

Original article

An Assessment of Sources of Noise and Their Effects on Healthcare Workers in Operation Theatre

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ABSTRACT

Background: Operating-theatre sound may interfere with communication, concentration, wellbeing, and task performance. **Objective:** To identify perceived sources of noise inside and outside operating theatres and examine their associations with self-reported health-effect domains among healthcare workers. **Methods:** This cross-sectional survey included 130 doctors, nurses, technicians, and technologists from Social Security Hospital Lahore and DHQ Hospital Gujranwala between December 2025 and March 2026. Participants completed a structured questionnaire covering perceived noise sources and subjective, emotional, physiological, and performance effects. Descriptive statistics and Spearman rank correlations were calculated in IBM SPSS Statistics version 27.0. **Results:** Participants most often rated conversations among visitors or family members inside the theatre as producing a lot of noise (30.0%), followed by patient moaning or crying (27.7%). Outside the theatre, staff conversation was most frequently rated as producing a lot of noise (30.0%). Emotion had the highest domain score (16.26 ± 3.72), followed by physiology (16.12 ± 3.66), performance (15.88 ± 3.74), and subjective perception (14.18 ± 4.01). The perceived noise score showed weak positive correlations with the overall health-effect score ($r=0.189$, $p=0.031$) and performance score ($r=0.173$, $p=0.049$); correlations with other domains were not statistically significant. **Conclusion:** Perceived operating-theatre noise was weakly associated with greater self-reported health effects, particularly performance-related disturbance. Human conversation and patient vocalization were prominent perceived sources, supporting locally tailored noise-awareness and communication practices. **Keywords:** Healthcare workers, Noise, Occupational health, Operating theatre, Perception Work performance.

EDITORIAL INFORMATION

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Ethical Approval: Faculty of Allied Health Sciences, The University of Lahore, Lahore, Pakistan.

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INTRODUCTION

Operating theatres are highly specialized and technologically intensive healthcare environments where patient safety depends on effective communication, vigilance, teamwork, and precise task execution. Healthcare professionals must maintain concentration while monitoring patients, operating medical equipment, and responding to clinical changes. However, these activities occur alongside numerous sources of sound, including monitoring alarms, ventilation systems, suction devices, surgical instruments, telephone alerts, staff movement, and clinical conversations. Sound becomes noise when it is unwanted, distracting, or interferes with an intended activity. Although some sounds are essential for patient monitoring and communication, excessive noise may disrupt clinical activities and contribute to physical and psychological discomfort. Beyond auditory injury associated with prolonged exposure, environmental noise has been linked to annoyance, stress, fatigue, sleep disturbances, reduced concentration, and impaired cognitive performance (1,2). These effects are particularly important in perioperative care, where effective communication and timely decision-making are essential for patient safety.

Operating-theatre sound levels vary considerably according to surgical procedures, equipment utilization, staffing patterns, and different phases of surgery. Previous reviews have reported average sound levels commonly ranging from 51 to 79 dB, with higher intermittent peaks generated by alarms,

suction equipment, powered instruments, and dropped surgical equipment (3-5). Both classic and contemporary investigations identify staff conversations as an important and potentially modifiable source of operating-theatre noise (6-10). Unnecessary discussions, simultaneous conversations, and frequent interruptions may increase background noise and interfere with communication among surgical, anaesthesia, and nursing teams. Although elevated sound levels do not necessarily indicate hazardous occupational exposure, competing speech and sudden noise peaks may reduce speech intelligibility, increase cognitive workload, and make it difficult to maintain attention during demanding procedures.

The consequences of operating-theatre noise extend beyond discomfort and may affect communication, concentration, emotional well-being, and work performance. Experimental and observational studies suggest that background noise can impair auditory processing, interfere with verbal instructions, and adversely affect selected technical and cognitive tasks, particularly during increased workload or unfamiliar procedures (11-17). Healthcare professionals must process information from multiple sources while maintaining situational awareness and responding to changing clinical conditions. Unnecessary noise may increase distraction, stress, irritability, and mental fatigue. Previous studies have also associated noise with communication difficulties, team distraction, and adverse operative processes, although findings vary and causal relationships remain uncertain (18-20). Assessing healthcare workers' perceptions is therefore important for understanding commonly experienced disturbances and their perceived effects, while recognizing that self-reported outcomes differ from objective acoustic measurements.

Operating-theatre noise may originate from both internal and external sources. Internal sources include monitoring equipment, surgical instruments, staff conversations, and movement of equipment, whereas external sources include corridor conversations, patient and attendant movement, door activity, and nearby hospital operations. These disturbances may be influenced by building design, staffing arrangements, equipment maintenance, and institutional practices. Identifying these sources separately is important because internal noise may be reduced through improved communication and equipment management, while external disturbances may require administrative control and better movement regulation.

