound levels in acoustically challenging hospital environments including intensive care units (ICU) (EICU, MICU, SICU, PICU), emergency departments, and cardiac care units (CCU) where continuous background noise was interspersed with intermittent high-level sounds.[13-15,17,20] Healthcare staff, including nurses, doctors, radiographers, and other hospital personnel, were the most frequently studied group. Patients represented the second most commonly studied population, indicating a predominant focus on occupational exposure and psychological strain among hospital workers. Psychological effects such as stress, fatigue, and alarm fatigue were the most frequently reported. Although most studies examined psychological or physiological effects, two studies addressed

Table II: JBI Appraisal Tool for all studies included

A) Cross Sectional Studies

Questions/Studies	Abbasi et al., 2022 [3]	Ali & Alharbi, 2024 [4]	Adams et al., 2024 [7]	Jung et al., 2020 [8]	Amoatey et al., 2022 [5]	Glans et al., 2022 [6]	Daraiseh et al., 2016 [9]	Ryan et al., 2016 [15]	Wongsuwan et al., 2019 [16]	Xie & Kang, 2012 [17]
Inclusion criteria	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Study subject and setting	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Validity of exposure measured	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Standard criteria for measurement condition	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Identified confounding factors	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Strategies to deal with confounding factors	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes
Validity of measured outcomes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Appropriate statistical analysis	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

B) Cohort Studies

Questions/Studies	Yang & Zhou, 2024 [13]	Tang et al., 2024 [14]	Folscher et al., 2015 [18]	Wang et al., 2024 [19]	Tahvili et al., 2025 [20]	Armbruster et al., 2023 [21]	Ituk et al., 2025 [22]
Groups recruited within same population	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Exposures measured similarly within groups	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Validity of the exposure measurement	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Identified confounding factors	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Strategies to deal with confounding factors	Yes	Yes	Yes	Yes	No	Yes	Yes
Participants free from the outcome at the start of the study	No	Yes	Yes	Yes	Yes	Yes	Yes
Validity of the outcome measurement	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sufficiency of the follow-up time for outcomes to occur	N/A	N/A	Yes	Yes	Yes	Yes	Yes
Follow up complete or reason to loss to follow up	N/A	N/A	Yes	Yes	Yes	Yes	Yes
Strategies to address incomplete follow up	N/A	N/A	N/A	N/A	Yes	Yes	N/A
Appropriate statistical analysis	Yes	Yes	Yes	Yes	Yes	Yes	Yes

C) Qualitative Study

Questions/Study	Honan et al., 2015 [23]
Congruity between philosophical perspective and research methodology	Yes
Congruity between methodology and research question/objectives	Yes
Congruity between methodology and data collection methods	Yes
Congruity between methodology and representation/analysis of data	Yes
Congruity between methodology and interpretation of results	Yes
Statement locating the researcher culturally or theoretically	Yes
Influence of the researcher on the research and vice-versa	Yes
Representation of participants and their voices	Yes
Ethical considerations	Yes
Relationship between conclusions and data	Yes

