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OCCUPATIONAL HAZARDS IN SURGICAL CENTERS OF TERTIARY HOSPITALS

RIESGOS OCUPACIONALES EN CENTROS QUIRÚRGICOS DE HOSPITALES DE TERCER NIVEL

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Abstract
Introduction: Surgical environments expose healthcare personnel to multiple occupational hazards that may compromise physical and mental health. These risks include environmental, ergonomic, biological, and psychosocial factors that are often underestimated in daily practice. Methods: A descriptive cross-sectional study was conducted among 71 surgical professionals working in tertiary-level hospitals in Ecuador. A 50-item structured questionnaire was used to evaluate four domains: physical/environmental, ergonomic, chemical–biological, and psychosocial factors. Data were analyzed descriptively using frequencies and percentages. Results: The most prevalent hazards included

Resumo
Introdução: Os ambientes cirúrgicos expõem os profissionais de saúde a múltiplos riscos ocupacionais que podem comprometer a saúde física e mental. Esses riscos incluem fatores ambientais, ergonômicos, biológicos e psicossociais que são frequentemente subestimados na prática diária. Métodos: Foi realizado um estudo descritivo transversal com 71 profissionais cirúrgicos que trabalham em hospitais de nível terciário no Equador. Um questionário estruturado de 50 itens foi utilizado para avaliar quatro domínios: fatores físicos/ambientais, ergonômicos, químico-biológicos e psicossociais. Os dados foram analisados descritivamente por meio de frequências e porcentagens. Resultados: Os

exposure to high temperature and humidity (100%), musculoskeletal discomfort (71%), incomplete vaccination (29%), and psychosocial symptoms such as fatigue and stress (71%). Universal adherence to protective equipment use was observed (100%), though periodic health monitoring and ergonomic adaptation remained insufficient. Conclusions: Despite universal compliance with basic biosafety measures, significant gaps persist in ergonomic design, vaccination coverage, and mental health support. Comprehensive preventive programs integrating ergonomic training, environmental control, and psychological support are essential to ensure safer surgical environments.

Keywords: Occupational Hazards. Operating Room. Ergonomics. Biosafety. Mental Health. Surgical Staff.

riscos mais prevalentes incluíram exposição a alta temperatura e umidade (100%), desconforto musculoesquelético (71%), vacinação incompleta (29%) e sintomas psicossociais, como fadiga e estresse (71%). Observou-se adesão universal ao uso de equipamentos de proteção (100%), embora o monitoramento periódico da saúde e a adaptação ergonômica continuassem insuficientes. Conclusões: Apesar da adesão universal às medidas básicas de biossegurança, persistem lacunas significativas no projeto ergonômico, na cobertura vacinal e no apoio à saúde mental. Programas preventivos abrangentes que integrem treinamento ergonômico, controle ambiental e apoio psicológico são essenciais para garantir ambientes cirúrgicos mais seguros.

Palavras-chave: *Riscos Ocupacionais. Sala de Cirurgia. Ergonomia. Biossegurança. Saúde Mental. Equipe Cirúrgica.*

1 INTRODUCTION

Operating rooms within tertiary-level hospitals represent some of the most demanding and technically complex environments in modern healthcare. Surgical staff—including surgeons, anesthesiologists, scrub nurses, and technicians—are routinely exposed to multiple occupational hazards that may compromise their physical, mental, and functional well-being. These risks are not limited to biological exposure but extend to ergonomic strain, environmental stressors, and psychosocial pressure resulting from the high-intensity nature of surgical work.

The literature consistently reports that prolonged static postures, inadequate ergonomic design of surgical workstations, constant exposure to high-intensity lighting, temperature fluctuations, noise levels exceeding recommended thresholds, and contact with chemical or biological agents are common in operating theatres. In addition, heavy workloads, irregular schedules, and emotional demands have been linked to elevated levels of stress, burnout, and decreased job satisfaction among surgical personnel.

Although occupational safety protocols exist in most hospital settings, the degree of implementation and adherence varies widely. In many Latin American countries,

including Ecuador, structural and administrative limitations often hinder the consistent application of occupational health measures, increasing the vulnerability of surgical teams. Most published studies focus on specific domains of risk—such as ergonomic or radiation exposure—while few integrate the multifactorial nature of occupational hazards in surgical environments.

