

Occupational Injuries Among Healthcare Workers in Selected Hospitals in Aseer Region, Saudi Arabia: A Multicenter Retrospective Observational Study

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Abstract:

Background:

Healthcare workers (HCWs) are exposed to a wide range of occupational hazards, including biological, chemical, physical, ergonomic, and psychosocial risks, which may result in work-related injuries and adverse occupational outcomes. Occupational injuries among HCWs remain a significant global occupational health concern due to their potential impact on workers' health, healthcare workforce sustainability, healthcare costs, and patient safety. Despite ongoing improvements in occupational health and safety programs in Saudi Arabia, multicenter evidence regarding the epidemiology, severity, and outcomes of occupational injuries among HCWs remains limited.

Objective:

This study aimed to describe the epidemiological characteristics, patterns, severity, and occupational outcomes of occupational injuries among healthcare workers in selected hospitals in the Aseer Region, Saudi Arabia, and to identify factors associated with injury severity.

Methods:

A multicenter retrospective observational study was conducted using occupational injury records from 24 healthcare facilities in the Aseer Region between January 2022 and June 2024.

A total of 806 documented occupational injury cases among healthcare workers were included. Data regarding demographic characteristics, healthcare profession, injury type, affected body region, injury severity, work absence duration, management, and occupational outcomes were extracted from institutional occupational health records and analyzed.

Descriptive statistics were used to summarize injury characteristics. Associations between categorical variables were assessed using Pearson's chi-square test or Fisher's exact test, as appropriate. Statistical significance was set at $p < 0.05$.

Results:

Among the 806 reported occupational injuries, nurses represented the largest proportion of affected healthcare workers (57.7%). Wounds and lacerations were the most frequently reported injury types (73.0%), followed by biological exposures related to infectious diseases (4.7%), confirmed occupational COVID-19 infection (4.3%), and needlestick injuries (4.1%).

The upper extremities were the most commonly affected anatomical region (78.4%). Most occupational injuries were classified as mild (69.6%), and the majority of affected healthcare workers experienced no work absence following injury (84.4%). Complete recovery with return to previous duties was documented in 97.8% of cases. Injury severity was significantly associated with injury type and affected body region ($p < 0.001$); however, no statistically significant associations were identified between injury severity and age, Gender, nationality, or healthcare profession.

Conclusion:

Occupational injuries among healthcare workers in the Aseer Region were predominantly mild and were associated with favorable occupational outcomes. Nevertheless, differences in injury severity according to injury mechanism and anatomical location highlight the need for targeted preventive strategies focusing on high-risk injury categories and vulnerable body regions.

Strengthening occupational injury surveillance systems, safety training, and workplace prevention programs may further improve healthcare worker safety in Saudi healthcare facilities.

Keywords: Occupational injuries; Healthcare workers; Occupational health; Workplace safety; Injury severity; Healthcare safety; Saudi Arabia; Multicenter retrospective study.

Introduction:

2.1 Background:

Healthcare workers (HCWs) represent a fundamental component of healthcare systems and play a central role in delivering safe, effective, and high-quality patient care. However, the nature of healthcare work exposes HCWs to a broad range of occupational hazards that may result in injuries, illnesses, and adverse professional consequences.

Occupational injuries are defined as physical injuries, biological or chemical exposures, or other adverse health events occurring during the performance of occupational duties or as a direct consequence of workplace-related activities.

In healthcare environments, these injuries remain an important occupational health challenge due to the complexity of clinical activities, frequent patient contact, and simultaneous exposure to multiple workplace hazards.

Beyond their direct effects on workers' health, occupational injuries contribute to absenteeism, reduced productivity, increased healthcare expenditures, workforce shortages, and potential compromise of patient safety (Debelu; Mengistu ; Tolera; Aschalew; Deriba, 2023; Khairallah; Al-Hajj; Mowafi ; Rahme;Sakr.).

Globally, occupational injuries among HCWs continue to represent a significant public health and workplace safety concern despite advances in occupational health regulations, infection prevention practices, and safety programs. Healthcare professionals are exposed to diverse occupational hazards, including biological agents, sharp medical instruments, hazardous chemicals, ergonomic stressors, radiation, physical hazards, and workplace violence. The occurrence of occupational injuries is influenced by multiple interacting factors, including heavy workload, prolonged working hours, inadequate staffing, fatigue, insufficient occupational safety training, high patient volume, and inconsistent adherence to standard precautions and personal protective equipment (PPE) use.

These risks affect healthcare workers across various clinical environments, including emergency departments, operating rooms, intensive care units, laboratories, inpatient wards, and outpatient services (de Lira ; Akutsu ; Costa; Leite;da Silva; Botelho; Raposo; Han; Ariza-Montes ;Araya-Castillo; Zandonadi, 2021; Rai ; El-Zaemey; Dorji; Rai; Fritschi ,2021; Ji; Liu; Song; Liu; He;Cheng ,2025).

Among occupational hazards in healthcare settings, biological exposures remain one of the most important threats to healthcare worker safety. Exposure to blood and body fluids through needlestick injuries, sharp-object injuries, mucosal contact, or contaminated instruments may result in transmission of blood-borne pathogens, including hepatitis B virus (HBV), hepatitis C virus (HCV), and human immunodeficiency virus (HIV).

Although vaccination programs, standard precautions, safety-engineered devices, and post-exposure prophylaxis have substantially reduced the consequences of these exposures, occupational biological injuries continue to occur worldwide and remain a preventable cause of morbidity among healthcare workers (World Health Organization, 2020).

Sharps injuries, particularly needlestick injuries, are among the most frequently reported occupational injuries among healthcare workers.

These injuries commonly occur during medication administration, blood sampling, intravenous procedures, surgical interventions, and disposal of contaminated sharp devices. In addition to the potential risk of infection transmission, sharps injuries may result in considerable psychological consequences, including anxiety, fear of infection, emotional distress, and reduced occupational well-being.

Previous studies have identified excessive workload, inadequate staffing, fatigue, insufficient training, improper disposal practices, and poor compliance with infection prevention measures as important factors contributing to sharps-related injuries among healthcare personnel (Abalkhail ; Kabir; Elmosaad; Alwashmi; Alhumaydhi;Alslamah; Almoammar; Alsalamah;Mahmud, 2022; Wong; Cherng;Kakinuma; Wyart; Okamoto, 2025).

Chemical hazards represent another important occupational risk in healthcare environments. Healthcare workers may be exposed to disinfectants, sterilizing agents, laboratory reagents, antineoplastic drugs, anesthetic gases, and pharmaceutical substances.

Acute exposure may result in skin irritation, chemical burns, respiratory symptoms, allergic reactions, and ocular injuries, while repeated injuries may result in chronic pain, functional limitations, reduced work capacity, absenteeism, decreased quality of life, and premature retirement, creating substantial consequences for both healthcare workers exposure may contribute to chronic respiratory and dermatological conditions.

Effective prevention requires appropriate engineering controls, adequate ventilation, safe handling procedures, environmental monitoring, and consistent use of PPE (de Lira et al., 2021; Lyakurwa ;Khalfan;Mugisha;Yao,2024).

Ergonomic hazards are also major contributors to occupational morbidity among healthcare workers. Tasks such as patient lifting and repositioning, prolonged standing, repetitive movements, manual handling of equipment, and awkward postures place healthcare professionals at increased risk of work-related musculoskeletal disorders (WMSDs).

Nurses, physiotherapists, emergency personnel, and other direct patient-care providers are particularly vulnerable due to the physical demands of their daily responsibilities. Musculoskeletal injuries may result in chronic pain, functional limitations, reduced work capacity, absenteeism, decreased quality of life, and premature retirement, creating

substantial consequences for both healthcare workers and healthcare organizations (Greggi et al., 2024).

Physical hazards, including slips, trips, falls, electrical incidents, radiation exposure, equipment-related injuries, and environmental hazards, also contribute to occupational morbidity among healthcare workers. Although these injuries may receive less attention compared with biological exposures, they remain important causes of workplace disability, lost workdays, and reduced workforce efficiency.

Comprehensive workplace safety programs incorporating hazard identification, environmental assessment, equipment maintenance, and continuous monitoring are essential for reducing preventable occupational accidents (Rai et al., 2021).

In addition to physical hazards, psychosocial risks and workplace violence have become increasingly recognized occupational health concerns among healthcare workers. Healthcare professionals, particularly those working in emergency departments, psychiatric units, intensive care units, and other high-demand settings, may experience verbal abuse, threats, harassment, bullying, and physical assault.

Workplace violence has been associated with psychological distress, burnout, anxiety, depression, reduced job satisfaction, impaired professional performance, and increased intention to leave the healthcare profession.

Therefore, occupational health programs should adopt a comprehensive approach addressing both physical safety and psychosocial well-being (Liu; Gan ; Jiang; Li ;Dwyer; Lu; Lu; Yan; Sampson; Xu ; Wang; Zhu; Chang; Yang; Yang; Chen; Song; Lu, 2019).

Collectively, these occupational hazards demonstrate the multifactorial nature of occupational injuries among healthcare workers. Despite improvements in workplace safety regulations, infection prevention programs, and occupational health initiatives, occupational injuries continue to occur across healthcare systems worldwide. Effective prevention requires reliable surveillance systems, standardized reporting mechanisms, continuous safety training, evidence-based interventions, and organizational commitment to developing a strong safety culture. Understanding the epidemiological characteristics, mechanisms, severity, and outcomes of occupational injuries is essential for identifying high-risk groups and implementing targeted prevention strategies (Debelu et al., 2023; Rai et al., 2021; Ji et al., 2025).

1.2 Occupational Injuries in Saudi Arabia:

Occupational injuries among healthcare workers remain an important occupational health concern in Saudi Arabia. The rapid expansion of healthcare services, increasing patient volumes, and complex clinical environments have resulted in continued exposure of healthcare personnel to multiple workplace hazards. Previous studies conducted in different regions of the Kingdom have reported occupational injuries involving needlestick injuries, sharps exposures, blood and body fluid exposure, musculoskeletal disorders, slips and falls, and other workplace-related incidents.

However, reported injury patterns vary according to healthcare setting, professional category, institutional characteristics, and reporting practices (Abalkhail et al., 2022; Khairallah et al., 2025).

Healthcare workers in Saudi Arabia do not experience occupational injuries equally across professional categories. Nurses have consistently been identified as the group at highest risk because of their frequent involvement in direct patient care, medication administration, invasive procedures, blood sampling, and handling of sharp instruments.

Other healthcare professionals, including physicians, laboratory personnel, dental professionals, technicians, and allied health workers, are also exposed to occupation-specific hazards related to clinical procedures, biological materials, chemicals, and equipment use (Alshehri et al., 2023; Makeen et al., 2022).

Despite improvements in occupational health regulations and infection prevention programs, occupational injuries remain underreported in many healthcare institutions.

Underreporting may result from fear of blame, limited awareness of reporting procedures, heavy workload, perceived minor severity of injuries, or insufficient organizational support. Inadequate reporting reduces the accuracy of occupational surveillance systems and limits the ability of healthcare institutions to identify hazards and implement effective prevention strategies.

Most published Saudi studies have focused on single hospitals or specific injury categories, particularly needlestick injuries and biological exposures. Consequently, comprehensive evidence describing the epidemiology, severity, affected body regions, management, lost workdays, and occupational outcomes of different types of occupational injuries among healthcare workers remains limited. This limitation highlights the need for multicenter studies based on standardized occupational health records.

