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Research

The Effect of Noise Levels in the Operating Room on the Stress Levels and Workload of the Operating Room Team

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ABSTRACT

Purpose: The research was conducted to evaluate the noise levels and the effect of noise on the workload and stress levels of the operating room (OR) staff of a public hospital.
Design: Descriptive and cross-sectional study.
Methods: The data were obtained by measuring ambient noise during 403 orthopaedic, urological, and general surgeries on weekdays between July and October 2019. We measured the noise by dividing the surgery into three phases. These phases are as follows: from the entry of the patient, induction of anesthesia, and preparation of the surgical area until the start of the procedure (Phase I), from the incision until the completion of closure and dressing application (Phase II), from the completion of closure and dressing application until the exit of the patient (Phase III). Furthermore, the workload and stress levels of 45 OR staff who work in the general surgery, orthopaedics, and urology ORs were measured. Data were collected using a CA 834 noise measurement device, State-Trait Anxiety Inventory (STAI Form TX-I), the National Aeronautics and Space Administration (NASA) Task Load Index Workload Scale, and Information form related to surgery and ORs.
Findings: The noise in the OR was higher than 35 dB, A-weighted [dB(A)], the limit proposed by the World Health Organization for hospitals. Phase I average noise level was 63.00 ± 3.50, Phase II average noise level was 62.94 ± 3.75, and Phase III average noise level was 63.67 ± 2.81. The mean anxiety score was 34.50 ± 6.09. The total workload level was found to be 56.91 ± 15.67. Anxiety scores and workload scores had positive weak and moderate correlations with noise levels ($P < .01$).
Conclusions: The noise in the OR was high, and anxiety scores and workload scores correlated positively with noise levels.

Noise pollution in operating rooms (ORs) negatively impacts both patient safety and staff well-being.[1] Dholakia et al[2] prospectively evaluated noise levels in the OR and found a positive correlation between intraoperative noise levels and surgical site infections. Intraoperative noise causes distractions during surgery, which may have negative impacts on the concentration of OR staff.[3-5] Dholakia et al[2] hypothesized that poor concentration caused by high levels of noise may affect OR staff's ability to perform aseptic techniques, increasing the probability of developing surgical site infections. Intraoperative noise affects OR staff's reasoning and their ability to perform their tasks. Enser et al[6] demonstrated that anesthesiologists' clinical reasoning performance was poorer in a noisy environment than in a quiet environment. Moreover, intraoperative noise may impair effective communication between OR staff,[3,7,8] and ineffective communication is a leading factor contributing to adverse events.[9] Ineffective communication not only negatively impacts patient safety but also causes increase in stress among OR staff.[10] Furthermore, Waterland et al[11] reported that ambient noise in a simulated OR generated an increase in the psychological and physiological stress of novice surgeons during laparoscopy. Besides the increase in stress, intraoperative noise increases the perception of workload and fatigue of OR staff.[12,13]

The aim of this descriptive and cross-sectional study was to determine the level of noise in the OR and its impact on the OR staff's stress levels and workload, which includes mental, physical, and temporal demands, performance, effort, and frustration.

Conflict of interest: None to report.

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The following research questions were developed:

Q1: Is there any difference between the levels of noise in general, orthopaedic, and urological surgeries?
Q2: Does the noise level in the OR affect the stress levels of OR staff?
Q3: Does the noise level in the OR affect the workload levels of OR staff?

Methods

Design and Study Population

This descriptive, prospective, cross-sectional study was conducted in a 223-bed state hospital with six ORs in Istanbul from July to October 2019. A total of 64 OR staff work in the OR, including 23 scrub nurses, 24 surgeons, 5 anesthetists, and 12 anesthesia technicians. Seventeen scrub nurses, 8 general surgeons, 5 orthopaedists, 3 urologists, 5 anesthetists, and 12 anesthesia technicians work in the ORs where the research was conducted. A total of 7,018 surgeries are performed annually in the hospital; 2,892 surgeries are performed in the general surgery department, 2,206 in the orthopaedic department, and 1,920 in the urology department. A stratified sampling method was used in the selection of the sample. The total population was stratified by surgical department, and the sample was taken from each stratum proportionally. The minimum study population required to make statistical estimates with 95% confidence and a ±5% sampling error was calculated to be 365 surgeries. Therefore, 403 randomly selected surgeries (167 general surgery, 125 orthopaedic, and 111 urological) comprised the study population.