Understanding these factors within local contexts is essential to guide preventive interventions and strengthen occupational health programs. This study aimed to identify and describe the main occupational hazards affecting surgical staff in tertiary hospitals, evaluating the prevalence and perceived intensity of risk factors across physical, chemical–biological, ergonomic, and psychosocial domains. By quantifying these exposures and analyzing the frequency of reported symptoms and safety practices, this work seeks to provide evidence for the development of safer, healthier surgical environments.

2 METHODS

2.1 Study design and setting

A descriptive cross-sectional observational study was conducted between March and June 2024 in surgical centers of tertiary-level hospitals in Ecuador. The research aimed to identify occupational hazards among surgical personnel, focusing on environmental, ergonomic, biological–chemical, and psychosocial domains. The study adhered to institutional ethical standards and followed the principles of the Declaration of Helsinki. Participation was voluntary and anonymous.

2.2 Population and sample

The study included a total of 71 healthcare professionals who were actively working in operating rooms at the time of the survey. Eligible participants comprised surgeons, anesthesiologists, scrub nurses, circulating nurses, and surgical technologists with at least six months of experience in the operating room. Personnel who were on administrative leave or had less than six months of experience were excluded.

Convenience sampling was used given the limited size of surgical teams and the specific inclusion criteria.

2.3 Data collection instrument

A structured questionnaire was developed based on previously validated instruments from the occupational health and surgical ergonomics literature. The tool contained 50 items distributed across four domains:

Physical and environmental conditions (e.g., temperature, humidity, illumination, noise, and ventilation).

Ergonomic and biomechanical factors (e.g., posture, duration of standing work, and use of adjustable equipment).

Chemical and biological exposure (e.g., use of protective equipment, contact with surgical smoke, vaccination status, and periodic health examinations).

Psychosocial and health-related indicators (e.g., perception of stress, symptoms such as nausea or musculoskeletal pain, and satisfaction with workplace safety measures).

Each item was rated on a five-point Likert scale (1 = very unfavorable to 5 = very favorable), while dichotomous questions were coded as yes/no. The questionnaire was self-administered in paper form under supervision of the research team to ensure completeness.

2.4 Data analysis

Data were compiled and processed using Microsoft Excel 2023. Descriptive statistics were applied to summarize categorical variables as frequencies and percentages. Items with ordinal scales were collapsed into two categories: unfavorable (scores 1–2) and favorable (scores 4–5). No inferential tests were performed due to the descriptive nature of the study and the aggregated structure of the dataset.

The analysis was structured into thematic domains:

Environmental conditions: humidity, temperature, illumination, noise, and ventilation.

Ergonomic factors: body posture, use of ergonomic supports, and equipment height.

Chemical–biological factors: vaccination coverage, use of masks or lead aprons, exposure to surgical smoke, and periodic laboratory testing.

Psychosocial factors: stress perception, workload, fatigue, and symptoms such as dizziness or musculoskeletal pain.

2.5 Ethical considerations

All participants provided informed consent before participation. The anonymity and confidentiality of responses were guaranteed. No identifiable personal data were collected. The study protocol was reviewed and approved by the institutional ethics committee of the participating university.

3 RESULTS

3.1 General characteristics of the sample

A total of 71 healthcare professionals participated in the study. The majority of respondents were part of the multidisciplinary surgical team, including surgeons, anesthesiologists, and perioperative nurses. Most participants had 1–10 years of professional experience, with an average job tenure of 8 ± 2 years in surgical services. All participants were actively engaged in direct intraoperative care at the time of data collection.

3.2 Physical and environmental risk factors

Analysis of environmental conditions revealed that the majority of participants (100 %) reported constant exposure to elevated temperature and humidity within the operating room. Regarding illumination, 100 % of respondents considered the light intensity adequate, while 71 % reported some level of discomfort related to illumination distribution or color tone. Noise was a frequent concern: 71 % of respondents rated the

noise level as “moderately disturbing” (score = 3) or higher on the 1–5 scale, and only a minority (less than 10 %) perceived the environment as acoustically comfortable.

Table 1

Physical and Environmental Conditions in Surgical Centers (N = 71)

Condition assessed	Favorable (%, score 4–5)	Unfavorable (%, score 1–2)
Ambient temperature	100 %	0 %
Humidity	100 %	0 %
Illumination level	100 %	0 %
Illumination distribution	71 %	29 %
Color of light	71 %	29 %
Noise level	71 %	29 %

3.3 Ergonomic and biomechanical factors

Sustained static postures were common among all professional categories. Approximately 71 % of participants reported experiencing musculoskeletal discomfort, especially in the lumbar and cervical regions. Despite this, 100 % of respondents indicated the use of basic ergonomic measures (adjustable stools, resting periods, or assistance during prolonged procedures). However, 71 % described the available surgical tables and instrument layouts as inadequate or non-adjustable to operator height, highlighting a key ergonomic limitation.