1.3 Research Gap:

Although previous studies have contributed valuable information regarding occupational injuries among healthcare workers in Saudi Arabia, several important knowledge gaps remain. Most available studies have been conducted using single-center designs, involved relatively small sample sizes, or focused on specific occupational groups or individual

injury categories, particularly needlestick injuries and biological exposures. Consequently, comprehensive evidence describing the overall epidemiological characteristics, injury mechanisms, anatomical distribution, severity, management approaches, and occupational outcomes of workplace injuries among healthcare workers remains limited.

Furthermore, relatively few studies have evaluated multiple categories of occupational injuries simultaneously, including biological exposures, musculoskeletal injuries, chemical exposures, ocular injuries, physical accidents, and other workplace-related events using standardized institutional occupational health records.

This limitation data are available regarding occupational injury characteristics across multiple healthcare facilities, differences between professional groups, injury severity, work absence, clinical management, and recovery outcomes.

The absence of region-specific multicenter evidence limits the ability of healthcare administrators and policymakers to develop targeted occupational safety interventions restricts a complete understanding of the occupational injury burden and prevents accurate identification of high-risk groups and injury patterns.

Evidence from the Aseer Region remains particularly scarce. Limited published data are available regarding occupational injury characteristics across multiple healthcare facilities, differences between professional groups, injury severity, work absence, clinical management, and recovery outcomes.

The absence of region-specific multicenter evidence limit the ability of healthcare administrators and policymakers to develop targeted occupational safety interventions based on local epidemiological patterns.

Therefore, a comprehensive assessment of occupational injuries among healthcare workers in the Aseer Region is required to strengthen occupational injury surveillance identify priority areas for prevention, and support evidence based occupational health policies.

1.4 Rationale of the Study:

Healthcare workers represent a critical component of healthcare systems and are continuously exposed to occupational hazard that may result in preventable injuries and adverse physical, psychological, and professional consequences. Occupational injuries may negatively influence workforce availability, increase healthcare expenditures, reduce productivity, and potentially compromise healthcare quality and patient safety.

A comprehensive understanding of occupational injury characteristics, including injury type, affected body region, severity, associated factors, management, and occupational outcomes, is essential for developing effective prevention strategies. Multicenter studies provide more representative evidence than single-institution investigations by allowing assessment of injury patterns across different healthcare facilities, clinical environments, and professional categories.

Although Saudi Arabia has made considerable progress in occupational health policies and workplace safety initiatives, available evidence remains fragmented. Many previous investigations have focused on specific occupational hazards or individual institutions, limiting the generalizability of their findings.

Therefore, evaluating occupational injuries using standardized records from multiple healthcare facilities in the Aseer Region may provide valuable evidence for improving occupational safety programs, strengthening reporting systems, and implementing targeted preventive interventions.

The findings of this study are expected to support healthcare organizations in identifying priority risk areas, improving occupational injury surveillance, enhancing safety training, and developing evidence-based strategies to protect healthcare workers and improve healthcare system performance.

1.5 Study Aim:

This multicenter retrospective observational study aimed to describe the epidemiological characteristics, patterns, severity, associated factors, and occupational outcomes of occupational injuries among healthcare workers in selected hospitals in the Aseer Region, Saudi Arabia.

Specifically, the study aimed to:

1. Describe the demographic and occupational characteristics of healthcare workers who experienced occupational injuries.

2. Identify the distribution and patterns of different occupational injury types and affected environments are considered among the most complex occupational settings because healthcare professionals routinely encounter biological agents, sharp medical instruments, hazardous chemicals, ergonomic stressors, radiation, physical hazards, and workplace violence during routine clinical activities. Despite advances in occupational safety body regions.

3. Assess injury severity, work absence duration, management approaches, and occupational outcomes following workplace injuries.

4. Examine associations between demographic, occupational, and injury-related characteristics and injury severity.

5. Provide evidence to support targeted occupational health interventions and workplace safety improvement strategies in healthcare facilities.

2. Global Burden of Occupational Injuries Among Healthcare Workers:

Occupational injuries among healthcare workers represent a major global occupational health challenge due to continuous exposure to diverse workplace hazards. Healthcare environments are considered among the most complex occupational settings because healthcare

professionals routinely encounter biological agents, sharp medical instruments, hazardous chemicals, ergonomic stressors, radiation, physical hazards, and workplace violence during routine clinical activities. Despite advances in occupational safety regulations, infection prevention practices, and workplace protection programs, occupational injuries continue to contribute substantially to morbidity, absenteeism, reduced productivity, and workforce instability worldwide (World Health Organization [WHO], 2022; World Health Organization & International Labour Organization, 2022).

The global burden of occupational injuries varies considerably according to geographic region, healthcare setting, occupational category, injury definition, and reporting systems. Healthcare workers, particularly nurses and frontline clinical professionals, experience high occupational injury rates because of frequent patient contact, invasive procedures, exposure to contaminated instruments, and physically demanding work activities.

The burden is disproportionately higher in low- and middle-income countries due to limited occupational health infrastructure, inadequate availability of personal protective equipment, insufficient safety training, and weak occupational injury surveillance systems.

Although high-income countries have achieved improvements through stronger regulations, reporting mechanisms, and preventive technologies, occupational injuries remain an ongoing concern in standard precautions, safety-engineered devices, and post-exposure prophylaxis have significantly reduced the consequences of biological exposures, sharps injuries remain a largely preventable occupational health problem. In addition to infection risks, affected healthcare workers may experience all healthcare systems (Hosseinipalangi et al., 2022; Kaweti & Feleke, 2024; WHO, 2022).

2.1 Needlestick Injuries and Blood and Body Fluid Exposure:

Needlestick injuries and other percutaneous exposures represent some of the most frequently reported and clinically important occupational injuries among healthcare workers. These injuries commonly occur during injections, blood collection, intravenous procedures, surgical interventions, medication preparation, and disposal of contaminated sharp devices.

Exposure to contaminated needles and sharp instruments places healthcare workers at risk of acquiring blood-borne infections, particularly hepatitis B virus (HBV), hepatitis C virus (HCV), and human immunodeficiency virus (HIV). The likelihood of infection depends on several factors, including injury depth, type of device involved, amount of blood exposure, source patient characteristics, and availability of timely post-exposure management.

A systematic review involving a large number of healthcare workers demonstrated a substantial global burden of needlestick injuries, with higher rates observed among nurses and healthcare workers in low-resource settings (Hosseinipalangi et al., 2022). Similar findings have been reported in other studies, emphasizing the continued

importance of occupational exposure prevention programs (Abere et al., 2020).

Although vaccination programs, standard precautions, safety-engineered devices, and post-exposure prophylaxis have significantly reduced the consequences of biological exposures, sharps injuries remain a largely preventable occupational health problem. In addition to infection risks, affected healthcare workers may experience anxiety, fear of disease acquisition, emotional distress, and prolonged medical follow-up. Underreporting remains a major challenge due to inadequate reporting systems, fear of blame, limited awareness, and perception that minor injuries do not require formal reporting (WHO, 2022; WHO & ILO, 2022).

2.2 Musculoskeletal Injuries Among Healthcare Workers:

Work-related musculoskeletal injuries represent another major component of the global occupational injury burden among healthcare workers. Healthcare professionals, particularly nurses and direct patient-care providers, are exposed to significant ergonomic demands resulting from patient lifting and transferring, repetitive movements, prolonged standing, manual handling of equipment, and awkward working postures.

These occupational exposures commonly contribute to lower back pain, neck and shoulder disorders, and other musculoskeletal conditions that negatively affect physical functioning and professional performance (WHO, 2022; Alasmari et al., 2025).

The consequences of musculoskeletal injuries extend beyond individual health outcomes and represent an organizational challenge for healthcare institutions. Persistent pain, functional limitations, reduced work capacity, absenteeism, and premature workforce withdrawal may affect healthcare service delivery and workforce sustainability. Evidence indicates that effective prevention requires comprehensive ergonomic strategies, including safe patient-handling programs, assistive equipment, workplace redesign, adequate staffing, and continuous ergonomic training (WHO & ILO, 2022; Alasmari et al., 2025).

2.3 Workplace Accidents, Chemical Exposures, and Other Occupational Injuries:

In addition to biological and ergonomic hazards, healthcare workers are exposed to a variety of workplace accidents and environmental hazards that contribute to occupational morbidity. These include slips, trips, and falls; injuries related to medical equipment; chemical splashes; electrical incidents; burns; radiation exposure; and other physical workplace hazards. Although these injuries may receive less attention compared with needlestick injuries and blood exposure incidents, they remain important contributors to occupational disability, medical treatment requirements, lost workdays, and reduced workforce efficiency (World

Health Organization [WHO], 2022; World Health Organization & International Labour Organization, 2022).

Chemical exposures represent a particularly relevant occupational risk because healthcare workers routinely handle disinfectants, sterilizing agents, laboratory reagents, antineoplastic medications, anesthetic gases, and other hazardous substances. Depending on the substance involved and the duration of exposure, chemical incidents may result in skin irritation, respiratory symptoms, allergic reactions, ocular injuries, chemical burns, and long-term health effects. Effective prevention requires appropriate chemical management systems, engineering controls, adequate ventilation, safe handling procedures, emergency response protocols, and consistent use of personal protective equipment (PPE) (de Lira et al., 2021; Lyakurwa et al., 2024).

Occupational ocular injuries represent an important but frequently underestimated category of workplace injuries among healthcare workers. Eye exposure may occur through splashes of blood and body fluids, chemical agents, laboratory materials, disinfectants, airborne particles, or accidental trauma during clinical procedures. Although ocular exposure generally carries a lower risk of infection transmission compared with percutaneous injuries, it may result in significant clinical consequences, including conjunctivitis, corneal injury, chemical burns, temporary visual impairment, and, in severe cases, permanent visual complications. Ensuring availability and consistent use of appropriate eye protection remains an essential component of occupational safety programs (WHO, 2022; Centers for Disease Control and Prevention [CDC], 2024).

2.4 Workplace Violence and Psychosocial Hazards:

Workplace violence has become increasingly recognized as a major occupational health concern affecting healthcare workers worldwide. Healthcare professionals working in emergency departments, psychiatric units, intensive care settings, and other high-pressure clinical environments are particularly vulnerable to verbal abuse, threats, harassment, bullying, and physical assault.

Exposure to workplace violence has been associated with adverse psychological and professional outcomes, including anxiety, depression, emotional exhaustion, burnout, reduced job satisfaction, impaired work performance, and increased intention to leave the healthcare profession. Furthermore, workplace violence negatively affects teamwork, communication, staff morale, and the overall quality of healthcare delivery. Therefore, modern occupational health programs should incorporate strategies addressing psychosocial hazards alongside traditional physical safety interventions (Liu et al., 2019; Fiorino et al., 2026).

2.5 Impact of Occupational Injuries on Healthcare Workers and Healthcare Systems:

Occupational injuries have substantial consequences for healthcare workers' physical health, psychological well-being, and professional performance. Depending on injury type and severity, affected workers may experience pain, functional limitations, anxiety, emotional distress, fear of infection, reduced quality of life, and decreased work engagement.