Evidence from South Asian public-sector hospitals remains comparatively limited, and operating-theatre noise may differ according to infrastructure, patient workload, staffing patterns, and local communication practices. Understanding healthcare workers' experiences can help identify major noise sources and their perceived effects on concentration, well-being, and clinical performance. Such information may support practical interventions, including staff education, reduction of unnecessary conversations, appropriate alarm management, and improved operating-theatre practices.

Therefore, this study aimed to identify perceived internal and external sources of operating-theatre noise and examine their associations with self-reported subjective, emotional, physiological, and work-performance effects among healthcare workers in two hospitals in Punjab, Pakistan. The findings may provide locally relevant evidence to guide noise-reduction strategies and improve the operating-theatre working environment.

MATERIALS AND METHODS

A descriptive cross-sectional survey was conducted from December 2025 to March 2026 in the operating theatres of Social Security Hospital Lahore and District Headquarters Hospital Gujranwala, Punjab, Pakistan. The report follows relevant recommendations of the Strengthening the Reporting of Observational Studies in Epidemiology statement (21). Using purposive sampling, 130 doctors, nurses, technicians, and technologists were recruited. Eligible participants were actively working in an operating theatre, had at least six months of operating-theatre experience, and provided written informed consent. Workers with pre-existing chronic hearing problems or tinnitus, students, visitors, and temporary staff were excluded.

Data were collected using a self-administered structured questionnaire developed from published literature on operating-theatre noise (3-5,12,13). It recorded demographic and occupational characteristics; perceived sources of noise inside and outside the theatre using the response categories

“a little,” “moderate,” and “a lot”; and self-reported effects grouped into subjective perception, emotion, physiology, and work performance. Higher composite scores represented greater perceived noise or greater reported disturbance.

Data were analysed using IBM SPSS Statistics version 27.0. Categorical variables are reported as frequency and percentage, and domain scores as mean $\pm$ standard deviation. Spearman rank correlation assessed monotonic associations between perceived noise and health-effect scores because the measures were derived from ordinal questionnaire responses. Correlation magnitudes were interpreted cautiously, and two-sided $p < 0.05$ indicated statistical significance (22). It was conducted in accordance with the ethical principles of the Declaration of Helsinki and the requirements of the Ethical Review Committee of the Faculty of Allied Health Sciences, The University of Lahore (Ref. No.: DRC/DHPT001/08/25). Written informed consent was obtained from all participants before enrolment. Participation was voluntary, confidentiality and anonymity were maintained throughout the study, and participants could withdraw without penalty at any stage of data collection.

RESULTS

All 130 participants were included in the analysis; 68 (52.3%) worked at DHQ Hospital Gujranwala and 62 (47.7%) at Social Security Hospital Lahore. Most were aged 30 years or younger (97/130, 74.6%), 80 (61.5%) were men, and 74 (56.9%) were graduates. Doctors comprised 41 (31.5%) participants, nurses 39 (30.0%), technicians 37 (28.5%), and technologists 13 (10.0%). Most participants had six months to five years of overall work experience (101/130, 77.7%) and operating-theatre experience (102/130, 78.5%) (Table 1).

Table 1. Demographics of Participants

Characteristic	Category	Total, n (%)
Hospital	Social Security Hospital Lahore	62 (47.7)
	DHQ Hospital Gujranwala	68 (52.3)
Age, years	≤ 25	44 (33.8)
	26-30	53 (40.8)
	31-35	21 (16.2)
	36-40	8 (6.2)
	≥ 41	4 (3.1)
Gender	Male	80 (61.5)
	Female	50 (38.5)
Marital status	Single	76 (58.5)
	Married	54 (41.5)
Education	Diploma	41 (31.5)
	Graduation	74 (56.9)
	Post-graduation	15 (11.5)
Job title	Doctor	41 (31.5)
	Nurse	39 (30.0)
	Technician	37 (28.5)
	Technologist	13 (10.0)
Work shift	Fixed	69 (53.1)
	Rotating	61 (46.9)
Overall experience	6 months-5 years	101 (77.7)
	5-14 years	24 (18.5)
	15-25 years	5 (3.8)
OT experience	6 months-5 years	102 (78.5)
	5-14 years	23 (17.7)
	15-25 years	5 (3.8)
OT specialty	General surgery	52 (40.0)
	Neurosurgery	12 (9.2)
	Burn/plastic	2 (1.5)

Characteristic	Category	Total, n (%)
	Medical	11 (8.5)
	Obstetrics/gynaecology	26 (20.0)
	Cardiac	11 (8.5)
	Orthopaedic	16 (12.3)

Inside the theatre, conversations among visitors or patients' family members were most frequently rated as producing "a lot" of noise (39/130, 30.0%), followed by patient moaning or crying (36/130, 27.7%) and phone ringing (32/130, 24.6%). Monitor alarms and ventilators were most often rated as producing moderate noise (71/130, 54.6%). Radio, television, or tape-recorder sound had the lowest proportion of "a lot" responses (16/130, 12.3%) (Table 2).