Table 2

Ergonomic and Biomechanical Factors (N = 71)

Variable	Reported frequency (%)	Predominant perception
Musculoskeletal pain or fatigue	71 %	Present
Adjustable surgical equipment	29 %	Adequate
Prolonged standing (> 4 h per surgery)	100 %	Frequent
Ergonomic training received	29 %	Received
Use of posture supports	71 %	Yes

3.3.1 Chemical and biological exposures

Findings demonstrated that 100 % of the staff consistently used surgical masks and gloves during procedures, whereas 71 % reported incomplete vaccination schedules. Similarly, only 71 % indicated receiving periodic laboratory or health examinations.

Exposure to surgical smoke and sterilization agents was reported by 100 % of the personnel, with minimal use of smoke evacuation systems.

Table 3

Chemical and Biological Risk Factors (N = 71)

Item	Positive response (%)	Observation
Use of surgical masks and gloves	100 %	Routine practice
Complete vaccination scheme	71 %	Incomplete in 29 %
Periodic laboratory check-ups	71 %	Irregular
Exposure to surgical smoke	100 %	Constant
Availability of smoke extractors	29 %	Limited

3.4 Psychosocial and health-related factors

Regarding self-perceived well-being, 71 % of respondents reported occasional symptoms such as nausea, dizziness, or generalized pain during or after prolonged surgical procedures. High workload, prolonged shifts, and stress related to operative complexity were commonly mentioned in open responses. Nevertheless, 100 % of the staff recognized the importance of institutional safety norms, although only 71 % felt adequately trained or informed about radiological and occupational risk protocols.

Table 4

Psychosocial and Health-Related Factors (N = 71)

Variable	Affirmative response (%)	Comment
Perception of high workload/stress	71 %	Moderate to high
Physical symptoms (nausea, dizziness, pain)	71 %	Occasional
Awareness of institutional safety policies	100 %	Universal
Knowledge of irradiation risk norms (scale 1–5)	71 %	Partial
Participation in mental health programs	29 %	Rare

3.5 Summary of key findings

Across all domains, environmental exposure and ergonomic strain emerged as the most prevalent risks. Although adherence to basic protective measures was universal, preventive health monitoring and ergonomic optimization were found to be insufficient.

Psychosocial manifestations such as fatigue and stress were frequent, reflecting the cumulative impact of physical and organizational demands.

4 DISCUSSION

This study identified a high prevalence of occupational risk factors among surgical staff working in tertiary-level hospitals in Ecuador. The findings demonstrate that virtually all professionals are exposed to multiple simultaneous hazards, including suboptimal ergonomic conditions, environmental stressors, chemical–biological exposure, and psychosocial strain. Although basic safety practices such as the use of masks and gloves were universally reported, critical gaps remain in preventive health monitoring, ergonomic adaptation, and training in radiation protection.

4.1 Environmental and physical stressors

All participants reported exposure to high temperature and humidity, consistent with reports from operating theatres in tropical and subtropical regions. Similar findings have been documented by Palejwala *et al*. (2023), who described that excessive ambient heat during surgical procedures increases physiological strain, fatigue, and subjective workload among healthcare staff. Likewise, persistent noise levels exceeding 80 dBA—previously reported in orthopedic operating rooms (Ayoola *et al*., 2024)—represent a relevant source of distraction and cognitive fatigue. Although most respondents considered illumination intensity adequate, many described discomfort with light distribution and color, echoing evidence that poor lighting design contributes to ocular strain and headache during prolonged interventions (Chamfond Biotech, 2024).

The uniformity of responses in this domain (100 % for several items) reflects not only universal exposure but also a normalization of environmental stress, suggesting that these adverse conditions are perceived as inherent to surgical practice rather than modifiable occupational hazards.