Biological exposures, particularly needlestick injuries, may result in prolonged medical follow-up and considerable psychological stress despite the relatively low probability of infection transmission in many cases. Similarly, musculoskeletal injuries may contribute to chronic pain, disability, reduced work capacity, sickness absence, and premature withdrawal from the healthcare workforce (Ji et al., 2025; Khairallah et al., 2025).

The consequences of occupational injuries extend beyond individual healthcare workers and create significant challenges for healthcare organizations. Injury management may require emergency assessment, diagnostic investigations, treatment, post-exposure prophylaxis, rehabilitation services, occupational health follow-up, and psychological support.

These requirements increase healthcare resource utilization and contribute to institutional expenditures.

Furthermore, occupational injuries contribute to absenteeism, productivity loss, staff turnover, replacement costs, and increased workload among remaining healthcare workers. In healthcare systems experiencing workforce shortages, these consequences may compromise service capacity, organizational efficiency, and continuity of safe patient care. Therefore, investment in occupational safety programs, injury surveillance systems, and preventive interventions is essential for maintaining healthcare workforce sustainability (WHO, 2022; WHO & ILO, 2022).

2.6 Occupational Injuries and Patient Safety Implications:

Healthcare worker safety and patient safety are closely interconnected. Occupational injuries may indirectly influence healthcare quality by contributing to fatigue, psychological distress, burnout, reduced engagement, and impaired clinical performance among healthcare professionals.

Healthcare workers experiencing injury-related consequences may have reduced ability to consistently adhere to safety procedures, potentially increasing the risk of medication errors, procedural complications, infection prevention failures, and adverse events. In addition, workforce shortages resulting from occupational injuries may increase workload among available staff, further contributing to fatigue and occupational stress.

International organizations increasingly recognize healthcare worker protection as an essential component of patient safety and healthcare system resilience. Creating safe working environments enables healthcare professionals to deliver safer and higher-quality care, demonstrating that occupational

health interventions should be and indirect economic burdens on healthcare organizations and national health systems. Direct costs include integrated into broader healthcare quality improvement strategies (WHO & ILO, 2022; World Health Organization, 2024; Kugler et al., 2024).

2.7 Economic Burden of Occupational Injuries Among Healthcare Workers:

Occupational injuries impose considerable direct and indirect economic burdens on healthcare organizations and national health systems. Direct costs include medical evaluation, diagnostic investigations, treatment, post-exposure prophylaxis, compensation claims, rehabilitation services, and occupational health follow-up. Indirect costs arise from sickness absence, productivity losses, replacement staffing, recruitment, workforce training, and reduced organizational efficiency.

Musculoskeletal injuries represent a particularly important economic concern because of their association with chronic disability, recurrent healthcare utilization, prolonged work restrictions, and premature workforce withdrawal. Similarly, needlestick injuries generate substantial costs related to exposure assessment, laboratory testing, preventive treatment, and follow-up care.

Evidence indicates that preventive strategies, including ergonomic interventions, vaccination programs, safety-engineered devices, occupational safety training, and effective surveillance systems, can substantially reduce both the human and economic burden associated with occupational injuries (Gao et al., 2025; WHO & ILO, 2022).

3. Occupational Injuries Among Healthcare Workers in Saudi Arabia:

Occupational injuries among healthcare workers have received increasing attention in Saudi Arabia due to the rapid development of healthcare services, increasing patient demand, and the complexity of healthcare environments. Healthcare personnel in the Kingdom are exposed to multiple occupational hazards, including biological exposures, sharps injuries, musculoskeletal stressors, chemical hazards, and workplace accidents.

Previous Saudi studies have demonstrated that needlestick injuries, sharp-object injuries, and blood and body fluid exposures remain among the most frequently reported occupational events among healthcare workers. These findings emphasize the continued need to strengthen occupational health programs, improve reporting systems, and implement evidence-based preventive strategies within healthcare institutions.

Several studies conducted in different regions of Saudi Arabia have reported variations in occupational injury prevalence and patterns according to healthcare setting, professional category, institutional characteristics, and reporting practices. A multicenter study conducted among healthcare workers in the Jazan Region demonstrated that needlestick and sharps injuries remained common occupational exposures and highlighted the importance of continuous safety training,

adherence to infection prevention practices, and institutional safety policies (Makeen et al., 2022).

Healthcare professionals in Saudi Arabia are not equally affected by occupational injuries. Nurses consistently represent the highest-risk occupational group due to their frequent involvement in direct patient care, invasive procedures, medication administration, blood sampling, and handling of sharp instruments. However, physicians, laboratory personnel, dental professionals, technicians, and allied health workers also experience occupation-specific risks related to their professional duties (Alshehri et al., 2023; Makeen et al., 2022).

Despite improvements in occupational safety regulations and infection prevention programs, important knowledge gaps remain. Most published Saudi studies have focused on single hospitals, specific professional groups, or selected injury categories, limiting the ability to understand the overall burden of occupational injuries across healthcare systems.

3.1 Research Gap and Rationale for the Current Study:

Although previous studies have provided valuable insights into occupational injuries among healthcare workers in Saudi Arabia, significant knowledge gaps remain. Most available evidence has been generated from single-center studies, focused on specific occupational groups, or limited to particular injury categories, especially needlestick injuries and biological exposures. Consequently, comprehensive multicenter evidence describing the epidemiological characteristics, mechanisms, anatomical distribution, severity, management, and occupational outcomes of different types of occupational injuries remains insufficient.

Furthermore, many previous investigations have relied on self-reported questionnaires, which may be affected by recall bias, reporting bias, and underreporting of minor or non-biological occupational injuries. As a result, the actual burden of occupational injuries among healthcare workers may be underestimated, particularly for events such as minor physical injuries, workplace accidents, ocular injuries, chemical exposures, and ergonomic-related disorders.

The Aseer Region represents an important healthcare setting with diverse healthcare facilities providing secondary, tertiary, and specialized medical services. However, published evidence regarding occupational injury patterns among healthcare workers in this region remains limited. Available information regarding injury severity, affected body regions, work absence, occupational outcomes, and factors associated with severe injuries is insufficient.

Understanding the epidemiological characteristics and determinants of occupational injuries in the Aseer Region is essential for developing targeted prevention strategies, improving

occupational injury surveillance systems, strengthening workplace safety policies, and optimizing resource allocation.

A multicenter assessment based on institutional occupational health records provides an opportunity to generate representative evidence regarding occupational injury patterns across different healthcare facilities and professional categories.

Therefore, this study was conducted to provide comprehensive multicenter evidence regarding occupational injuries among healthcare workers in selected hospitals in the Aseer Region, Saudi Arabia.

The findings may support evidence-based occupational health interventions, improve workplace safety practices, and contribute to protecting healthcare workers while maintaining safe and high-quality healthcare delivery.

4. Study Objectives:

4.1 General Objective:

To describe the epidemiological characteristics, patterns, severity, associated factors, and occupational outcomes of occupational injuries among healthcare workers in selected hospitals in the Aseer Region, Saudi Arabia.

4.2 Specific Objectives:

This study aimed to:

1. Describe the demographic and occupational characteristics of healthcare workers who experienced occupational injuries.
2. Determine the distribution of occupational injury types, affected body regions, injury severity, and immediate management approaches.
3. Assess work absence duration and occupational outcomes following reported occupational injuries.
4. Examine the association between healthcare profession and occupational injury type.
5. Identify demographic, occupational, and injury-related factors associated with injury severity.

5. Research Questions

The study addressed the following research questions:

1. What are the demographic and occupational characteristics of healthcare workers who

reported occupational injuries in selected hospitals in the Aseer Region, Saudi Arabia?

2. What are the most common occupational injury types, affected anatomical regions, and severity categories among injured healthcare workers?
3. What are the patterns of work absence duration and occupational outcomes following occupational injuries?
4. Is healthcare profession significantly associated with the type of reported occupational injury?
5. Are demographic characteristics, occupational characteristics, and injury-related factors associated with occupational injury severity?

6. Research Hypotheses:

First Hypothesis (H01):

There are no statistically significant differences in the distribution of occupational injuries according to the sociodemographic characteristics of healthcare workers (age, Gender, nationality, educational level, and insurance coverage) in the Aseer Region, Saudi Arabia.

Second Hypothesis (H02):

Occupational injuries among healthcare workers in the Aseer Region are predominantly characterized by mild injuries affecting the upper extremities, with wounds and lacerations representing the most common type of occupational injury.

Third Hypothesis (H03):

Most occupational injuries among healthcare workers in the Aseer Region are associated with favorable occupational outcomes, including minimal work absence, complete recovery, and return to work without permanent disability.

Fourth Hypothesis (H04):

Occupational injury patterns differ according to healthcare profession among healthcare workers in the Aseer Region, Saudi Arabia.

Fifth Hypothesis (H05):

There are no statistically significant associations between healthcare workers' sociodemographic characteristics, occupational characteristics, injury-related characteristics, and the severity of reported occupational injuries in the Aseer Region, Saudi Arabia.

Sixth Hypothesis (H06):

There are no independent predictors of occupational injury severity among healthcare workers in the Aseer Region after adjusting for sociodemographic, occupational, and injury-related characteristics.

7. Methods:

7.1 Study Design:

A multicenter retrospective observational study was conducted to evaluate the epidemiological characteristics, patterns, severity, associated factors, and occupational outcomes of occupational injuries among healthcare workers in selected hospitals in the Aseer Region, Saudi Arabia.

A retrospective design was selected because it enabled systematic analysis of existing occupational health records and institutional injury reporting databases to identify injury patterns, characterize affected healthcare worker groups, and evaluate factors associated with injury severity and outcomes.

The multicenter approach allowed inclusion of healthcare facilities with different levels of care and clinical services, thereby improving the representativeness of the findings and providing a broader understanding of occupational injury patterns across the region.

Data were retrospectively extracted from occupational health records, employee health databases, workplace incident reporting systems, infection prevention and control records, and other approved institutional sources covering the period from January 1, 2022, to June 30, 2024.

7.2 Study Setting:

This study was conducted in 24 healthcare facilities located in the Aseer Region, southwestern Saudi Arabia. The Aseer Region provides healthcare services through a wide network of secondary and tertiary hospitals serving both urban and rural populations.

The participating facilities included hospitals and healthcare sectors affiliated mainly with the Saudi

Ministry of Health. These institutions provide a broad range of healthcare services, including emergency medicine, surgery, internal medicine, obstetrics and gynecology, pediatrics, intensive care, laboratory medicine, radiology, outpatient services, and other specialized clinical services.

The inclusion of multiple healthcare facilities allowed assessment of occupational injury patterns across different healthcare environments, professional categories, and clinical departments. This multicenter design enhanced the external validity of the study findings and provided a comprehensive regional assessment of occupational injuries among healthcare workers.