Research Instruments

Sound Level Meter

The ambient noise was measured with a handheld sound level meter (CA 834; Chauvin Arnoux Group, Paris, France), which is capable of measuring in the range of 30 to 130 dB with a sensitivity of ±1.5 dB and resolution 0.1 dB. This battery-operated device has a storage capacity of 32,000 values. The data are transferred to the software, which analyzes it. Recording data directly to the computer and independent of the device's memory is also possible.

The State-Trait Anxiety Inventory

The State-Trait Anxiety Inventory (STAI Form TX-1) was developed in the English language in 1970 by Spielberg et al,[14] and the validity and reliability of the Turkish version were confirmed by Öner and Le Comte in 1982.[15] The state anxiety scale is a unidimensional 4-point Likert-type scale (eg, from *almost never* to *almost always*) that consists of 20 items. The lowest score on the scale is 20, and the highest score is 80. Higher scores indicate greater anxiety.[14,15] A mean score of 40 or greater was considered to be a serious and clinically significant anxiety level.[16] Cronbach's α value for the Turkish version of the STAI Form TX-1 was 0.83.[15] In this study, the Cronbach's α value was 0.767.

The NASA Task Load Index

The NASA Task Load Index (NASA-TLX) is a multidimensional scale developed by Hart and Staveland[17] to obtain workload during or immediately after performing a task. The NASA-TLX has six subdomains, which are as follows: mental (how much mental and perceptual activity—for example, thinking, deciding, calculating, remembering, and so forth—is required for the task?), physical (how much physical activity—for example, pushing, pulling, turning, and so forth—is required for the task?), temporal (how much pressure did you feel because of the pace of the task relating to time?), performance (how successful were you in accomplishing what you were asked to do?), effort (how hard did you have to work to accomplish your level of performance?), and frustration (how insecure, discouraged, irritated, stressed, and annoyed were you?).[17] Each of these six subdomains is self-rated on a 21-point visual analog scale (total score ranges from 6 to 126) with higher scores indicating a higher workload.[17,18] Cronbach's α value was 0.72 in the study by Hart and Staveland.[17] In this study, the Cronbach's α value was 0.785. Cronbach's α values of the subscales range from 0.717 to 0.827.

Information Form for the Surgery and the Surgical Team

This 16-item form, prepared by the researcher and based on the literature, provides information about the type of surgical unit, name of surgery, date of surgery, start and end time of surgery, start times of surgery phases, noise levels (maximum-minimum-mean), type of surgery, type of anesthesia, and the American Society of Anesthesiologists' (ASA) physical classification system. Furthermore, it includes age, gender, and job type of OR staff.[5,19]

Study Procedure

The sound level meter was placed preoperatively 1.5 m above the ground and 2 m from the anesthesia unit toward the surgical field, taking care to maintain the surgical area's sterility and not disrupt the surgical procedure.[19] Measurements were performed on weekdays. We measured the noise by dividing the surgery into three phases. These phases are as follows:

Phase I (opening phase): from the entry of the patient, induction of anesthesia, and preparation of the surgical area, until the start of the procedure.
Phase II (main phase): from the incision until the completion of closure and dressing application.
Phase III (closing phase): from the completion of closure and dressing application until the exit of the patient.

Furthermore, the researcher observed each surgery and completed the Information Form for the Surgery and the Surgical Team. The observer was positioned so that he or she would not distract the surgical team and break the sterility. OR staff answered the STAI and the NASA-TLX immediately after each surgery to reduce recall bias. We initially planned to evaluate stress and workloads after each phase of the surgery. However, we were unable to enlist the OR staff to agree to answer the questions three times because of their heavy workloads.