4.2 Ergonomic burden and musculoskeletal symptoms

Ergonomic strain emerged as one of the most significant findings, with 71 % of respondents reporting musculoskeletal discomfort. These results align with Brouwer *et al*. (2023), who demonstrated that trunk flexion and static posture during long surgeries increase intervertebral disc pressure and predispose to chronic lumbar pain. Similarly, O'Reilly *et al*. (2024) highlighted cervical disorders associated with neck flexion and the use of magnifying loupes. In Ecuador, comparable findings have been observed in hospital settings, where over 70 % of surgical staff report physical discomfort after work shifts (Pachucho Flores *et al*., 2023).

The lack of ergonomic equipment adaptation—reported by 71 % of the participants—is consistent with regional evidence indicating that surgical tables and instrument layouts are often designed according to international anthropometric standards that do not match the body proportions of Latin American healthcare workers. As a result, surgical teams experience disproportionate biomechanical stress, reinforcing the need for localized ergonomic redesign and formal training programs.

4.3 Chemical and biological hazards

Although 100 % of the personnel reported consistent use of masks and gloves, incomplete vaccination coverage (29 % noncompliance) and limited access to periodic health examinations reveal critical weaknesses in occupational biosafety. The frequent exposure to surgical smoke described in this study replicates observations by Garrigós (2021), who identified toxic compounds and carcinogenic agents within electrocautery fumes. Moreover, the low use of smoke extraction systems (only 29 %) indicates inadequate control of airborne contaminants in local operating rooms. Similar shortcomings in biosafety practices have been reported across Latin American hospitals (Obando, 2021), where resource constraints limit the implementation of advanced protective systems.

4.4 Psychosocial factors and mental well-being

The psychosocial dimension showed that 71 % of participants experienced symptoms such as dizziness, nausea, or generalized pain during long procedures—manifestations that may reflect cumulative fatigue or stress. These findings are consistent with international evidence linking surgical work to elevated anxiety, burnout, and somatic symptoms (Wei *et al*., 2023; Barello *et al*., 2020). The universal acknowledgment of safety policies (100 %) contrasts with the fact that only 71 % of respondents felt sufficiently informed about radiation risks, suggesting a gap between policy existence and practical comprehension. Similar discrepancies were identified by Granja Moreno *et al*. (2022) in Ecuador, where nearly half of healthcare personnel reported medium to high levels of psychosocial risk despite institutional safety protocols.

This pattern underlines the need for mental health support mechanisms within perioperative teams, as chronic stress and emotional fatigue directly affect cognitive performance, teamwork, and ultimately patient safety.

4.5 Implications for occupational health and prevention

The convergence of environmental, ergonomic, and psychosocial risks underscores the multifactorial nature of surgical occupational exposure. From a preventive perspective, several priorities emerge:

Ergonomic adaptation of surgical workstations to local anthropometric standards.

Implementation of smoke evacuation systems and continuous monitoring of chemical exposure.

Regular health surveillance, including vaccination and laboratory testing schedules.

Psychological support programs and fatigue management strategies for surgical personnel.

Structured ergonomic and safety training, integrated into residency and continuing education curricula.

Investing in these measures could significantly reduce long-term morbidity among surgical professionals, improving both occupational safety and the quality of patient care.

4.6 Limitations

This study is limited by its descriptive design and aggregated data structure, which precluded inferential statistical analysis. Additionally, self-reported measures may introduce response bias, and the results are representative of the studied institutions but not generalizable to all tertiary hospitals in Ecuador. Nevertheless, the uniformity and internal consistency of the responses strengthen the reliability of the descriptive findings.

5 CONCLUSIONS

This study demonstrated that surgical staff in tertiary-level hospitals are continuously exposed to multiple occupational hazards that can compromise their health and professional performance. Environmental stressors such as heat, humidity, illumination, and noise coexist with persistent ergonomic strain, biological and chemical exposures, and psychosocial demands.

Although universal adherence to basic protective practices—such as the use of gloves and masks—was observed, significant gaps remain in vaccination coverage, periodic medical monitoring, and ergonomic optimization of surgical environments. The high frequency of musculoskeletal discomfort and self-reported symptoms highlights the cumulative burden of these exposures.

Comprehensive preventive strategies are urgently required. These should include continuous ergonomic training, the adaptation of surgical workspaces to local anthropometric standards, systematic biosafety surveillance, and institutional programs for mental health and fatigue management. Strengthening occupational health systems in surgical settings will not only improve the well-being of healthcare workers but also enhance the safety and efficiency of perioperative care.

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Authors' Contribution

All authors contributed equally to the development of this article.

Data availability

All datasets relevant to this study's findings are fully available within the article.

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