Table 1. Participating Healthcare Facilities

No.	Healthcare Facility
1	Abha Private Hospital
2	Abha Sector
3	AlBarak General Hospital
4	AlFarshah Hospital
5	AlHarjah General Hospital
6	AlMadhah Hospital
7	AlMajardah General Hospital
8	AlNamas General Hospital
9	AlQahmah General Hospital
10	Aseer Central Hospital

11	Bareq Sector
12	Blhamar General Hospital
13	Blhsamar General Hospital
14	Daweni Medical Clinics
15	Dhahran Al-Janoab General Hospital
16	Khamis Mushayt General Hospital
17	Khamis Mushayt Maternity Hospital
18	Mahayel General Hospital
19	Maternity in Abha
20	Mental Health Hospital in Aseer
21	Rejal Almaa General Hospital
22	Sarat Ubaida General Hospital
23	Uhod Rafidah General Hospital
24	Wadi Bin Hashbel Sector

7.3 Study Period:

The study included all eligible occupational injury records documented between **January 1, 2022, and June 30, 2024**.

This period was selected to provide an adequate timeframe for evaluating the epidemiological characteristics, injury patterns, severity, associated factors, and occupational outcomes of work-related injuries among healthcare workers across participating healthcare facilities.

Data were retrospectively extracted from institutional occupational health records, employee health databases, workplace incident reporting systems, infection prevention and control records, and other approved hospital documentation systems. All available occupational injury reports during the study period were reviewed according to predefined eligibility criteria.

Because this study relied on routinely collected occupational health records, potential limitations related to retrospective data collection, including incomplete documentation and possible underreporting, were considered during data interpretation.

7.4 Study Population:

The study population included all healthcare workers with documented occupational injuries recorded in the participating healthcare facilities during the study period.

Eligible participants included physicians, nurses, dentists, pharmacists, laboratory personnel, radiology staff, technicians, allied health professionals, and other healthcare workers who sustained occupational injuries while performing their official professional duties.

Occupational injuries included biological exposures, needlestick injuries, sharps injuries, blood and body fluid exposures, musculoskeletal injuries, ocular injuries, chemical exposures, slips, trips, falls, population enabled comprehensive evaluation of occupational injury patterns, severity, associated factors, and outcomes across multiple healthcare professions and institutional settings in the and other documented workplace-related injuries reported through institutional occupational health departments,

employee health services, infection prevention and control units, or hospital incident reporting systems.

Healthcare workers were included regardless of age, Gender, nationality, professional category, years of experience, or department, provided that the injury occurred during occupational activities within one of the participating healthcare facilities during the study period.

This population enabled comprehensive evaluation of occupational injury patterns, severity, associated factors, and outcomes across multiple healthcare professions and institutional settings in the Aseer Region.

7.5 Inclusion Criteria:

Healthcare workers were included if they fulfilled all of the following criteria:

1. Employment at one of the participating healthcare facilities during the study period.
2. Documentation of a work-related occupational injury sustained during official professional duties.
3. The injury was officially recorded in an occupational health department, employee health service, infection prevention and control database, or institutional incident reporting system.
4. The occupational injury occurred between January 1, 2022, and June 30, 2024.
5. Availability of sufficient information regarding the main study variables, including demographic characteristics, occupational information, injury type, mechanism, severity, management, and occupational outcomes.

7.6 Exclusion Criteria:

Records were excluded if they met any of the following criteria:

- Injuries involving individuals who were not healthcare workers, including visitors, students, volunteers, contractors, administrative personnel, or non-clinical workers.
- Injuries unrelated to occupational duties or occurring outside the workplace.
- Occupational injuries occurring before January 1, 2022, or after June 30, 2024.
- Duplicate records representing the same injury event; in such cases, the most complete record was retained.
- Records lacking essential information required for the primary analyses, including occupation, injury type, injury mechanism, severity classification, or occupational outcome.

These criteria were applied to improve data quality, minimize information bias, and ensure reliable epidemiological analysis.

8. Operational Definitions:

8.1 Occupational Injury:

An occupational injury was defined as any acute physical injury, biological exposure, chemical exposure, physical hazard-related event, ergonomic injury, or other adverse health event sustained by a healthcare worker during the

performance of official occupational duties or as a direct consequence of workplace activities.

Included events comprised needlestick injuries, sharps injuries, blood and body fluid exposures, musculoskeletal injuries, ocular injuries, chemical exposures, slips, trips, falls, and other documented workplace accidents.

This definition was consistent with occupational health principles established by the World Health Organization (WHO) and the International Labour Organization (ILO).

8.2 Healthcare Worker:

A healthcare worker was defined as any individual employed within a participating healthcare facility who was involved directly or indirectly in healthcare delivery or healthcare support services and who could potentially be exposed to occupational hazards during professional activities.

The definition included physicians, nurses, dentists, pharmacists, laboratory personnel, radiology staff, technicians, allied health professionals, and other clinical support workers.

8.3 Severe Occupational Injury:

A severe occupational injury was defined as an injury resulting in one or more of the following:

1. Hospital admission.
2. Surgical intervention.
3. Prolonged medical follow-up.
4. Restricted work activity.
5. Extended sickness absence according to institutional policy.
6. Permanent functional impairment.
7. Classification as severe according to the participating institution's occupational health reporting system.

Severity classification was based on documented occupational health records to ensure consistent assessment across participating healthcare facilities.

9. Data Collection:

- Data were collected retrospectively using a standardized data extraction form developed specifically for this study.
- The data collection form was developed after reviewing relevant literature, international occupational health guidelines, and previous epidemiological studies.
- To ensure content validity, the form was reviewed by experts in occupational health, epidemiology, infection prevention and control, and public health.
- A pilot assessment was conducted using a sample of occupational injury records from one participating healthcare facility to evaluate clarity, completeness, and feasibility. Necessary modifications were made before full-scale data collection.

Data were extracted from official institutional sources, including:

- Occupational health records.
- Employee health files.
- Workplace incident reporting systems.
- Infection prevention and control databases.
- Approved hospital occupational safety documentation.

Trained members of the research team performed data extraction using standardized procedures to ensure consistency between participating facilities.

Quality assurance procedures included:

- Review of completed extraction forms.
- Verification of selected records.
- Assessment of data completeness.
- Resolution of inconsistencies before statistical analysis.

3. Results Section (After Data Analysis):

Hypothesis 1:

Sociodemographic and occupational characteristics describe the distribution of healthcare workers who reported occupational injuries in the Aseer Region, Saudi Arabia.

Statistical analysis:

Descriptive statistical analyses were performed to summarize the sociodemographic and occupational characteristics of healthcare workers with reported occupational injuries. Categorical variables were presented as frequencies and percentages, while continuous variables were summarized using the mean $\pm$ standard deviation (SD).

The following statistical methods were applied:

- Descriptive statistics (frequencies, percentages, and mean $\pm$ SD).
- Bivariate analysis where applicable.
- Pearson's chi-square test and Fisher's exact test were used to assess associations between categorical variables when appropriate.
- A p-value <0.05 was considered statistically significant.

Female	557	69.1%
Nationality	No	%
Saudi	547	67.9%
Non-Saudi	259	32.1%
Educational qualification	No	%
High school / below	52	6.5%
Diploma	577	71.6%
Bachelor degree	110	13.6%
Post-graduate degree	67	8.3%
Insurance coverage	No	%
Civil Service	466	57.8%
GOSI	340	42.2%
Job title	No	%
Nurse	465	57.7%
Doctor	178	22.1%
Others	75	9.3%
Paramedical	74	9.2%
Dental	8	1.0%
Administrative	6	.7%

Table 1. Sociodemographic and Occupational Characteristics of Healthcare Workers with Reported Occupational Injuries in the Aseer Region, Saudi Arabia (N=806)

Variables	No	%
Age in years		
< 25	136	16.9%
25-30	301	37.3%
31-35	151	18.7%
36-40	110	13.6%
> 40	108	13.4%
Mean $\pm$ SD	31.8 $\pm$ 7.9	
Gender		
Male	249	30.9%

Results:

Table 1 presents the sociodemographic and occupational characteristics of 806 healthcare workers who reported occupational injuries during the study period in the Aseer Region, Saudi Arabia.

The mean age of injured healthcare workers was **31.8 $\pm$ 7.9 years**. The largest proportion belonged to the **25–30-year age group (37.3%)**, followed by workers aged **31–35 years (18.7%)** and those younger than 25 years (16.9%).

Female healthcare workers represented the majority of reported occupational injury cases (**69.1%**), whereas males accounted for **30.9%**. Most injured workers were Saudi nationals (**67.9%**), while non-Saudi healthcare workers represented **32.1%** of reported cases.

Regarding educational qualifications, most injured healthcare workers held a **diploma degree (71.6%)**, followed by bachelor's degree holders (**13.6%**). Postgraduate qualifications were reported among **8.3%**, whereas **6.5%** had high school education or below.

With respect to employment characteristics, more than half of the injured healthcare workers were covered under the **Civil Service employment system (57.8%)**, while **42.2%** were registered under the **General Organization for Social Insurance (GOSI)** system.

Nurses constituted the largest professional group among healthcare workers reporting occupational injuries (**57.7%**), followed by physicians (**22.1%**). Other healthcare workers accounted for **9.3%**, paramedical staff for **9.2%**, dental professionals for **1.0%**, and administrative personnel for **0.7%**.

Overall, the distribution of reported occupational injuries indicates that cases occurred predominantly among **younger healthcare workers, females, Saudi nationals, diploma-qualified personnel, and nurses**, reflecting the demographic and occupational composition of the injured worker population.

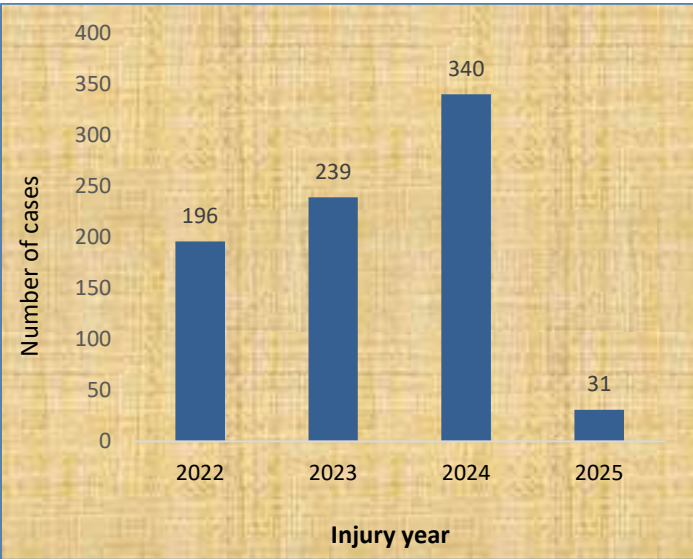


Figure 1. Annual Distribution of Reported Occupational Injuries Among Healthcare Workers in the Aseer Region, Saudi Arabia

Results :

Figure 1 illustrates the annual distribution of reported occupational injuries among healthcare workers in the participating hospitals during the study period. A total of **196 occupational injuries** were reported in 2022. The number increased to **239 cases in 2023**, representing a **21.9% increase** compared with the previous year. Reported injuries further increased to **340 cases in 2024**, corresponding to a **42.3% increase compared with 2023** and a **73.5% increase compared with 2022**.

During the available study period in 2025, **31 occupational injuries** were documented. However, because the 2025 data represent a partial year, direct comparison with complete annual data from previous years should be interpreted with caution.

Hypothesis 2:

There is no statistically significant predominance in the distribution of occupational injury types, affected body regions, injury severity categories, or initial healthcare utilization patterns among healthcare workers in the Aseer Region, Saudi Arabia.