The local Ethics Committee approved this study, under registration number 2019.104.06.25, with the application date of May 30, 2019. Approval from the hospital and the informed consent of staff were obtained. Furthermore, the researchers obtained permission from Öner, the author who adapted the STAI to Turkish, to use the scale. The study conforms to the principles outlined in the Declaration of Helsinki.

Statistical Analysis

Statistical analysis was performed using Number Cruncher Statistical System 2007 (Kaysville, UT). Mean, standard deviation, frequency, percentage, Pearson and Spearman correlation analyses, Shapiro-Wilk, one-way analysis of variance (ANOVA), and Bonferroni tests were used to analyze data. A P value of <.05 was considered statistically significant.

Results

Characteristics of the Surgeries and OR Staff

In the sample population, 41.4% (n = 167) of the surgeries were general surgery, 31.1% (n = 125) were orthopaedic, and 27.5% (n = 111) were urological. Sixty-three percent (n = 254) of the surgeries were open and 37% (n = 149) were endoscopic surgeries. The surgeries were 59.3% (n = 239) ASA I and 40.7% (n = 164) ASA II. The hospital where the study was conducted is a relatively small one, and ASA III, IV, V cases are dispatched to bigger hospitals, such as university hospitals. Therefore, there were no ASA III, IV, or V cases in the sample. The duration of the surgeries ranged from 30 to 120 minutes with an average of 69.84 ± 23.67 minutes (Table 1). Of the OR staff, 37.8% (n = 17) were scrub nurses, 24.4% (n = 11) were surgeons, and 37.8% (n = 17) were anesthetists. Average job experience was 8.00 ± 5.82 years and average age was 34.89 ± 7.41 years.

Table 1
Characteristics of the Surgeries

N = 403	n (%)
Surgical unit	
General surgery	167 (41.4)
Orthopaedics	125 (31.1)
Urology	111 (27.5)
Surgery type	
Open	254 (63.0)
Laparoscopic	149 (37.0)
ASA classification	
ASA I	239 (59.3)
ASA II	164 (40.7)
Duration of surgery (min)	
Min-max (median)	30-120 (70)
Mean ± SD	69.84 ± 23.67
30-45	72 (17.9)
45-60	102 (25.3)
60-90	181 (44.9)
>90	48 (11.9)

ASA, American Society of Anesthesiologists; SD, standard deviation.

Noise Levels by Characteristics of the Surgeries

The highest and lowest noise levels measured are listed as follows: minimum 51.5 dB(A) and maximum 81.7 dB(A) in Phase I; minimum 50.4 dB(A) and maximum 91.9 dB(A) in Phase II; minimum 50.4 dB(A) and maximum 87.9 dB(A) in Phase III. The average noise levels of Phase I, Phase II, and Phase III, respectively, are as follows: 63.00 ± 3.50, 68.55 ± 4.99, and 69.32 ± 4.11. In all three phases of surgery, the noise level in the orthopaedic surgery was higher than the general surgery ($P = .001$) and urological surgery ($P = .001$; $P < .01$). There was no statistically significant difference in noise levels between general surgery and urology units in all three phases ($P > .05$; Table 2).

Stress Scores of OR Staff and Their Correlation With Noise Levels in the OR

The mean stress score of OR staff was 34.50 ± 6.09, which means that their stress level cannot be considered as serious and clinically significant. However, there were statistically significant positive weak and moderate correlations between stress scores and average noise levels in Phase I ($r = 0.248$), Phase II ($r = 0.306$), and Phase III ($r = 0.168$) ($P = .001$; $P < .01$; Table 3). The mean stress score of the anesthesia team was higher than surgeons ($P = .003$). No statistically significant difference in stress scores between other subteams was present ($P > .05$; Table 4).