*Note: N/A = Not Applicable

Table III: Characteristics of the included studies

Study	Country	Study Design	Sample Size	Study Setting	Indicator
Ali & Alharbi., 2024[4]	Saudi Arabia	Cross-sectional	216 nurses	NICU and PICU	d,e
Glans et al., 2022[6]	Sweden	Cross-sectional	529 MRI and/or CT radiographers	Radiology department	d,e,f
Abbasi et al., 2022[3]	Iran	Cross-sectional	209 nurses	Across all departments	a,d,e
Adams et al., 2024[7]	Australia	Cross-sectional	Not applicable (area noise monitoring)	ED	a
Jung et al., 2020[8]	South Korea	Cross-sectional	Not applicable (area noise monitoring)	IR, OU, NS, MICU, SICU, and PICU CCU	a a
Ryan et al., 2016[15]	USA	Cross-sectional	Not applicable (area noise monitoring)	Gastrointestinal, colorectal surgery, rehabilitation, cardiac step-down,	b,e,f,h
Daraiseh et al., 2016[9]	Ohio	Cross-sectional	65 nurses	medical/surgical, neurology, diabetes/endocrinology, NICU, PICU, complex airway, cardiac intensive care, cystic fibrosis/complex pulmonary, and transitional care units in paediatric inpatient units.	
Amoatey et al., 2022[5]	Oman	Cross-sectional	72 nurses, doctors, and patients	FMW, SLW, EMW, and ICU	a,d,e,h
Wongsuwan et al., 2019[16]	Thailand	Cross-sectional	82 hospital workers (43 males, 39 females)	Physical and Environmental Unit, Maintenance and Repairman Unit, Nutrition and Cooking Unit, Central Service Unit, and the Vehicle and Transportation Unit	c,f,g
Xie & Kang., 2012[17]	United Kingdom	Cross-sectional	Not applicable (area noise monitoring)	ICU	a
Wang et al., 2024[19]	Taiwan	Cohort study	21 hospital workers	These included those working in the clinic (n=6), clinical laboratory (n=5), front desk (n=3), central supply centre (n=5), and primarily in janitorial services (n=2)	c,g
Tang et al., 2024[14]	China	Retrospective cohort study	42 hospital workers (group A) in ED and 39 hospital workers (group B) in RD	ED and RD	a,d,e
Yang & Zhou, 2024[13]	China	Retrospective cohort study	200 patients	EICU	a,d,e
Folscher et al., 2015[18]	South Africa	Prospective cohort study	41 doctors	ED	a,d,e
Armbruster et al., 2023[21]	Germany	Prospective cohort study	179 hospital workers	ICUs (anaesthesiologic, neonatological, and neurological)	d,e,h
Ituk et al., 2025[22]	USA	Prospective cohort study	65 women patients undergoing caesarean delivery	OR	a,d,e
Honan et al., 2015[23]	USA	Qualitative study	406 nurses	Based on Health-care Technology Foundation (HTF) survey by using Survey Monkey	d,e

*Note: a = area noise monitoring, b = personal noise monitoring, c = audiological assessment, d = validated questionnaire, e = psychological outcome, f = physiological outcome, g = noise-induced hearing loss, h = noise source identified, PICU = Paediatric Intensive Care Unit, NICU = Neonatal Intensive Care Unit, CCU = Cardiac Care Unit, MICU = Medical Intensive Care Unit, SICU = Surgical Intensive Care Unit, EICU = Emergency Intensive Care Unit, FMW = Female Medical Ward, EMW = Emergency Ward, SLW = Isolated Ward, OR = Operating Room, IR = Isolation Room, OU = Open Unit, NS = Nursing Station, RD = Rehabilitation Department.

NIHL as primary outcome among hospital workers exposed to hospital noise over the course of their working experience.[16,19] Included studies also identified specific noise sources, with equipment alarms, ventilation systems, and human activity being the most common contributors. Table III presents the detailed characteristics of the included studies.

Qualitative Synthesis for Outcome Measured

The included studies were grouped into five outcome categories namely hospital noise levels, psychological and physiological effects on hospital workers and patients, NIHL, and identified noise sources as shown in Table IV. Twelve studies measured noise levels across hospital settings, including general wards, ICUs, EDs, and ORs. Most reported average noise levels above 40 dB(A), often exceeding 60 dB(A) in high-activity areas, far above WHO recommendations as shown in Table IV(A). ICUs and EDs were consistently identified as the noisiest environments, with peaks of 98.8 dB(A) and 99.7 dB(A) respectively.[7,20] In contrast, Folscher et al.[18] reported ED noise levels never exceeded 52 dB(A) indicating that noise sources and clinical activity vary by study location and time of day. Eleven studies