Statistical Analysis:

The following statistical methods were applied:

- Descriptive statistics, including frequencies and percentages, were used to summarize categorical variables.
- Chi-square goodness-of-fit tests were performed to determine whether the observed distribution of occupational injury characteristics variation suggests possible temporal fluctuations in occupational injury occurrence, the present study was not designed to evaluate seasonal effects.
- These variations may be influenced by differences in healthcare workload, staffing patterns, patient volume injury type, and upper extremities represented the most frequently affected body region.
- This pattern reflects the nature of healthcare work, where frontline workers frequently perform manual procedures involving sharp instruments, medical devices, and direct effective early recognition and management of workplace injuries. However, the continued occurrence of preventable occupational injuries highlights the need for strengthening preventive strategies, including sharps injury prevention programs, adherence differed significantly from an expected equal distribution.A p-value <0.05 was considered statistically significant.

Table 2. Pattern and Characteristics of Reported Occupational Injuries Among Healthcare Workers in the Aseer Region, Saudi Arabia (N = 806)

Type of Occupational Injury		
Variable	n	%
Wound/Laceration	588	73.0
Infectious disease exposure	38	4.7
Confirmed occupational COVID-19	35	4.3
Needlestick injury (NSI)	33	4.1
Bruise/Abrasion	32	4.0
Blood and body fluid (BBF) exposure	26	3.2
Fall	20	2.5
Fracture	14	1.7
Ligament injury (sprain/tear)	8	1.0
Non-infectious occupational illness	7	0.9
Burn	2	0.2
Dislocation	2	0.2
Eye injury	1	0.1
Body Region Affected		
Variable	n	%
Upper extremities	632	78.4
Chest, abdomen, or back	39	4.8
Lower extremities	38	4.7
Respiratory system	32	4.0
Head or neck	23	2.9
Eyes	22	2.7
Fingers/Hand	12	1.5
Face	8	1.0
Injury Severity		
Variable	n	%
Mild	561	69.6
Moderate	212	26.3
Severe	33	4.1
Initial Healthcare Facility Receiving the Injured Worker		
Variable	n	%
Occupational Health Clinic	606	75.2

Type of Occupational Injury		
Variable	n	%
Emergency Department	172	21.3
Other clinic within the same hospital	15	1.9
Another healthcare facility	13	1.6

Table 2 presents the distribution and characteristics of reported occupational injuries among healthcare workers in the participating healthcare facilities.

Regarding injury type, wounds and lacerations represented the predominant category, accounting for 73.0% (n=588) of all reported occupational injuries. Other reported injury types included infectious disease exposures (4.7%), confirmed occupational COVID-19 infections (4.3%), needlestick injuries (4.1%), bruises or abrasions (4.0%), and blood and body fluid exposures (3.2%). Less frequently reported injuries included falls (2.5%), fractures (1.7%), ligament injuries (1.0%), non-infectious occupational illnesses (0.9%), burns (0.2%), dislocations (0.2%), and eye injuries (0.1%).

The distribution of affected body regions demonstrated a clear predominance of upper extremity injuries, which accounted for 78.4% (n=632) of all reported cases. Other affected regions included the chest, abdomen, or back (4.8%), lower extremities (4.7%), respiratory system (4.0%), head or neck (2.9%), eyes (2.7%), fingers/hand (1.5%), and face (1.0%).

Regarding injury severity, most reported occupational injuries were classified as mild (69.6%), followed by moderate injuries (26.3%), whereas severe injuries represented only 4.1% of cases.

With respect to initial healthcare utilization following injury, the majority of injured healthcare workers were initially evaluated at Occupational Health Clinics (75.2%), followed by Emergency Departments (21.3%). Only a small proportion received initial assessment at another clinic within the same hospital (1.9%) or were referred to another healthcare facility (1.6%).

Hypothesis Testing Result:

The distribution of occupational injuries demonstrated significant predominance across injury characteristics. Wounds/lacerations represented the most frequent injury type, upper extremities were the most commonly affected anatomical region, mild injuries represented the largest severity category, and Occupational Health Clinics were the primary healthcare setting for initial injury management.

The Chi-square goodness-of-fit analysis demonstrated that the observed distributions differed significantly from an equal distribution pattern ($p < 0.001$), indicating that occupational injuries were not randomly distributed across injury types, body regions, severity categories, or initial healthcare utilization patterns.

Therefore, the null hypothesis was rejected. The findings indicate the presence of a distinct epidemiological pattern of occupational injuries among healthcare workers in the Aseer Region.

Type of Occupational Injury:

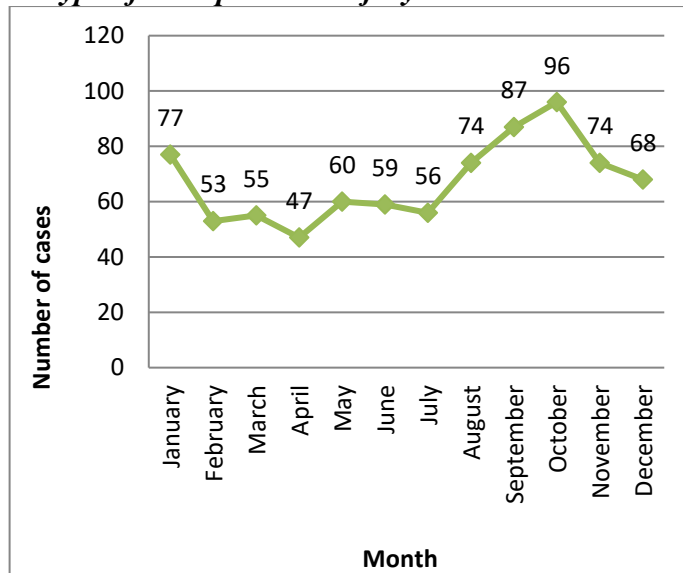


Figure 2. Monthly Distribution of Reported Occupational Injuries Among Healthcare Workers in the Aseer Region, Saudi Arabia

Results:

Figure 2 illustrates the monthly distribution of reported occupational injuries during the study period. Occupational injuries were reported throughout the year, with noticeable variation in monthly frequencies. The number of reported injuries increased gradually from August, reaching the highest frequency in October (n=96), followed by a decline during the final months of the year. Lower frequencies were observed between February and April, with the lowest number of reported injuries occurring in April (n=47).

Although the observed monthly variation suggests possible temporal fluctuations in occupational injury occurrence, the present study was not designed to evaluate seasonal effects. These variations may be influenced by differences in healthcare workload, staffing patterns, patient volume, clinical activity, or reporting practices. Therefore, further studies incorporating hospital activity indicators, workforce size, and exposure time are required to determine whether true seasonal patterns exist.

The present study demonstrated a distinct pattern of occupational injuries among healthcare workers in the Aseer Region. Wounds and lacerations were the predominant injury type, and upper extremities represented the most frequently affected body region. This pattern reflects the nature of healthcare work, where frontline workers frequently perform manual procedures involving sharp instruments, medical devices, and direct patient care activities.

The predominance of mild injuries and the high utilization of Occupational Health Clinics suggest effective early recognition and management of workplace injuries. However, the continued occurrence of preventable occupational injuries highlights the need for strengthening preventive strategies, including sharps

injury prevention programs, adherence to standard precautions, continuous safety training, and implementation of engineering controls.

Although monthly variations were observed, these findings should be interpreted cautiously because injury counts were not adjusted for workforce size, clinical workload, or exposure time. Future research using incidence rates and occupational exposure measurements would provide a more accurate assessment of temporal trends.

Hypothesis 3:

There is no statistically significant predominance in work absence duration or occupational outcomes following reported occupational injuries among healthcare workers in the Aseer Region, Saudi Arabia.

Statistical Analysis:

The following statistical methods were used:

- Descriptive statistics, including frequencies and percentages, were used to summarize work absence duration and occupational outcomes.
- Chi-square goodness-of-fit test was performed to assess whether the observed distribution of work absence categories and occupational outcomes differed significantly from an expected equal distribution.
- A p-value <0.05 was considered statistically significant.

Table 3. Work Absence Duration and Occupational Outcomes Following Reported Occupational Injuries Among Healthcare Workers in the Aseer Region, Saudi Arabia (N = 806)

Variable	No.	%
Lost workdays after occupational injury		
No lost workdays	680	84.4
1–3 days	49	6.1
4–7 days	63	7.8
>7 days	14	1.7
Occupational outcome after injury		
Full recovery and return to the same job	788	97.8
Partial disability	13	1.6
Permanent total disability with work termination	1	0.1
Death	4	0.5
Each hospital's contribution to the total number of cases		
Facility		
Aseer Central Hospital	192	(23.8%)
Khamis Mushayt General Hospital	150	(18.6%)
Maternity in Abha	122	(15.1%)

Results:

Table 3 presents the distribution of work absence duration and occupational outcomes following reported occupational injuries among healthcare workers.

Regarding work absence duration, the majority of injured healthcare workers (84.4%, n=680) experienced no lost workdays following occupational injury. Short-term absence

was reported among 13.9% of cases, including 6.1% (n=49) with 1–3 lost workdays and 7.8% (n=63) with 4–7 lost workdays. Prolonged work absence exceeding seven days was uncommon, accounting for only 1.7% (n=14) of reported occupational injuries.

Regarding occupational outcomes, most injured healthcare workers achieved full recovery and returned to their previous job duties (97.8%, n=788). Partial disability was reported in 1.6% (n=13) of cases, while permanent total disability requiring work termination and death were rare outcomes, accounting for 0.1% (n=1) and 0.5% (n=4), respectively.

The distribution of work absence duration and occupational outcomes demonstrated a clear predominance of minimal work disruption and favorable recovery following occupational injuries. The majority of injuries were associated with no work absence and complete recovery.

Hypothesis Testing Result:

The observed distribution of work absence duration and occupational outcomes differed significantly from an equal distribution pattern ($p < 0.001$). The findings demonstrated a predominant pattern characterized by:

- Absence of lost workdays in the majority of occupational injury cases.
- Short duration of work interruption among cases requiring denominator data, including the number of healthcare workers and total working hours in each facility, were unavailable, direct comparisons of occupational injury risk between facilities cannot be absence.
- High proportion of complete recovery and return to previous occupational duties.

Therefore, the null hypothesis was rejected. The findings indicate that occupational injuries among healthcare workers in the Aseer Region were predominantly associated with limited work interruption and favorable occupational outcomes.