Table 2. Perceived sources of noise inside the operation theatre

Noise source	A little, n (%)	Moderate, n (%)	A lot, n (%)
Monitor alarms and ventilators	37 (28.5)	71 (54.6)	22 (16.9)
Phone ringing	44 (33.8)	54 (41.5)	32 (24.6)
Patient moaning or crying	29 (22.3)	65 (50.0)	36 (27.7)
Conversation among workers	36 (27.7)	65 (50.0)	29 (22.3)
Oxygen or suction apparatus	39 (30.0)	64 (49.2)	27 (20.8)
Medical equipment	43 (33.1)	58 (44.6)	29 (22.3)
Visitors/family conversation	23 (17.7)	68 (52.3)	39 (30.0)
Doors opening or closing	51 (39.2)	56 (43.1)	23 (17.7)
Radio/television/recorder	46 (35.4)	68 (52.3)	16 (12.3)
Drawers or cupboards opening	53 (40.8)	51 (39.2)	26 (20.0)
Cleaning or sweeping	49 (37.7)	60 (46.2)	21 (16.2)
Any respiratory complication	4 (5.3)	11 (14.7)	0.83

Outside the theatre, staff conversation was most frequently rated as producing "a lot" of noise (39/130, 30.0%). Visitors' or family members' conversation and trolley wheels each received this rating from 38 participants (29.2%), followed by patient moaning or crying (33/130, 25.4%). Most sources were more commonly rated as moderate than as producing a lot of noise (Table 3).

Table 3. Perceived sources of noise outside the operation theatre

Noise source	A little, n (%)	Moderate, n (%)	A lot, n (%)
Hospital renovation	40 (30.8)	60 (46.2)	30 (23.1)
Registration-area activity	41 (31.5)	61 (46.9)	28 (21.5)
Patient moaning or crying	30 (23.1)	67 (51.5)	33 (25.4)
Conversation among workers	32 (24.6)	59 (45.4)	39 (30.0)
Visitors/family conversation	20 (15.4)	72 (55.4)	38 (29.2)
Trolley wheels	43 (33.1)	49 (37.7)	38 (29.2)
Doors opening or closing	36 (27.7)	66 (50.8)	28 (21.5)
Cleaning or sweeping	49 (37.7)	50 (38.5)	31 (23.8)
Radio/television/recorder	42 (32.3)	59 (45.4)	29 (22.3)

The emotion domain had the highest mean score (16.26 ± 3.72), followed closely by physiology (16.12 ± 3.66) and performance (15.88 ± 3.74); subjective perception had the lowest mean score (14.18 ± 4.01) (Table 4). These scores describe the relative burden reported on the questionnaire and do not represent objectively measured clinical disorders.

Table 4. Health-effect domain scores

Domain	Mean $\pm$ SD	Reported components
Subjective perception	14.18 ± 4.01	Distress, inattention, sleep difficulty, fright, dizziness
Emotion	16.26 ± 3.72	Communication difficulty, scalp tingling, ill temper, irritability, tension
Physiology	16.12 ± 3.66	Tachycardia, tinnitus, headache, fatigue, loss of appetite

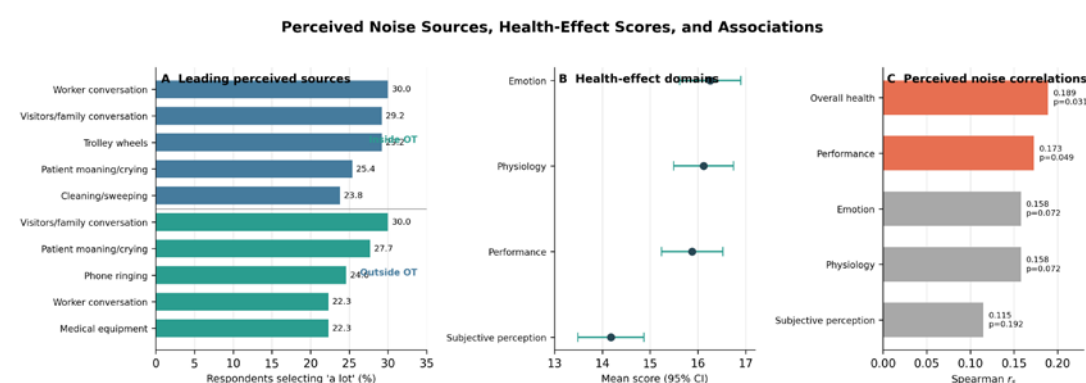
Domain	Mean ± SD	Reported components
Performance	15.88 ± 3.74	Reduced productivity, concentration difficulty, non-adherence, carelessness, auditory masking

The perceived noise score was weakly positively correlated with the overall health-effect score ($r=0.189$, $p=0.031$). Among individual domains, only performance reached the prespecified significance threshold ($r=0.173$, $p=0.049$). Correlations with emotion ($r=0.158$, $p=0.072$), physiology ($r=0.158$, $p=0.072$), and subjective perception ($r=0.115$, $p=0.192$) were small and not statistically significant (Table 5).

