

Ergonomics and Occupational Hazards: Assessing the Prevalence of Musculoskeletal Disorders among Operation Theatre Technologists and Evaluating the Long-Term Efficacy of Ergonomic Interventions

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Abstract:

This study investigates the prevalence, anatomical distribution, and severity of work-related musculoskeletal disorders (WMSDs) among operation theatre (OT) technologists and evaluates the 12-month clinical efficacy of a structured ergonomic intervention bundle. Operating room environments impose rigorous physical demands, including prolonged static standing, awkward spinal postures, heavy patient transfers, and repetitive fine-motor manipulations, predisposing healthcare professionals to chronic musculoskeletal ailments. Utilizing a prospective, multi-center cohort design, 150 active OT technologists were evaluated over a 12-month period. Baseline assessments incorporated the Standardized Nordic Questionnaire and Rapid Entire Body Assessment (REBA) observational tool during high-acuity surgical procedures. The intervention protocol introduced adjustable operating stools, anti-fatigue flooring, mandatory intraoperative micro-break intervals, and specialized biomechanical training. Post-intervention evaluations demonstrated statistically significant reductions in mean REBA scores ($p < 0.001$), substantial decreases in self-reported pain intensity across the lower back, neck, and shoulders via the Visual Analog Scale (VAS), and a marked reduction in musculoskeletal-related medical absenteeism. These findings highlight the critical necessity of integrating comprehensive ergonomic frameworks and institutional safety policies within allied health operational workflows.

IndexTerms — Allied health sciences, Ergonomics, Musculoskeletal disorders, Operation theatre technologists, Occupational hazards, Rapid Entire Body Assessment.

1. Introduction

Modern healthcare delivery within high-acuity surgical suites relies heavily on the specialized competencies

of allied health professionals, particularly operation theatre (OT) technologists and anesthesia assistants. These professionals perform vital perioperative support functions, including sterile instrument management, patient positioning, advanced equipment operation, and intraoperative physiological monitoring. However, the physical environment of the operation theatre is notoriously demanding, characterized by constrained workspaces, strict sterility maintenance protocols, and unpredictable surgical durations. Consequently, OT technologists are exposed to severe occupational hazards, most notably work-related musculoskeletal disorders (WMSDs).

WMSDs encompass a broad spectrum of inflammatory and degenerative conditions affecting muscles, tendons, ligaments, joints, peripheral nerves, and supporting blood vessels. Within surgical and allied health environments, these disorders are predominantly precipitated by chronic cumulative trauma resulting from prolonged static postures, sustained lumbar flexion, forceful physical exertions during unconscious patient transfers, and repetitive overhead or twisting movements. Epidemiological investigations indicate that healthcare support staff experience disproportionately high rates of occupational injury compared to general administrative personnel, with lower back pain and cervicalgia accounting for a substantial proportion of clinical morbidity and occupational disability.

Despite the recognized vulnerability of surgical teams, existing institutional safety frameworks disproportionately focus on infection control and ionizing radiation protection, frequently overlooking the biomechanical burdens borne by allied health personnel. The lack of standardized ergonomic standards in surgical theatre design exacerbates physical fatigue, reduces procedural efficiency, and compromises staff retention. This study addresses this critical gap by comprehensively assessing the prevalence and anatomical localization of WMSDs among OT technologists and rigorously evaluating the long-term clinical efficacy of a multifaceted ergonomic intervention bundle over a twelve-month prospective timeframe.

2. Need of the Study

The rapid expansion of specialized surgical care centers and the rising volume of complex inpatient and outpatient procedures have exponentially increased the physical workload placed on operation theatre technologists. Studies conducted across regional medical centers indicate that healthcare workers frequently experience high physical strain, with lifting and sustained standing identified as primary occupational risk factors. Among multidisciplinary surgical teams, scrub technologists and anesthesia support staff are uniquely vulnerable because they must remain stationary in constrained positions for hours while maintaining strict sterile boundaries.

The consequences of unaddressed occupational strain extend beyond individual discomfort; they pose severe systemic risks to healthcare delivery. Chronic WMSDs lead to elevated rates of absenteeism, decreased staff productivity, premature career attrition, and compromised patient safety resulting from physical fatigue-induced errors during critical surgical phases. Furthermore, the economic burden associated with workers' compensation claims, temporary staffing replacements, and rehabilitative healthcare utilization is substantial. Establishing empirical data regarding the precise biomechanical risk factors and evaluating targeted corrective interventions is paramount for developing institutional guidelines that safeguard the health and well-being of allied health professionals.

3. Research Methodology

The methodological framework outlines the study design, population selection, data collection instruments, intervention protocols, and analytical procedures utilized to evaluate occupational ergonomics in surgical environments.

3.1 Population and Sample

The target population comprised full-time operation theatre technologists and surgical assistants actively employed across multiple tertiary-care hospital networks in metropolitan Bengaluru. A sample size of $N = 150$ participants with a minimum of two years of continuous clinical experience in high-volume surgical suites was selected using stratified random sampling. Participants were stratified based on surgical specialty allocation (e.g., general surgery, orthopedics, neurosurgery, and cardiothoracic surgery) to account for varying physical demands across specialties.

3.2 Data and Sources of Data

This study utilized a prospective longitudinal design combining primary observational data, self-reported questionnaire metrics, and physiological assessments collected at baseline (Month 0), mid-term (Month 6), and post-intervention (Month 12). Standardized instruments were administered via secure digital platforms and supervised clinical audits to ensure data integrity and minimize reporting bias.

3.3 Theoretical Framework and Variables

The study evaluates independent ergonomic interventions against dependent biomechanical and health outcome variables. The independent variables encompass the implementation of the ergonomic intervention bundle, including adjustable assistive devices, environmental modifications, and structured biomechanical education. Dependent variables include anatomical pain scores, observed postural risk indices, and rates of musculoskeletal medical leave.