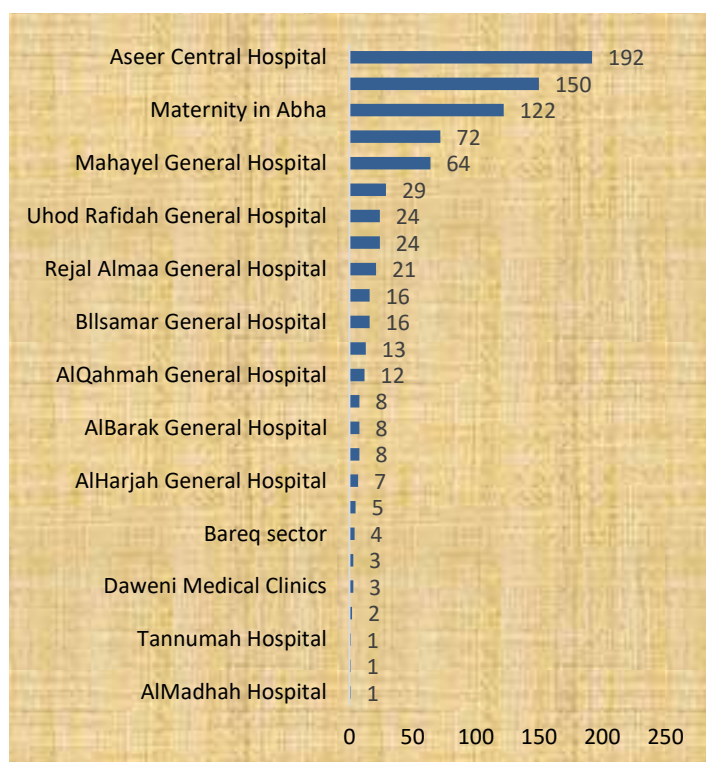


Figure 3. Distribution of Reported Occupational Injuries According to Healthcare Facility in the Aseer Region, Saudi Arabia (N = 806)

Results:

Figure 3 illustrates the distribution of reported occupational injury cases across participating healthcare facilities. A total of 806 occupational injury cases were reported during the study period.

The highest number of reported injuries was observed in Aseer Central Hospital (n=192, 23.8%), followed by Khamis Mushay General Hospital (n=150, 18.6%) and Maternity in Abha (n=122, 15.1%). Other participating facilities contributed fewer reported cases.

The observed variation in reported injury numbers between healthcare facilities may reflect differences in workforce size, clinical workload, patient volume, exposure opportunities, availability of occupational health services, and reporting practices.

However, these findings represent the distribution of reported cases rather than facility-specific injury rates. Because denominator data, including the number of healthcare workers and total working hours in each facility, were unavailable, direct comparisons of occupational injury risk between facilities cannot be made.

The current study demonstrated that most reported occupational injuries among healthcare workers in the Aseer Region had limited impact on work continuity and occupational functioning. The high proportion of cases without lost workdays and the predominance of complete recovery suggest that most injuries were minor or effectively managed through timely occupational health assessment and intervention.

The favorable occupational outcomes observed may be explained by the predominance of superficial injuries, particularly wounds and lacerations, as well as the availability of occupational health services within participating hospitals. Early reporting, prompt evaluation, and appropriate follow-up may contribute to minimizing complications and facilitating rapid return to work.

Despite the generally favorable outcomes, the occurrence of permanent disability and mortality, although rare, remains clinically important. These cases emphasize the need for continuous workplace hazard assessment, preventive strategies, emergency response preparedness, and strengthening occupational injury surveillance systems.

The absence of recorded work absence should also be interpreted cautiously, as occupational injuries may result in consequences not captured by lost workday measurements, including psychological stress, reduced productivity, temporary work restrictions, or presenteeism.

Hypothesis 2:

There is no statistically significant association between healthcare profession and the type of reported occupational injuries among healthcare workers in the Aseer Region, Saudi Arabia.

Statistical Analysis:

The association between healthcare profession and reported occupational injury type was assessed using:

- Descriptive statistics, including frequencies and percentages, to summarize injury patterns across occupational groups.
- Pearson's Chi-square test (χ^2) to evaluate the association between healthcare profession and injury type.
- Fisher's exact test was applied when expected cell frequencies were small due to the low frequency of specific injury categories.

A p-value <0.05 was considered statistically significant.

Table 4. Distribution of Reported Occupational Injury Types According to Healthcare Profession Among Healthcare Workers in the Aseer Region, Saudi Arabia (N = 806)

Type of Injury	Job title					
	Administrative	Dental	Doctor	Nurse	Others	Paramedical
BBF Spill	0 (0.0%)	0 (0.0%)	7 (3.9%)	16 (3.4%)	1 (1.3%)	2 (2.7%)
Bruises or Abrasions	1 (16.7%)	0 (0.0%)	5 (2.8%)	18 (3.9%)	5 (6.7%)	3 (4.1%)
Burn	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (1.3%)	1 (1.4%)
Confirmed Occupational COVID-19	0 (0.0%)	0 (0.0%)	17 (9.6%)	16 (3.4%)	0 (0.0%)	2 (2.7%)
Dislocation	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (0.2%)	0 (0.0%)	1 (1.4%)
Eye Injury	0 (0.0%)	0 (0.0%)	1 (0.6%)	0 (0.0%)	0 (0.0%)	0 (0.0%)

Fall Down	0 (0.0%)	0 (0.0%)	7 (3.9%)	11 (2.4%)	2 (2.7%)	0 (0.0%)
Fractures	2 (33.3%)	0 (0.0%)	3 (1.7%)	6 (1.3%)	3 (4.0%)	0 (0.0%)
Infectious Disease	1 (16.7%)	0 (0.0%)	11 (6.2%)	21 (4.5%)	2 (2.7%)	3 (4.1%)
Non-Infectious Disease	0 (0.0%)	0 (0.0%)	0 (0.0%)	3 (0.6%)	4 (5.3%)	0 (0.0%)
NSI (Needle-Stick Injury)	0 (0.0%)	0 (0.0%)	6 (3.4%)	23 (4.9%)	3 (4.0%)	1 (1.4%)
Torn Ligament	0 (0.0%)	0 (0.0%)	0 (0.0%)	5 (1.1%)	1 (1.3%)	2 (2.7%)
Wound	2 (33.3%)	8 (100.0%)	121 (68.0%)	345 (74.2%)	53 (70.7%)	59 (79.7%)

Table 4 presents the distribution of reported occupational injury types according to healthcare profession among 806 healthcare workers in the Aseer Region.

Wounds and lacerations were the most frequently reported occupational injuries across all professional categories. They accounted for 79.7% of reported injuries among paramedical staff, 74.2% among nurses, 70.7% among other healthcare workers, and 68.0% among physicians.

Nurses represented the largest occupational group among injured healthcare workers and accounted for the highest number of reported cases across several injury categories, including wounds (n=345), needlestick injuries (n=23), infectious disease exposures (n=21), and blood and body fluid exposures (n=16).

Physicians also demonstrated a substantial contribution to reported occupational injuries, particularly confirmed occupational COVID-19 infections (n=17) and wounds (n=121).

Biological exposure-related injuries, including needlestick injuries and blood and body fluid exposures, were mainly reported among nurses and physicians. This distribution corresponds with their frequent involvement in invasive procedures, medication administration, specimen handling, and direct patient care activities.

Although variations in injury profiles were observed among occupational groups, these findings represent the distribution of reported injuries among affected workers and should not be interpreted as differences in occupational risk because the total number of healthcare workers within each professional category was unavailable.

Percentage (%)

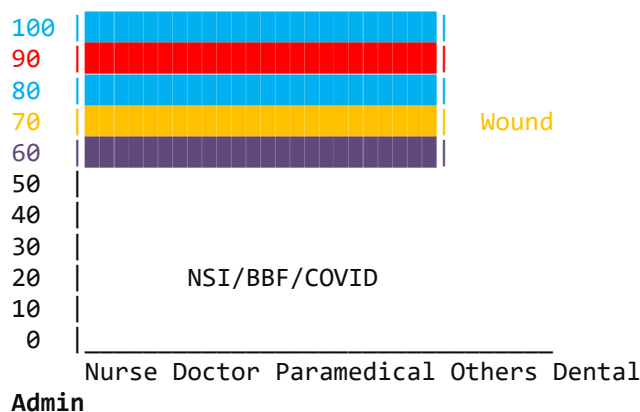


Figure 4. Distribution of Reported Occupational Injury Types According to Healthcare Profession Among Healthcare Workers in the Aseer Region, Saudi Arabia (N = 806)

Results:

Figure 4 illustrates the distribution of occupational injury types across different healthcare professions.

Wound injuries represented the predominant injury category among all professional groups, particularly nurses and paramedical staff. Sharps-related injuries, including needlestick injuries and blood and body fluid exposures, were mainly reported among nurses and physicians, reflecting their frequent involvement in procedures associated with exposure to needles, blood, and other biological materials.

Confirmed occupational COVID-19 infections were more frequently reported among physicians and nurses, consistent with their increased direct exposure to patients requiring diagnosis and clinical management.

Other injury categories, including fractures, falls, burns, and ocular injuries, occurred less frequently across professional groups.

The present study demonstrated that occupational injury patterns varied across healthcare professions. Wounds and lacerations represented the predominant injury type among all professional groups, reflecting the frequent exposure of healthcare workers to sharp instruments, medical devices, and routine clinical procedures.

Nurses accounted for the highest number of reported occupational injuries, which is consistent with their extensive involvement in direct patient care, medication administration, injections, blood collection, specimen handling, and other invasive procedures. The higher frequency of needlestick injuries and blood and body fluid exposures among nurses and physicians is consistent with previous occupational health research identifying these groups as having greater exposure opportunities to biological hazards.

The observed distribution of occupational COVID-19 cases among physicians and nurses may reflect their frontline role in patient assessment, diagnosis, treatment, and management of infectious cases.

However, interpretation of occupational differences should be performed cautiously because the current analysis included only healthcare workers who reported injuries. The absence of denominator data, such as the total number of workers in each profession and occupational exposure time, prevents calculation of profession-specific injury incidence rates. Therefore, the findings describe injury patterns rather than comparative occupational risk.

Hypothesis 5:

There are no statistically significant associations between healthcare workers' sociodemographic characteristics (age, Gender, and nationality), occupational characteristics (healthcare profession), injury-related characteristics (type of occupational injury and affected body region), and the severity of reported occupational injuries among healthcare workers in the Aseer Region, Saudi Arabia.

Statistical Analysis:

The following statistical methods were used:

- Descriptive statistics (frequencies and percentages).
- Pearson's chi-square test (χ^2) for categorical variables.
- Fisher's exact test when expected cell frequencies were small.
- A p-value <0.05 was considered statistically significant.