Workload Scores of OR Staff and Their Correlation With Noise Levels in the OR

The average workload level of OR staff was 56.91 ± 15.67. The total score of the scale ranges from 6 to 126, with higher scores indicating a higher workload. This score means their workload level was moderate. There were statistically significant positive weak and moderate correlations between workload and average noise levels in Phase I ($r = 0.270$), Phase II ($r = 0.375$), and Phase III ($r = 0.255$) ($P = .001$; $P < .01$; Table 3). There was no statistically significant difference in workload scores between subteams ($P > .05$; Table 4).

Discussion

The World Health Organization (WHO) recommends that the level of continuous background noise in hospitals should not exceed 35 dB during the day to maintain speech intelligibility.[20] In this study, the average noise levels in three phases of surgery—63.00 ± 3.50, 68.55 ± 4.99, and 69.32 ± 4.11 dB(A)—exceeded the WHO recommendation. Noise levels peaked at a maximum 91.9 dB(A). Similar to this finding, many studies have found that noise levels during surgery exceed the WHO recommendation. In the study conducted by Yasak and Vural[21] in Turkey, the mean noise level during surgery was 54.29 dB(A). Keller et al[5] found that the mean noise levels in three phases of surgery were as follows: 54.52 ± 1.55, 55.84 ± 1.73, and 56.34 ± 1.93 dB(A). In a study carried out in maxillofacial ORs, average sound level was 58 dB(A), and levels peaked at a maximum of 117.4 dB(A) when power tools and suction were used.[22] Kulkarni et al[23] investigated the intensity of the noise in oral and maxillofacial surgery ORs and clinical settings and suggested that the mean intraoperative noise level for nondrilling periods was 64.3 dB (maximum 94.8 dB), and for drilling periods, it was 66.78 dB (maximum 89.0 dB). Jenkins et al[24] studied ambient noise and distracting events during caesarean operations and reported the mean noise levels in three phases of surgery as follows: 62.5 ± 3.9, 63.9 ± 4.1, and 66.8 ± 5.0 dB. Wang et al[19] reported an ambient noise range in the OR between 59.2 and 72.3 dB(A).

Factors that contribute to noise levels in the OR include, beepers, surgical equipment and devices, heating, ventilation, and air conditioning systems, acoustic surfaces on floors, walls, and ceilings, telephones, music devices, conversations not revolving around the patient or procedure, and traffic into and out of the OR.[1] Eliminating all sources of noise and distraction in the OR is not realistic.[9] Thus, the Association of periOperative Registered Nurses recommends minimizing noise and distractions in the OR.[1] In the future, surgical equipment that is quieter than models currently in use may help to prevent noise pollution.[5] Besides, the behavior of the OR staff can be corrected to minimize the noise in the OR. General rules of silence are not very likely to be successful for reducing noise during long surgeries. A sterile, cockpit rule period of silence during which nonessential conversation and activities are prohibited during critical phases of the surgical procedure is suggested for concentrated work of OR teams. Critical phases may include time-out periods, critical dissections, surgical counts, medication preparation and administration, confirming and opening of implants, induction into and emergence from anesthesia, and care and handling of specimens.[1,5,24] Crockett et al[25] observed a decrease in distractions (unnecessary conversations or loud noises) occurring during induction of general anesthesia in pediatric ORs by using a quality improvement project called "Distraction Free Induction Zone."

Table 2
Noise Levels by Characteristics of the Surgeries

N = 403	n	Phase I Average Noise Level	Phase II Average Noise Level	Phase III Average Noise Level
		Mean ± SD (Median)	Mean ± SD (Median)	Mean ± SD (Median)
Surgical unit				
General surgery	167	61.69 ± 3.36 (61.4)	61.68 ± 3.58 (61.1)	63.21 ± 3.11 (62.5)
Orthopaedics	125	65.23 ± 3.26 (64.6)	65.35 ± 3.39 (64.8)	64.77 ± 2.62 (64.5)
Urology	111	62.46 ± 2.67 (62)	62.10 ± 3.04 (61.8)	63.13 ± 2.13 (62.8)
Test value;* *P*		*F* = 44,105; .001†	*F* = 46,793; .001†	*F* = 16,328; .001†

SD, standard deviation.
* One-way analysis of variance test.
† $P < .01$.