Table IV: Outcomes measured in the included studies

A) Noise level reported according to studies n=11 studies

Studies	Area measured	Noise Level reported
Abbasi et al., 2022 [3]	1510 locations in Iranian hospital	Mean low exposure: 48.8; mean moderate exposure: 54.9; mean high exposure: 61.8
Adams et al., 2024 [7]	6 locations in ED waiting room and treatment areas	Mean 56.5 dB; ED Wait Room (59.9 ±4.6); Ambulance Bay (56.9 ±5.0); ED Treatment 1 (59.4 ± 3.8); ED Treatment 2 (60.0 ± 3.7); EMU 1 (51.9 ± 3.6); EMU 2 (51.0 ± 3.6) with peaks in Ambulance Bay (102.8 dB) and ED Wait Room (99.7 dB)
Jung et al., 2020 [8]	IR, OU, and NS in MICU, SICU, PICU.	IQR 24-hour for all ICUs 54.5 (51.1–57.5) dB(A); MICU (53.8 (50.6-57.0)) dB(A); SICU (55.4 (52.0 – 58.8)) dB(A); PICU (54.1 (50.7 – 56.7)) dB(A).
Ryan et al., 2016 [15]	CCU (patient rooms and nurse station)	Nurse station (49.9 - 65.0) dB; Patient Room 1 (43.0 - 54.4) dB; Patient Room 7 (49.7 – 58.9) dB.
Amoatey et al., 2022 [5]	FMW, SLW, EMW, ICU wards	Mean FMW: 61.7 dB(A); mean SLW: 58.8 dB(A); mean ICU: 55.2 dB(A).
Xie & Kang., 2012 [17]	ICU	Range: 45–70 dB (A)
Tang et al., 2024 [14]	ED and RD	ED: (58.7 ± 8.3) dB; RD: (50.5 ± 5.8) dB
Yang & Zhou, 2024 [13]	EICU	Ideal sleep group: 52.75 ± 3.21 (peak: 68.44 ± 3.89) dB; non-ideal sleep group: 54.32 ± 4.17 (peak: 69.92 ± 4.76) dB
Folscher et al., 2015 [18]	3 venues in ED	Range: 40–52 dB(A); never > 52 dB(A)
Tahvili et al., 2025 [20]	ICU	Mean 68.6 dB; peak 98.8 dB; min 44.2 dB
Ituk et al., 2025 [22]	OR	OR1: (53.4 dB); OR2 (58.5 dB); LAeq 60.2–68.4 dB; LCpeak (79.1–122.9 dB (A)) during patient admission

B) Psychological effects on staff and patients n=9 studies

Studies	Subject	Psychological effect
Abbasi et al., 2022 [3]	209 nurses	Increased annoyance, greater noise sensitivity, and lower perceived quality of care.
Glans et al., 2022 [6]	529 (345 worked with MR, and 392 worked with CT)	Drowsiness, forgetfulness, difficulty concentrating, and sleep problems.
Amoatey et al., 2022 [5]	11 doctors, 29 nurses, 32 patients	Distraction, loss of focus, impaired performance and patient recovery.
Tang et al., 2024 [14]	42 medical staff in emergency department, 39 medical staff in rehabilitation department	Emotional fatigue, work apathy, low achievement, resignation intention.
Folscher et al., 2015 [18]	41 doctors	Lack of concentration, pressure, irritation, and distraction.
Armbruster et al., 2023 [21]	179 hospital workers in ICUs (anaesthesiologic, neonatological, and neurological)	Seek rest after shift, reduced mood, more sensitive to sound.
Daraiseh et al., 2016 [9]	115 nurses in 14 units (gastrointestinal, colorectal surgery, rehabilitation, cardiac step-down, medical/surgical, neurology, diabetes/endocrinology, NICU, PICU, complex airway, CCU, cystic fibrosis/complex pulmonary, and transitional care)	Higher stress level.

B) Psychological effects on staff and patients (Continued) n=2 studies

Studies	Subject	Psychological effect
Honan et al., 2015 [23]	410 nurses	Alarm leads to desensitization, affecting patient safety, and fatigue.
Ali & Alharbi, 2024 [4]	216 NICU and PICU nurses	Disrupted patient care, and decrease trust in alarm systems, and experienced alarm fatigue.
Yang & Zhou, 2024 [13]	200 patients (96 ideal sleep group), 104 (non-ideal sleep group)	Sleep disturbance, difficulty falling asleep, nightmares or vivid dreams, and sleepwalking episodes.
Ituk et al., 2025 [22]	65 women undergoing caesarean delivery	Higher noise sensitivity, noise perception and stress.