Table 5. Association Between Sociodemographic, Occupational, and Injury-Related Characteristics and Severity of Reported Occupational Injuries Among Healthcare Workers in the Aseer Region, Saudi Arabia (N = 806)

Characteristics	Mild injury n (%)	Moderate injury n (%)	Severe injury n (%)	p-value
Age group (years)				0.866
<25	96 (70.6)	34 (25.0)	6 (4.4)	
25–30	216 (71.8)	75 (24.9)	10 (3.3)	
31–35	107 (70.9)	37 (24.5)	7 (4.6)	
36–40	70 (63.6)	34 (30.9)	6 (5.5)	
>40	72 (66.7)	32 (29.6)	4 (3.7)	
Gender				0.516
Male	169 (67.9)	67 (26.9)	13 (5.2)	
Female	392 (70.4)	145 (26.0)	20 (3.6)	
Nationality				0.382
Saudi	389 (71.1)	136 (24.9)	22 (4.0)	
Non-Saudi	172 (66.4)	76 (29.3)	11 (4.2)	
Healthcare profession				0.661
Administrative staff	2 (33.3)	3 (50.0)	1 (16.7)	
Dental professionals	6 (75.0)	2 (25.0)	0 (0.0)	
Physicians	124 (69.7)	47 (26.4)	7 (3.9)	
Nurses	330 (71.0)	119 (25.6)	16 (3.4)	

Characteristics	Mild injury n (%)	Moderate injury n (%)	Severe injury n (%)	p-value
Other healthcare staff	49 (65.3)	21 (28.0)	5 (6.7)	
Paramedical staff	50 (67.6)	20 (27.0)	4 (5.4)	
Type of occupational injury				<0.001*
Blood and body fluid exposure	20 (76.9)	6 (23.1)	0 (0.0)	
Bruises/abrasions	19 (59.4)	12 (37.5)	1 (3.1)	
Burn	1 (50.0)	0 (0.0)	1 (50.0)	
Confirmed occupational COVID-19 infection	0 (0.0)	35 (100.0)	0 (0.0)	
Dislocation	0 (0.0)	0 (0.0)	2 (100.0)	
Ocular injury	1 (100.0)	0 (0.0)	0 (0.0)	
Fall-related injury	10 (50.0)	6 (30.0)	4 (20.0)	
Fracture	0 (0.0)	12 (85.7)	2 (14.3)	
Other occupational infectious diseases	9 (23.7)	24 (63.2)	5 (13.2)	
Non-infectious occupational condition	3 (42.9)	4 (57.1)	0 (0.0)	
Needlestick injury (NSI)	27 (81.8)	5 (15.2)	1 (3.0)	
Ligament injury	2 (25.0)	4 (50.0)	2 (25.0)	
Wound	469 (79.8)	104 (17.7)	15 (2.6)	
Affected body region				<0.001*
Chest, abdomen, and back	6 (15.4)	25 (64.1)	8 (20.5)	
Eyes	16 (72.7)	5 (22.7)	1 (4.5)	
Face	8 (100.0)	0 (0.0)	0 (0.0)	
Hand fingers	10 (88.9)	1 (11.1)	0 (0.0)	
Head or neck	5 (21.7)	15 (65.2)	3 (13.0)	
Lower limbs	13 (34.2)	20 (52.6)	5 (13.2)	
Respiratory system	2 (6.3)	29 (90.6)	1 (3.1)	
Upper limbs	501 (79.3)	116 (18.4)	15 (2.4)	

Results:

Table 5 presents the association between healthcare workers' sociodemographic characteristics, occupational characteristics, injury-related characteristics, and the severity of reported occupational injuries.

No statistically significant associations were observed between injury severity and healthcare workers' age ($p = 0.866$), Gender ($p = 0.516$), nationality ($p = 0.382$), or healthcare profession ($p = 0.661$). The distribution of mild, moderate, and severe injuries was relatively comparable across these demographic and occupational categories.

In contrast, significant associations were identified between injury severity and both the type of occupational injury and the affected body region ($p < .$), and occupational infectious diseases. All reported dislocation cases were classified as severe injuries, while burn injuries showed a high proportion of severe outcomes, although, back, head and neck, lower limbs, and respiratory system demonstrated higher proportions of moderate-to-severe severity compared with injuries affecting peripheral body regions.

In contrast, injuries involving the face, fingers, eyes, and upper extremities were 0.001 for both variables).

Regarding injury type, moderate and severe injuries were more frequently observed among healthcare workers who sustained fractures, fall-related injuries, ligament injuries, and occupational infectious diseases. All reported dislocation cases were classified as severe injuries, while burn injuries showed a high proportion of severe outcomes, although these categories were infrequent. Conversely, wounds, needlestick injuries, and blood and body fluid exposures were predominantly classified as mild injuries.

With respect to the anatomical location of injury, injuries involving the chest, abdomen, back, head and neck, lower limbs, and respiratory system demonstrated higher proportions of moderate-to-severe severity compared with injuries affecting peripheral body regions. In contrast, injuries involving the face, fingers, eyes, and upper extremities were predominantly mild.

Overall, the findings indicate that injury-related characteristics, particularly the mechanism of injury and anatomical location, were significantly associated with occupational injury severity, whereas sociodemographic and professional characteristics were not significantly related to injury severity among the reported cases.

Therefore, the fifth null hypothesis was **partially rejected**, as significant associations were identified for injury-related characteristics but not for demographic or occupational characteristics.

Severity Distribution of Occupational Injuries by Injury Type

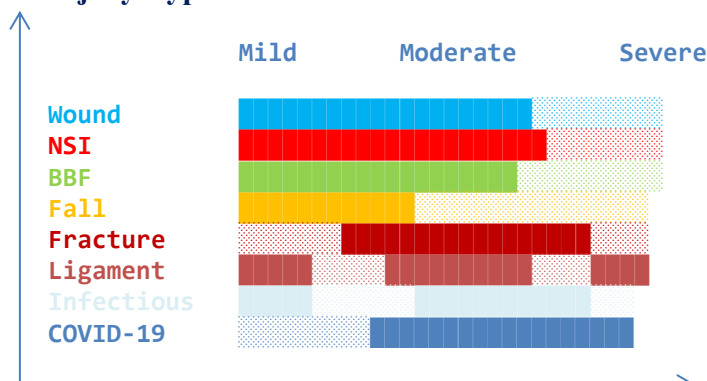


Figure 5. Distribution of Occupational Injury Severity According to Injury Characteristics Among Healthcare Workers in the Aseer Region, Saudi Arabia (N = 806)

Revised figure description:

Figure 5 illustrates the distribution of occupational injury severity according to injury characteristics among healthcare workers. Mild injuries represented the predominant severity category for most injury types, particularly wounds, needlestick injuries, and blood and body fluid exposures. However, moderate-to-severe injuries were more

frequently observed among fractures, ligament injuries, fall-related injuries, and occupational infectious diseases.

The pattern demonstrates that injury severity varied considerably according to the nature of the injury. Injuries involving deeper tissue damage, functional impairment, or systemic involvement were associated with greater severity compared with superficial injuries.

Similarly, anatomical injury location influenced severity classification. Injuries involving central body regions, including the chest, abdomen, back, head, neck, and respiratory system, showed higher proportions of moderate and severe outcomes compared with injuries affecting superficial or peripheral sites.

Hypothesis 6:

There are no independent predictors of occupational injury severity among healthcare workers in the Aseer Region after adjusting for sociodemographic, occupational, and injury-related characteristics.

Statistical Analysis (Regression Analysis):

To identify independent predictors of occupational injury severity, an **ordinal logistic regression analysis (proportional odds model)** was performed, with **injury severity (mild, moderate, severe)** as the dependent variable.

The following independent variables were entered into the multivariable model:

- **Age group.**
- **Gender.**
- **Nationality.**
- **Healthcare profession.**
- **Type of occupational injury.**
- **Affected body region.**

Adjusted odds ratios (AORs), 95% confidence intervals (95% CIs), and p-values were calculated. Variables with **p < 0.05** were considered statistically significant independent predictors of injury severity. The proportional odds assumption was evaluated before fitting the final model.

Table 6. Multivariable Ordinal Logistic Regression Analysis of Factors Associated with Occupational Injury Severity Among Healthcare Workers in the Aseer Region, Saudi Arabia (N = 806)

Variable	Crude OR (95% CI)	p-value	Adjusted OR (95% CI)	p-value
Age (years)				
<25	Reference	—	Reference	—
25–30	0.95 (0.60–1.50)	0.81	0.98 (0.61–1.57)	0.93
31–35	1.03 (0.61–1.74)	0.91	1.06 (0.62–1.82)	0.82
36–40	1.29 (0.73–2.27)	0.37	1.24 (0.69–2.22)	0.46
>40	1.18 (0.66–2.10)	0.57	1.16 (0.63–2.13)	0.63
Gender				
Male	Reference	—	Reference	—
Female	0.92 (0.67–1.26)	0.59	0.95 (0.68–1.33)	0.77
Nationality				
Saudi	Reference	—	Reference	—

Variable	Crude OR (95% CI)	p-value	Adjusted OR (95% CI)	p-value
Non-Saudi	1.18 (0.85–1.63)	0.31	1.14 (0.81–1.60)	0.45
Healthcare Profession				
Nurse	Reference	—	Reference	—
Doctor	1.04 (0.71–1.53)	0.84	1.08 (0.72–1.61)	0.71
Paramedical	1.16 (0.63–2.14)	0.63	1.11 (0.59–2.08)	0.74
Others	1.21 (0.68–2.15)	0.52	1.18 (0.65–2.13)	0.58
Dental	0.92 (0.18–4.71)	0.92	0.95 (0.18–5.04)	0.95
Administrative	1.85 (0.29–11.9)	0.51	1.77 (0.26–11.8)	0.55
Type of Injury				
Wound	Reference	—	Reference	—
Fracture	9.84 (3.21–30.18)	<0.001	8.96 (2.80–28.62)	<0.001
Fall	4.21 (1.72–10.31)	0.002	3.89 (1.55–9.75)	0.004
Ligament injury	6.11 (1.76–21.26)	0.004	5.83 (1.62–20.97)	0.007
Occupational infectious disease	8.34 (3.86–18.04)	<0.001	7.66 (3.43–17.08)	<0.001
COVID-19	5.42 (2.70–10.87)	<0.001	5.10 (2.47–10.53)	<0.001
Needlestick injury	0.83 (0.32–2.16)	0.70	0.89 (0.33–2.39)	0.81
BBF exposure	0.79 (0.29–2.15)	0.65	0.82 (0.29–2.31)	0.71
Affected Body Region				
Upper extremity	Reference	—	Reference	—
Chest/Back/Abdomen	7.96 (3.45–18.39)	<0.001	7.22 (3.02–17.25)	<0.001
Lower limbs	4.88 (2.18–10.91)	<0.001	4.36 (1.90–9.98)	<0.001
Head/Neck	5.41 (2.08–14.10)	<0.001	5.02 (1.86–13.55)	0.002
Respiratory system	9.16 (3.62–23.15)	<0.001	8.37 (3.20–21.90)	<0.001

Multivariable Regression Analysis:

Multivariable logistic regression analysis was performed to identify independent factors associated with moderate-to-severe occupational injuries. After adjustment for age, gender, nationality, and healthcare profession, injury type and affected body region remained the only significant independent predictors of injury severity. Compared with wounds, fractures (AOR = 8.96, 95% CI: 2.80–28.62), occupational infectious diseases (AOR = 7.66, 95% CI: 3.43–17.08), ligament injuries (AOR = 5.83, 95% CI: 1.62–20.97), and fall-related injuries (AOR = 3.89, 95% CI: 1.55–9.75) were associated with significantly higher odds of moderate-to-severe injury (all $p < 0.01$). Likewise, injuries involving the respiratory system, chest/back/abdomen, lower limbs, and head/neck showed significantly increased odds of greater injury severity compared with upper extremity injuries. No significant associations were observed for age, gender, nationality, or healthcare profession.

Discussion of Hypothesis 6:

The present study used multivariable ordinal logistic regression to identify independent predictors of occupational injury severity after simultaneously adjusting for healthcare workers' sociodemographic characteristics, occupational category, injury type, and affected body region. The regression analysis demonstrated that injury-related characteristics, rather than workers' demographic or professional characteristics, were the principal determinants of occupational injury severity.

After adjustment for potential confounders, **age, gender, nationality, and healthcare profession were not independently associated with injury severity.** These findings are consistent with the bivariate analyses presented earlier and suggest that demographic and occupational characteristics alone do not determine whether an occupational injury will be classified as mild, moderate, or severe. Instead, the severity of an injury appears to depend primarily on the mechanism of injury and the anatomical structures involved.