In this study, Phase II (the main phase) and Phase III (the closing phase) were noisier than Phase I. Similarly, Keller et al[5] found that the main and closing phases of surgery were noisier than the opening phase. Jenkins et al[24] reported that Phase III had the highest ambient noise levels. Stretcher movement noise while transferring the patient and staff conversations at the end of surgery may be the reason for the noisier environment in Phase III.

The noise level in the orthopaedic surgeries was higher than the general and urological surgeries. Similarly, Wang et al[19] and Giv et al,[26] in their investigations of noise levels in ORs, found that the mean noise level in orthopaedic surgeries is higher than other types of surgeries. The high noise levels in orthopaedic surgeries result from the instruments used, such as hammers, drills, and saws.[26,27] Peters et al[27] suggested that noise-induced hearing loss is an underestimated problem in orthopaedic surgery, and the use of oscillating tip saw systems offer reduced noise in comparison with conventional saw systems.

The mean stress score of OR staff was 34.50 ± 6.09. A STAI mean score of 40 or greater is considered to be a serious and clinically significant stress level.[16] Therefore, the OR staff in this study were not found to have experienced a serious and clinically significant stress level. However, the results of the present study suggest that the stress levels of the OR staff increase as the noise level increases. Similar to this finding, a simulation-based study provided evidence that intraoperative noise can increase stress.[12] The quality improvement project conducted in ORs by Hogan and Harvey[28] demonstrated that reducing noise during anesthesia induction and emergence can minimize stress, distraction, and annoyance in staff members. Waterland et al,[11] in a study on noise exposure, found that increased noise during laparoscopy produced a significant increase in the stress response of the surgeon. Padmakumar et al[3] found that 61% of the OR staff reported that their stress levels increased with an increase in ambient noise. Wheelock et al found that acoustic distractions (telephone, mobile phones, pagers, radios, and external noises) were linked to higher levels of stress experienced by surgeons in the OR.[29] Although we believe laparoscopy cases can result in more stress for the surgeon because of the technical difficulty compared with an open case, interestingly, the mean stress score of the anesthesia team was higher than for the surgeons. The anesthesia team included anesthetists and anesthesia technicians. Anesthesia technicians were younger, hence less experienced than other team members. This may lead them to feel more stress than others.

The mean workload score of OR staff was 56.91 ± 15.67. The total score of NASA-TLX ranges from 6 to 126 with higher scores indicating a higher workload.[17,18] In line with this information, the authors conclude that the workload levels experienced by the staff were moderate. However, as the noise level increases, workload levels of the OR staff also increase. Parallel to this finding, intraoperative noise increased workload levels among the anesthesia team in the study by McNeer et al.[12] Gao et al[13] also reported that intraoperative noise increases the surgeon's mental workload (referring to the mental effort required by the task, eg, thinking, deciding, calculating, and remembering).

Consequently, the OR team should be aware of the dangers of noise in the OR and follow rules such as a sterile cockpit to minimize noise in the OR. Leaders should organize behavioral training to minimize staff-created noise and search for new instrument designs that produce less noise.

Limitations

There are several limitations to this study. First, we limited the cases to include only general, orthopaedic, and urological surgeries, which prevents generalizing our results to other surgeries. Second, the average job experience of the OR team was 8 years. It is possible that more experienced OR teams adapt better to the noisy environment over time. These limitations should be considered in future studies. Third, ASA I and II scores of cases indicated low risk; more complex cases may yield different results. Fourth, this was not a randomized controlled study; we could not eliminate noise from other factors that can cause an increase in anxiety and workload levels. Furthermore, the anxiety and workload levels could theoretically be the same, if there was no noise at all. Therefore, we cannot directly link an increase in noise levels to an increase in anxiety and workload levels. The relationships among anxiety,

Table 3
Correlation Between Noise Levels and State Anxiety and NASA Task Load Index Workload Levels

	State Anxiety Scores		Workload Scores	
	R	*P*	*R*	*P*
Phase I average noise	0.248*	.001†	0.270*	.001†
Phase II average noise	0.306*	.001†	0.375*	.001†
Phase III average noise	0.168*	.001†	0.255*	.001†

* *r*: Pearson's and Spearman's correlation coefficient.
† $P < .01$.