C) Physiological effect on staff and patients n=3 studies

Studies	Subject	Psychological effect
Glans et al., 2022 [6]	529 (345 worked with MR, and 392 worked with CT)	Vertigo, nausea, metallic taste, illusion of movement, tinnitus, and headache.
Amoatey et al., 2022 [5]	11 doctors, 29 nurses	Risk of cardiovascular disease, annoyance and sleep disturbances.
Folscher et al., 2015 [18]	41 doctors	Physical distress, headache, and tiredness

C) Physiological effect on staff and patients (Continued) n=2 studies

Studies	Subject	Physiological effect
Daraiseh et al., 2016 [9]	115 nurses in 14 different units	Nurses with a baseline HR less than 100 bpm, the average HR increased 0.8% when SPLs were greater than 75 dB(A) (2.3% when 90 dB(A)). Time in tachycardia increases as heart rate increases.
Wongsuwan et al., 2019 [16]	82 hospital workers (43 males and 39 females) between June 2018 and July 2018.	33 had NIHL for workers with more than 18 years working experience.

D) Noise-induced Hearing Loss n=2 studies

Studies	Instrument used	Clinical Outcome
Wongsuwan et al., 2019 [16]	Clinical audiometer, GSI AudioStar ProTM, 2012.	33 cases of NIHL were identified, with a higher prevalence among smokers (59.3% vs. 25.9%), particularly among workers exposed to noise levels >85 dB in the physical and environmental, maintenance, nutrition, central service, and transportation units.
Wang et al., 2024 [19]	Audiometer	Significant hearing threshold shifts in the HNE group after 6 months, particularly at 0.25–0.5 kHz and 0.5–4 kHz frequencies.

E) Noise sources identified in Hospital n=6 studies

Studies	Noise sources identified	Noise level (dB (A))
Amoatey et al., 2022 [5]	Visitor footsteps, phone ringing, operation of medical equipment, doors, air conditioning, trolley wheels, staff/visitor conversation, alarms.	Range: 55 – 62 dB(A)
Yang & Zhou, 2024 [13]	Conversational speech, equipment alarms, ambient hospital background.	Speech: 42–44 dB(A); alarms: 58–60 dB(A); ambient: 49–53 dB(A)
Tahvili et al., 2025 [20]	Patient repositioning, medication, suctioning, blood collection, extubating, tracheostomy, drain removal.	Mean 68.6 dB(A); peaks: 98.8 dB(A).
Armbruster et al., 2023 [21]	Mechanical ventilator, surveillance monitor alarms, dialysis machine, suction pump, telephones, bed-brakes, door movements, packaging, staff conversations.	Alarm often > 70 dB(A).
Daraiseh et al., 2016 [9]	Staff communication, patient/family interaction, equipment uses, door activity, paging systems, procedures, stocking, cleaning, and auxiliary room operations.	Frequent peaks > 75 dB(A); dominant sources: staff conversation 51%.
Jung et al., 2020 [8]	Patient monitor alarms, oxygen via facial mask, syringe pump alarms, pneumatic compression, nebulizer, endotracheal suction, wall suction normal, obstruction, warmer, ventilator normal, alarm, physiotherapy, continuous renal replacement alarms.	43.9 – 91.6 dB(A) overall range across devices.

*Note: EMU = Emergency Medical Unit, IQR = Interquartile Range, SPL: Sound Pressure Level.

reported the psychological effects of noise, including reduced performance, focus, sleep disturbance and stress as shown in Table IV(B). More than 70% of hospital workers found noise distracting. This is due to increased stress, emotional exhaustion, and sleep disturbances frequently reported.[5] Alarm fatigue was a recurring issue, contributing to reduced alertness and lower confidence in alarm systems.[4,23] Patients also experienced sleep disruption, stress, and impaired recovery.[13] Five studies addressed physiological impacts, reporting headaches, dizziness, and fatigue, particularly among radiology staff as shown in Table IV(C).[7,19] Exposure above 75 dB(A) was associated with elevated heart rates and cardiovascular risks.[9] Two studies investigated NIHL among hospital staff as shown in Table IV(D), identifying permanent hearing damage among long-term staff exposed to sound levels beyond 85 dB(A). Smoking and prolonged exposure were associated with higher prevalence of NIHL in hospital workers. Six studies identified primary noise sources in hospital as shown in Table IV(E). Noise mainly came from alarms, medical devices, and human activities such as conversation, footsteps, and equipment handling.[5,9] Procedures such as suctioning, repositioning, and patient care activities contributed to transient peaks.[20] Overall, hospital environments consistently exceeded safe noise limits, risking the psychological, physiological, and auditory health of the hospital community.