Table 5. Correlations between perceived noise and health-effect scores

Outcome	Spearman r_s	p-value
Overall health-effect score	0.189	0.031
Emotion	0.158	0.072
Physiology	0.158	0.072
Performance	0.173	0.049
Subjective perception	0.115	0.192

Figure 1. Perceived noise sources, health-effect scores, and associations



Panel A presents the five sources inside and outside the theatre most frequently rated as producing “a lot” of noise. Panel B presents domain means with 95% confidence intervals calculated from the reported standard deviations and $N=130$. Panel C presents Spearman correlations; orange bars indicate $p<0.05$. OT, operation theatre. Human conversation occupied the highest rank both inside and outside the theatre, while domain means were relatively close, ranging from 14.18 to 16.26. All correlations were below 0.20; the largest was for the overall health-effect score ($r=0.189$, $p=0.031$), followed by performance ($r=0.173$, $p=0.049$), indicating statistically significant but weak associations.

DISCUSSION

This two-hospital survey found that healthcare workers perceived both human activity and clinical processes as important sources of operating-theatre noise. Conversations involving visitors, family members, or staff and patient vocalization were prominent, while alarms, ventilation, suction, telephones, and other equipment contributed to the overall soundscape. Emotional, physiological, and performance scores were similar in magnitude. Perceived noise was associated with the overall health-effect score and performance, but both correlations were weak, and no significant correlations were observed for the other domains.

The prominence of conversation is consistent with earlier operating-theatre research identifying speech and staff behavior as common and partly modifiable contributors to noise (3-7,13). Equipment remains clinically necessary, and alarms cannot simply be reduced without considering patient safety; however, unnecessary conversation, uncontrolled traffic, and poorly configured alarms may add avoidable sound. Studies measuring sound directly have documented marked variation across procedures and intermittent peaks from suction, powered instruments, alarms, and equipment handling (8-10). The present findings complement those measurements by showing which sources workers themselves notice in routine practice.

The weak association with performance is directionally consistent with experimental evidence that noise can impair speech processing, increase task time, or increase errors under selected conditions (12,14-

17). Observational evidence also suggests that noise distracts surgical teams, particularly during complex phases of an operation (13,23). Nevertheless, the small coefficients in this study indicate limited shared variation between perceived noise and reported outcomes. Perception, workload, fatigue, professional experience, task complexity, and organizational climate may all influence both exposure ratings and reported disturbance. The results therefore do not establish that perceived noise caused poorer performance.

The emotional and physiological domain means were slightly higher than the performance and subjective-perception means, but their correlations with noise did not reach statistical significance. This distinction is important: a relatively high domain score describes reported symptom burden, whereas correlation asks whether participants with higher perceived-noise scores also tended to report higher domain scores. Broader evidence links environmental and occupational noise with stress and non-auditory health responses (1,2,24), but the present questionnaire and cross-sectional design cannot diagnose these effects or determine their temporal sequence.

The findings support proportionate, context-specific interventions. Theatre teams could define quiet periods during induction, critical operative steps, and emergence; reinforce closed-loop communication; limit non-essential traffic and conversation; review alarm settings through formal safety processes; maintain noisy equipment; and monitor staff feedback. Behavioral approaches should complement, not replace, objective acoustic assessment. Direct sound-level monitoring before and after an intervention would allow hospitals to determine whether perceived improvements correspond to measurable reductions.

The study included multiple professional groups from two hospitals and assessed sources both inside and immediately outside the theatre. Its limitations include purposive sampling, restriction to two institutions, self-reported exposure and outcomes, lack of sound-pressure or dosimetry measurements, and the use of a single cross-sectional assessment. Common-method bias may have strengthened correlations because exposure and outcomes were reported by the same participants. The small coefficients, absence of temporal information, and lack of multivariable adjustment limit causal and generalizable conclusions. Future multicenter studies should combine validated perception measures with dosimetry, procedural phase, workload indicators, and prespecified adjusted analyses.

CONCLUSION

Healthcare workers identified conversation, patient vocalization, alarms, and clinical equipment as recurrent perceived sources of operating-theatre noise. Higher perceived-noise scores were weakly associated with greater overall health-effect and performance scores, whereas associations with emotional, physiological, and subjective-perception domains were not statistically significant. These findings support targeted communication, workflow, alarm-safety, and equipment-maintenance measures alongside objective acoustic monitoring.

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