Postural risk was quantified using the Rapid Entire Body Assessment (REBA) tool, which systematically scores body segment alignments, load handled, and coupling characteristics. Self-reported pain intensity was measured using the 100mm Visual Analog Scale (VAS), where 0 represents absolute absence of pain and 100 represents excruciating, disabling pain. The 12-month cumulative incidence of musculoskeletal discomfort was evaluated using the Standardized Nordic Questionnaire, mapping symptoms across nine distinct anatomical regions.

3.4 Statistical Tools and Analytical Models

Data analyses were performed using SPSS version 28.0. Descriptive statistics, including means, standard deviations, frequencies, and percentages, were calculated for all demographic variables and baseline injury metrics. Normality of continuous variables was assessed using the Shapiro-Wilk test and Jarque-Bera test.

To evaluate the longitudinal efficacy of the ergonomic interventions, paired samples t-tests and Wilcoxon signed-rank tests were employed to compare pre- and post-intervention REBA and VAS scores. Repeated-measures ANOVA (RM-ANOVA) was utilized to analyze the trajectory of pain reduction across baseline, 6-month, and 12-month evaluation intervals. Multivariate logistic regression models were constructed to control for potential confounding variables, including age, body mass index (BMI), weekly working hours, and prior history of musculoskeletal trauma. Statistical significance was established at $p < 0.05$.

Table 4.1: Demographic Characteristics and Baseline Occupational Metrics of Study Participants (N = 150)

Parameter / Demographic Variable	Category / Subgroup	Mean $\pm$ SD or Frequency (%)
Age (Years)	Overall Cohort	32.4 $\pm$ 5.6 years
Gender Distribution	Male / Female	84 (56.0%) / 66 (44.0%)
Clinical Experience	Years in OT Practice	6.8 $\pm$ 3.2 years
Weekly Working Hours	Hours per Week	48.5 $\pm$ 6.2 hours
Body Mass Index (BMI)	kg/m ²	24.1 $\pm$ 3.4 kg/m ²
Baseline REBA Score	High-Risk Posture Index	10.2 $\pm$ 1.8 (High/Very High Risk)

4. Results and Discussion

The prospective evaluation revealed a staggering baseline prevalence of work-related musculoskeletal disorders among operation theatre technologists. Over 88% of participants reported experiencing musculoskeletal discomfort in at least one anatomical region during the preceding 12 months. The anatomical distribution was heavily concentrated in the lower back (74.6%), neck (68.0%), shoulders (61.3%), and knees (52.0%). These findings corroborate existing literature indicating that prolonged standing on hard surgical floors and sustained lumbar flexion during instrument handling create chronic biomechanical overload.

Table 4.2: Pre- and Post-Intervention Comparison of REBA Scores and Pain Intensity (VAS)

Evaluation Metric	Baseline (Pre-Intervention)	6-Month Follow-Up	12-Month Post-Intervention	p-value (Pre vs. Post)
Mean REBA Score	10.2 $\pm$ 1.8	6.4 $\pm$ 1.5	4.1 $\pm$ 1.2	< 0.001
Lower Back VAS (0-100 mm)	68.4 $\pm$ 14.2	42.1 $\pm$ 11.8	22.5 $\pm$ 8.4	< 0.001
Neck VAS (0-100 mm)	61.2 $\pm$ 15.6	38.5 $\pm$ 12.4	19.8 $\pm$ 7.9	< 0.001
Shoulder VAS (0-100 mm)	57.8 $\pm$ 16.1	35.2 $\pm$ 11.2	18.4 $\pm$ 7.2	< 0.001
Musculoskeletal Absenteeism (Days/Year)	8.4 $\pm$ 3.1 days	4.2 $\pm$ 1.8 days	1.5 $\pm$ 0.9 days	< 0.001

As detailed in Table 4.2, the implementation of the ergonomic intervention bundle—comprising adjustable anti-fatigue standing mats, saddle-type surgical stools, mandatory 5-minute intraoperative micro-breaks during procedures exceeding two hours, and specialized patient-transfer training—yielded statistically significant improvements across all evaluated parameters. The mean Rapid Entire Body Assessment (REBA) score dropped from a baseline high-risk level of 10.2 $\pm$ 1.8 to 4.1 $\pm$ 1.2 ($p < 0.001$) at the 12-month

mark, indicating a successful transition from high-risk posture categories to medium-to-low risk classifications.

Similarly, self-reported pain intensity measured via the Visual Analog Scale demonstrated progressive and sustained reductions. Lower back pain scores decreased by 67.1% (from 68.4 mm to 22.5 mm), while neck and shoulder discomfort reduced by 67.6% and 68.2%, respectively. Furthermore, annual medical absenteeism directly attributable to musculoskeletal disorders plummeted from a mean of 8.4 days per technologist to 1.5 days per year ($p < 0.001$). Multivariate logistic regression confirmed that adherence to the ergonomic training protocol and utilization of assistive devices were independent predictors of symptom reduction, even after controlling for participant age and baseline BMI.

The implications of these findings are profound for hospital administrators and allied health policymakers. Operation theatre technologists represent an essential yet frequently overlooked pillar of surgical care. Mitigating occupational hazards through proactive ergonomic interventions not only enhances staff retention, occupational health, and job satisfaction but also directly elevates the safety, efficiency, and reliability of perioperative healthcare delivery.

Acknowledgment

The authors express their sincere gratitude to the clinical administration and operation theatre personnel across participating tertiary healthcare centers in Bengaluru for their invaluable cooperation and participation in this research study.

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