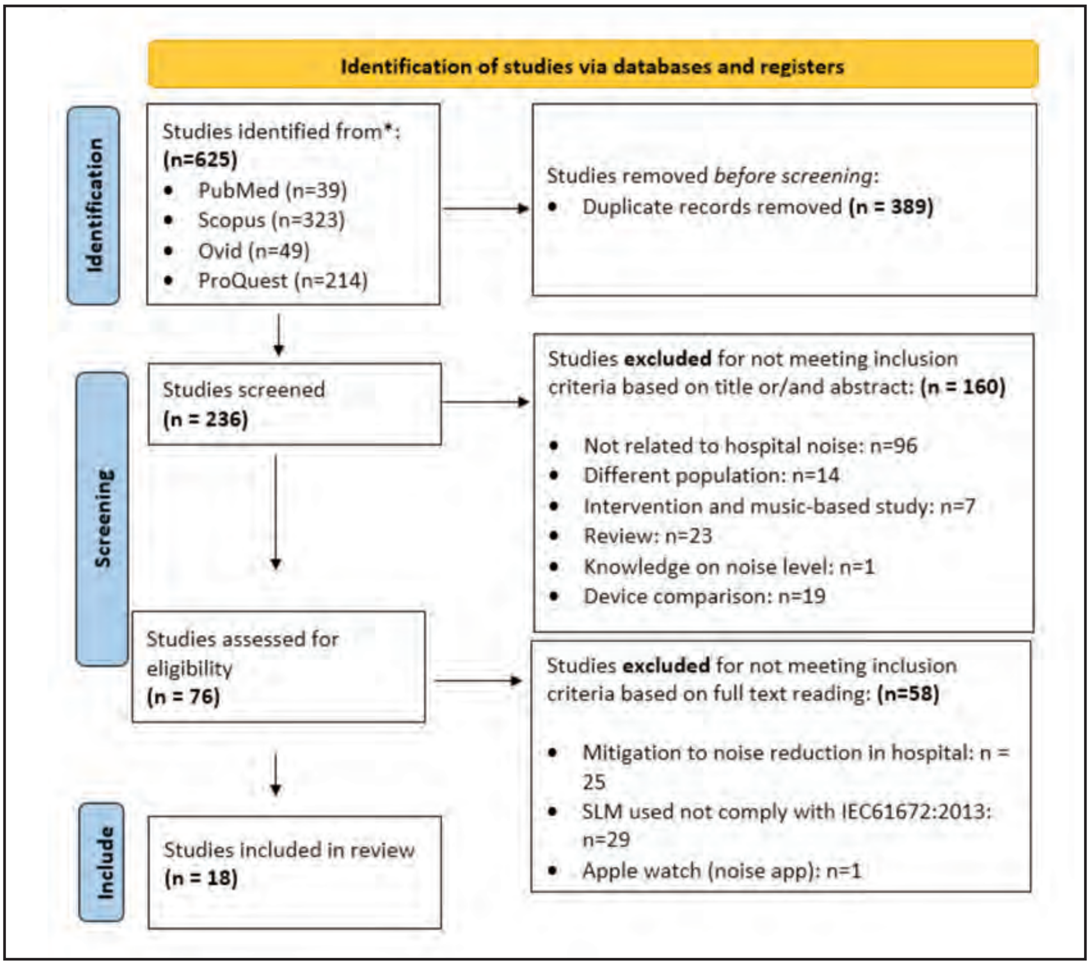

Fig. 1: PRISMA 2020 flow diagram showing the identification, screening, eligibility, and inclusion of studies

DISCUSSION

This systematic review compiled data from eighteen research studies that examined hospital noise exposure, its sources, and the psychological, physiological, and auditory effects including NIHL on hospital staff. According to the WHO, 30 dB(A) is the threshold for sleep disruption, while 45 dB(A) may interfere with learning and create attention problems, especially in sensitive settings like hospitals.[2] Similarly, a variety of non-auditory health effects, such as stress and physiological arousal responses, have been linked to an average of 55 dB(A) for day-night-evening weighted sound pressure level (L_den).[2]