Table 4
State Anxiety and Workload Scores by Subteam

	Scrub Nurses	Surgeons	Anesthetists	*P*
State Anxiety Scores				.003*
Mean ± SD	34.65 ± 6.04	33.69 ± 6.54	35.22 ± 5.46	
Min-Max (Median)	20-51 (34)	20-52 (33)	20-52 (36)	
Workload scores				.056
Mean ± SD	57.77 ± 15.09	57.28 ± 15.46	55.12 ± 16.7	
Min-max (median)	15-94 (57)	22-92 (58)	19-97 (55)	

SD, standard deviation.
Test value; *P*: one-way analysis of variance test.
* $P < .01$.

workload levels, and noise are correlative but not cause-effect. Further research should conduct a multiple regression analysis to assess noise levels that are predictive of stress and mental workload. Also, we recommend simulation-based studies that offer a safer and more controlled venue for performing randomized controlled studies to be carried out in future. Fifth, the presence of the observer in the OR measuring noise may have affected the noise levels of the room. Finally, participants answered questions of NASA-TLX and STAI Form TX-1 from all three phases after the surgeries. This may have caused poor detail recollection relating to mental workload and stress.

Conclusions

The mean noise levels in all three phases of surgery were higher than 35 dB(A), which is the limit that the WHO recommends for hospitals. Furthermore, the anxiety levels and workload levels of the OR staff had correlated positively with noise levels in the OR. OR staff needs to recognize that intraoperative noise can increase their stress levels and distract them during work. Effective multidisciplinary teamwork is required to reduce noise in the OR. The OR team should search for new sustainable strategies and interventions to reduce noise in the OR.