The evidence consistently suggests that hospital noise levels exceeded WHO-recommended limits. Across the studies reviewed for noise levels measurement, equivalent continuous sound levels (LAeq) of intensive care, paediatric, emergency, and surgical units often varied between 51 dB(A) and 75.8 dB(A).[7,9] The majority of the reviewed studies used LAeq as the primary metric of noise exposure, which allowed for cross-study comparison and showed consistency in measuring cumulative sound energy. However, noise levels in hospitals are event-driven, depending on clinical activities, equipment alarms, and human interaction that vary throughout the day. Xie and Kang[17] and Adams et al.[7] documented instantaneous peaks in emergency and multibed ward settings that approached 100 dB(A). Although LAeq reflects the cumulative noise exposure, it is unable to capture the short, high-intensity peaks that occur within less than a second. Several studies combined LAeq with maximum-level metrics such as LAFmax to measure the significant short-term variations. Consistent with that, Daraiseh et al.[9] found a mean LAFmax of 75.8 ± 8.9 dB(A), but Jung et al.[8] reported maximum noise level around 91 dB(A). These findings highlight the need to use numerous acoustic descriptors to describe both continuous exposure and intermittent acoustic stressors in hospital settings. Most studies employed A-weighting, which appropriately reflex human hearing sensitivity, but attenuates low frequency content below 250 Hz. Consequently, it fails to represent mechanical hums from ventilation systems or medical equipment that emit low frequency noise that may lead to negative psychological outcomes. These findings demonstrate that hospital soundscapes are dynamic and acoustically complex. Multiple metrics are therefore required to characterise exposure accurately. LAeq reflects cumulative sound energy, whereas LAFmax and LASmax capture transient peaks and LCpeak identifies impulsive noise events that may be overlooked by A-weighted measurements. The choice of acoustic metric should therefore be guided by the health outcome under investigation, LAeq for long-term exposure evaluation, LAFmax for instantaneous arousal or communication interference, and LCpeak for low-frequency stress potential.

Hospital noise has a significant psychological impact on both hospital workers and patients, acting as a chronic environmental stressor that reduces emotional stability, cognitive efficiency, and well-being. Hospital workers in high-noise departments reported greater emotional exhaustion, indifference, and decreased achievement, with auditory stress reducing desired care performance by 14-23%.[3] Constant alerts in NICU and PICU cause alarm fatigue, with 62.5% of nurses suffering moderate fatigue and 8.3% experiencing severe exhaustion, which is associated with worry and desensitisation.[4] These psychological consequences contribute to poor cognitive function, as exposure to 80-85 dB(A) during clinical activities resulted in 65% distraction and 88% stress in doctors.[18] Noise sensitivity was significantly associated with mental strain and less concentration whereas persistent noise during rest periods was associated with restlessness, anxiety, and dissatisfaction.[15] Intermittent sounds from alarms, especially in high-acuity units, are essential for notifying healthcare staff about the patient's condition, but excessive exposure might affect patient comfort and contribute to alarm desensitization among staff. Over time, constant auditory load reduces the efficiency of patient care and increases the risk of patient safety incidents. Notably, Armbruster et al.[21] found that even moderate 3 dB reductions improved stress and concentration results. Therefore, noise control may represent an effective strategy for reducing occupational risks within the hospital environment. Reducing unnecessary acoustic disturbances can improve emotional resilience, and support clearer communication among healthcare staff. These improvements contribute not only to staff well-being but also to more effective clinical services, smoother workflows, and safer decision-making.

Physiologically, hospital noise may act as a persistent biological stressor, activating the sympathetic nervous system and disrupting homeostatic balance. Prolonged exposure to LAeq levels of 55-62 dB(A) in Omani ICUs was associated with sleep disruption, irritation, and reduced focus, while elevated SPLs of 75.8 ± 8.9 dB(A) in PICU correlated with increased heart rate, indicating acute cardiovascular strain.[9] Amoatey et al.[5] reported that higher noise levels were associated with increased reports of noise sensitivity (56%) and loss of concentration among healthcare staff, alongside notable impacts on work performance (73%) and workplace distraction (70%). These findings suggest that elevated hospital noise may adversely affect cognitive functioning and occupational efficiency.[5] The observed associations were further supported by logistic binary regression analysis, which indicated a positive relationship between noise levels and both noise sensitivity and concentration loss (OR = 1.54–1.61), although the wide confidence intervals suggest variability in the strength of these associations.[5] Beyond acute effects, long-term occupational exposure has been associated with auditory pathology in which 41.5% of Thailand hospital personnel had NIHL, with age over 40 and smoking significantly increasing risk.[16] This finding is consistent with observations in industrial settings, where noise levels above 85 dB(A) in hospitals may present comparable risks to hearing, especially among personnel working in maintenance and service departments. In addition to these physiological responses, prolonged exposure to elevated noise levels may also affect auditory function, particularly among hospital workers working in high-noise environments. The progression from chronic noise exposure to measurable hearing impairment is well established. Wang et al.[19] observed significant changes in hearing thresholds after six months of exposure to noise levels of 70.4 ± 4.5 dB(A). However, the findings by Wang et al.[19] warrant caution. The study's method of determining NIHL used mainly speech-frequency thresholds (0.5, 1, 2 and 4 kHz) instead of the higher frequencies where NIHL typically manifests. The absence of bone conduction testing to confirm the type of hearing loss is also a concern, as NIHL is a sensorineural hearing loss. This could affect the actual incidence which may have been underestimated and the results may reflect pathologies other than noise-induced pathology.

Hospital noise arises from the complex interaction of human, mechanical, and structural sources. Effective mitigation therefore requires a multidisciplinary approach. Behavioural sources, such as staff communication, visitor activity, footsteps, and cleaning, consistently keep ambient levels above 55 dB(A), whereas equipment-related sounds, such as ventilator alarms, suctioning, and monitors, produce frequent peaks of 85-98 dB(A).[6,9-10,20] According to Armbruster et al.[21], recurrent mechanical events contribute to alarm fatigue and desensitisation. Furthermore, activity-based peaks caused by patient repositioning and medication administration indicate procedural rhythms that increase the acoustic load.[20] Hospital noise should be treated as an institutional issue rather than a technical nuisance, necessitating policies that incorporate acoustic awareness into staff training, prioritise alarm algorithms based on urgency, and incorporate low-noise technologies into procurement standards. Addressing these core issues through architectural acoustics, workflow redesign, and behavioural teaching would improve auditory comfort while maintaining patient safety and staff well-being. Strategies that can be implemented include engineering controls through installing sound-absorbing materials, optimising alarm settings, and isolating high-noise equipment, administrative controls instituting visitor regulations, staff training, and quiet hours, and technological controls using smart alarm systems that prioritise critical alerts.[23] These findings suggest that hospital noise may represent an emerging occupational health concern, although further longitudinal studies are required to confirm long-term effects.

LIMITATIONS

This review has several limitations. Most included studies were cross-sectional or cohort studies, which limits the ability to determine cause and effect between hospital noise and its impacts. There was considerable variation in study design, measurement methods, and hospital settings, making direct comparison of findings and quantitative meta-analysis difficult. Different instruments and noise metrics were used. Variations in ward type, patient load, and activity levels may also have influenced the results. Many studies relied on self-reported outcomes such as stress and annoyance, which may be affected by recall bias.

CONCLUSION

Hospital noise levels frequently exceeded the WHO recommended limits and were primarily attributed to medical equipment alarms, staff communication, and routine patient care activities. Such excessive noise exposure was associated not only with psychological effects, including stress, burnout, and communication errors among hospital workers, but also with physiological disturbances in patients, such as sleep disruption and altered cardiovascular responses. In addition, prolonged occupational exposure may increase the risk of NIHL among hospital workers, particularly those working in high-noise environments. These findings underscore that hospital noise should not be regarded merely as an environmental nuisance, but as a significant occupational and clinical hazard. Therefore, noise mitigation strategies should be incorporated into hospital design and management practices from the outset, with emphasis on both environmental engineering controls and behavioural interventions, including adaptive alarm management and staff-focused strategies, to enhance patient recovery and staff well-being.

CONFLICT OF INTEREST

The authors have no conflicts of interest to disclose.

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