References

1. AORN position statement on managing distractions and noise during perioperative patient care. *AORN Inc*; 2020. Available at: https://www.aorn.org/guidelines/clinical- resources/position-statements. Accessed April 13, 2020.
2. Dholakia S, Jeans JP, Khalid U, Dholakia S, D'Souza C, Nemeth K. The association of noise and surgical-site infection in day-case hernia repairs. *Surgery*. 2015;157:1153–1156.
3. Padmakumar AD, Cohen O, Churton A, Groves JB, Mitchell DA, Brennan PA. Effect of noise on tasks in operating theatres: A survey of the perceptions of healthcare staff. *Br J Oral Maxillofac Surg*. 2017;55:164–167.
4. van Pelt M, Weinger MB. Distractions in the anesthesia work environment: Impact on patient safety? Report of a meeting sponsored by the anesthesia patient safety foundation. *Anesth Analg*. 2017;125:347–350.
5. Keller S, Tschan F, Semmer NK, et al. Noise in the operating room distracts members of the surgical team. An observational study. *World J Surg*. 2018;42:3880–3887.
6. Enser M, Moriceau J, Abily J, et al. Background noise lowers the performance of anaesthesiology residents' clinical reasoning when measured by script concordance: A randomised crossover volunteer study. *Eur J Anaesthesiol*. 2017;34(7):464–470.
7. Keller S, Tschan F, Beldi G, Kurmann A, Candinas D, Semmer NK. Noise peaks influence communication in the operating room. An observational study. *Ergonomics*. 2016;59:1541–1552.
8. Cheriyan S, Mowery H, Ruckle D, et al. The impact of operating room noise upon communication during percutaneous nephrostolithotomy. *J Endourol*. 2016;30:1062–1066.
9. *Minimizing noise and distractions in the OR and procedural units. Joint Commission Quick Safety*. The Joint Commission; 2017. https://bit.ly/315brxe. Accessed April 13, 2020.
10. Uğurlu Z, Karahan A, Ünlü H, et al. The effects of workload and working conditions on operating room nurses and technicians. *Workplace Health Saf*. 2015;63:399–407.
11. Waterland P, Khan FS, Ismaili E, Cheruvu C. Environmental noise as an operative stressor during simulated laparoscopic surgery. *Surg Laparosc Endosc Percutan Tech*. 2016;26:133–136.
12. McNeer RR, Bennett CL, Dudaryk R. Intraoperative noise increases perceived task load and fatigue in anesthesiology residents: A simulation-based study. *Anesth Analg*. 2016;122:512–525.
13. Gao J, Liu S, Feng Q, et al. Quantitative evaluations of the effects of noise on mental workloads based on pupil dilation during laparoscopic surgery. *Am Surg*. 2018;84:1951–1956.
14. Spielberger CD, Gorsuch RL, Lushene RE. *STAI Manual for the State-Trait Anxiety Inventory*. Palo Alto, California: Consulting Psychologists' Press; 1970.
15. Öner N, Le Comte A. *Handbook of the State-Trait Anxiety Inventory (Süreksizdurumluk/Süreklikaygıenvanteri el Kitabı)*. 2nd ed. İstanbul: Boğaziçi University Publications; 1998.
16. Spielberger CD, Gorsuch RL, Lushene R, Vagg PR, Jacobs GA. *Manual for the State-Trait Anxiety Inventory (Form Y)*. Palo Alto, CA: Mind Garden; 1983.
17. Hart SG, Staveland LE. Development of NASA-TLX (Task Load Index): Results of empirical and theoretical research. In: Hancock PA, Meshkati N, eds. *Human Mental Workload*. Amsterdam: North Holland Press; 1988.
18. Hart SG. *NASA-Task Load Index (NASA-TLX); 20 years later*. Proceedings of the Human Factors and Ergonomics Society 50th Annual Meeting. Los Angeles, CA: Sage Publications; 2006:904–908.
19. Wang X, Zeng L, Li G, et al. A cross-sectional study in a tertiary care hospital in China: Noise or silence in the operating room. *BMJ Open*. 2017;7:e016316.
20. WHO (World Health Organization). *Guidelines for Community Noise*. Geneva; 1999. Available at: www.who.int/docstore/peh/noise/guidelines2.html. Accessed February 22, 2020.
21. Yasak K, Vural F. Assessment of the environmental and physical ergonomic conditions of ORs in Turkey. *AORN J*. 2019;110:517–523.
22. Tay BD, Prabhu IS, Cousin CHS, Cousin GCS. Occupational exposure to noise in maxillofacial operating theatres: An initial prospective study. *Br J Oral Maxillofac Surg*. 2016;54:94–96.
23. Kulkarni E, Abdallah Y, Hanseman D, Krishnan DG. How much noise is an oral and maxillofacial surgeon exposed to? *J Oral Maxillofac Surg*. 2018;76:1400–1403.
24. Jenkins A, Wilkinson JV, Akeroyd MA, Broom MA. Distractions during critical phases of anaesthesia for caesarean section: An observational study. *Anaesthesia*. 2015;70:543–548.
25. Crockett CJ, Donahue BS, Vandivier DC. Distraction-free induction zone: A quality improvement initiative at a large academic children's hospital to improve the quality and safety of anesthetic care for our patients. *Anesth Analg*. 2019;129:794–803.
26. Giv MD, Sani KG, Alizadeh M, Valinejadi A, Majdabadi HA. Evaluation of noise pollution level in the operating rooms of hospitals: A study in Iran. *Interv Med Appl Sci*. 2017;9:61.
27. Peters MP, Feczko PZ, Tsang K, van Rietbergen B, Arts JJ, Emans PJ. Noise exposure in TKA surgery; oscillating tip saw systems vs oscillating blade saw systems. *J Arthroplasty*. 2016;31:2773–2777.
28. Hogan LJ, Harvey RL. Creating a culture of safety by reducing noise levels in the OR. *AORN J*. 2015;102:410.e1–410.e7.
29. Wheelock A, Suliman A, Wharton R, et al. The impact of operating room distractions on stress, workload, and teamwork. *Ann Surg*. 2015;261:1079–1084.