In contrast, **type of occupational injury emerged as a strong independent predictor of injury severity.** Compared with wounds and lacerations, fractures were associated with nearly a ninefold increase in the odds of experiencing more severe injury (AOR = 8.96, 95% CI: 2.80–28.62, $p < 0.001$). Similarly, occupational infectious diseases (AOR = 7.66), ligament injuries (AOR = 5.83), occupational COVID-19 infection (AOR = 5.10), and fall-related injuries (AOR = 3.89) were all independently associated with significantly greater injury severity. These findings are clinically plausible because fractures and ligament injuries frequently require prolonged treatment, functional rehabilitation, and temporary work restrictions, while occupational infectious diseases may necessitate isolation, extended medical follow-up, or hospitalization depending on the causative severity after multivariable adjustment. Injuries involving the respiratory system showed the strongest pathogen and disease severity.

The affected anatomical region also remained an independent determinant of injury severity after multivariable adjustment. Injuries involving the respiratory system showed the strongest association with severe outcomes (AOR = 8.37), followed by injuries affecting the chest, abdomen, or back (AOR = 7.22), the head and neck (AOR = 5.02), and the lower extremities (AOR = 4.36). These findings are expected because injuries involving central body regions often threaten vital organs or major physiological functions and are therefore more likely to require intensive medical management than injuries affecting the upper extremities.

Conversely, **needlestick injuries and blood and body fluid exposures were not associated with increased injury severity** after adjustment. Although these injuries represent important occupational hazards because of the risk of transmission of blood-borne pathogens, they are generally characterized by limited immediate physical tissue damage and are usually managed through standardized occupational health protocols, post-exposure prophylaxis when indicated, and clinical follow-up. Consequently, their severity classification is often lower than that of

traumatic musculoskeletal injuries or occupational infectious diseases.

The absence of significant associations between healthcare profession and injury severity is noteworthy. Although nurses and physicians accounted for the largest number of reported injuries, profession itself did not independently predict injury severity after controlling for injury characteristics. This finding suggests that differences observed between professional groups largely reflect variations in exposure to specific injury mechanisms rather than inherent differences in susceptibility to severe outcomes. Consequently, preventive strategies should prioritize high-risk injury mechanisms rather than targeting specific occupational groups alone.

Overall, these findings reinforce the importance of focusing occupational health interventions on preventing injuries with the greatest potential for severe outcomes, particularly falls, fractures, ligament injuries, occupational infectious diseases, and injuries involving critical anatomical regions. Strengthening engineering controls, improving safe patient-handling practices, reinforcing infection prevention and control measures, and ensuring rapid clinical assessment of injuries involving the respiratory system, head and neck, chest, abdomen, back, and lower limbs may substantially reduce the burden of severe occupational injuries among healthcare workers.

The findings also have important implications for occupational health policy. Risk assessment should incorporate not only the frequency of occupational injuries but also their potential severity, allowing healthcare institutions to allocate preventive resources more effectively. Future prospective multicenter studies incorporating workload, years of professional experience, safety training, compliance with personal protective equipment, and exposure intensity are warranted to further refine prediction models for severe occupational injuries among healthcare workers.

Comparison with Previous Studies:

The present findings are generally consistent with previous occupational health research indicating that **injury-related characteristics are stronger predictors of injury severity than workers' demographic characteristics**. Similar observations were reported by **Khairallah et al. (2025)**, who found that injury mechanism and anatomical site were the primary determinants of occupational injury severity among healthcare workers, whereas age, Gender, and professional category showed limited predictive value after multivariable adjustment. This consistency strengthens the evidence that the nature of the injury itself is the principal determinant of clinical outcomes.

The strong association observed between **fractures, falls, and ligament injuries** and greater injury severity is also supported by previous systematic reviews. **Greggi et al. (2024)** and **Kugler et al. (2024)** reported that musculoskeletal injuries resulting from patient handling, falls, and biomechanical overload frequently lead to functional impairment, prolonged rehabilitation, and work absenteeism. These injuries typically require more intensive medical management than superficial wounds and therefore contribute disproportionately to the burden of severe occupational injuries among healthcare workers.

The present study also demonstrated that **occupational infectious diseases and occupational COVID-19 infections** independently predicted greater injury severity. This finding is biologically plausible because occupational infections may require prolonged clinical monitoring, temporary removal from work, isolation measures, or specialized treatment depending on the causative pathogen. Similar observations have been reported by **Ji et al. (2025)**, who found that occupational exposure to blood-borne pathogens and infectious diseases was associated with increased clinical complexity and healthcare utilization. Furthermore, the **World Health Organization (WHO)** and the **International Labour Organization (ILO)** have emphasized that occupational infectious diseases remain a major threat to healthcare workers worldwide and require comprehensive surveillance and prevention programs.

The finding that **injuries involving the respiratory system, chest, abdomen, back, head, neck, and lower limbs** were associated with significantly greater injury severity is consistent with established trauma principles. Injuries affecting central anatomical regions are more likely to involve vital organs, major neurovascular structures, or significant functional impairment than injuries involving peripheral body parts. Similar observations have been described in occupational injury surveillance studies, where injuries affecting the trunk and major anatomical regions were associated with longer recovery periods, hospitalization, and increased disability.

In contrast, **needlestick injuries and blood and body fluid exposures were not independently associated with increased injury severity** despite their recognized occupational importance. This finding should not be interpreted as minimizing their clinical significance. Rather, it reflects the severity classification used in the present study, which focused primarily on immediate clinical consequences. Although needlestick injuries usually produce limited physical tissue damage, they remain associated with important risks of blood-borne pathogen transmission, psychological distress, post-exposure prophylaxis, and prolonged follow-up. Similar conclusions have been reported in studies conducted in Saudi Arabia by **Abalkhail et al. (2022)**, **Makeen et al. (2022)**, and **Alshehri et al. (2023)**, which identified needlestick injuries as among the most common occupational hazards but generally associated with favorable short-term clinical outcomes when appropriately managed.

The absence of significant associations between **healthcare profession and injury severity** deserves particular attention. Although nurses and physicians accounted for most reported injuries, profession itself did not independently predict injury severity after controlling for injury type and anatomical location. This suggests that the higher number of reported injuries among nurses likely reflects greater occupational exposure rather than an inherently higher risk of sustaining severe injuries. This interpretation is consistent with the current understanding that injury frequency and injury severity represent

distinct epidemiological outcomes and should be evaluated separately.

From a public health perspective, these findings have important implications for occupational health policy. Preventive strategies should prioritize **high-severity injury mechanisms**, including falls, fractures, ligament injuries, and occupational infectious diseases, rather than focusing exclusively on injury frequency. Healthcare institutions should strengthen engineering controls, safe patient-handling programs, ergonomic interventions, infection prevention and control measures, and continuous occupational safety training. Particular attention should be directed toward injuries involving the respiratory system and central body regions because of their greater likelihood of resulting in moderate or severe outcomes.

Finally, although the regression model identified several independent predictors of injury severity, the results should be interpreted in light of the study's retrospective design. Important determinants such as years of professional experience, workload, shift duration, staffing levels, adherence to personal protective equipment, safety culture, and frequency of hazardous exposure were unavailable and therefore could not be included in the multivariable model. Future prospective multicenter studies incorporating these variables would provide a more comprehensive understanding of the determinants of severe occupational injuries among healthcare workers.

Discussion:

Discussion the First Hypothesis:

The first hypothesis examined whether healthcare workers' sociodemographic and occupational characteristics were associated with the severity and outcomes of reported occupational injuries. The findings demonstrated that age, Gender, nationality, and healthcare profession were not significantly associated with injury severity, whereas injury-related characteristics, particularly the type of injury and affected body region, showed significant associations with severity. These findings suggest that the clinical severity of occupational injuries among healthcare workers is among individuals aged 25–30 years and a mean age of 31.8 ± 7.9 years. This finding is consistent with previous occupational health research indicating that younger healthcare workers often account for a substantial proportion of reported workplace injuries. This pattern may reflect their greater representation within the active healthcare workforce, frequent involvement in direct patient care activities, and increased exposure to clinical procedures more closely related to the nature and anatomical consequences of the injury rather than to workers' demographic or professional characteristics.

The present study provides an overview of the sociodemographic and occupational profile of healthcare workers who reported occupational injuries across multiple healthcare facilities in the Aseer Region. Injuries were more frequently reported among younger healthcare workers, with the largest proportion occurring among individuals aged 25–30 years and a mean age of 31.8 ± 7.9 years. This finding is consistent with previous occupational health research indicating that younger healthcare workers often account for a substantial

proportion of reported workplace injuries. This pattern may reflect their greater representation within the active healthcare workforce, frequent involvement in direct patient care activities, and increased exposure to clinical procedures during the early stages of professional practice.

However, younger age should not be interpreted as an independent risk factor based solely on the present findings because the study population consisted only of healthcare workers who reported injuries. Differences in injury occurrence according to age require comparison with the total workforce distribution and exposure time within each age category.

Female healthcare workers accounted for more than two-thirds of reported occupational injuries in this study. This finding likely reflects the workforce composition of participating healthcare facilities, particularly the high proportion of female nurses, rather than indicating a higher inherent susceptibility to occupational injuries among women. Nursing remains a predominantly female profession in many healthcare systems, and nurses represent one of the largest groups exposed to direct patient care activities and clinical occupational injury cases. This observation is likely influenced by the demographic composition of the healthcare workforce in the participating facilities. Nationality-specific occupational injury risk cannot be accurately determined without denominator data describing the total number of hazards. Therefore, Gender-related differences in reported injury frequency should be interpreted within the context of occupational distribution and job exposure patterns.

Saudi healthcare workers represented approximately two-thirds of reported occupational injury cases. This observation is likely influenced by the demographic composition of the healthcare workforce in the participating facilities. Nationality-specific occupational injury risk cannot be accurately determined without denominator data describing the total number of Saudi and non-Saudi healthcare workers and their corresponding working hours.

Most injured healthcare workers had diploma-level qualifications, which corresponds with the predominance of nurses in the study population. Educational qualification is closely associated with professional role, and therefore should not be considered an independent predictor of occupational injury without adjustment for occupation, workplace exposure, and job responsibilities.

Nurses represented the largest occupational group among injured healthcare workers, accounting for more than half of all reported cases. This finding is consistent with international evidence showing that nurses frequently represent a substantial proportion of occupational injury reports in healthcare settings.

The increased number of reported injuries among nurses may be explained by their continuous involvement in injuries among demographic and professional groups represents the characteristics of reported injury cases rather than occupational incidence rates.

The absence of workforce denominators prevents younger healthcare workers, females, and nurses. These observations support the need for targeted occupational safety interventions focusing on frontline healthcare workers, including continuous safety education, competency-based training, adequate staffing, engineering controls, and promotion of a strong workplace safety culture. Such strategies may contribute to reducing preventable occupational injuries and improving healthcare worker protection patient care activities, including medication administration, venipuncture, intravenous procedures, specimen handling, patient repositioning, and exposure to biological and ergonomic hazards.

Physicians constituted the second largest occupational group affected by reported injuries. Although physicians generally perform fewer bedside procedures than nurses, they may experience occupational exposures related to invasive procedures, diagnostic activities, surgical interventions, and management of infectious patients.

Importantly, the observed distribution of injuries among demographic and professional groups represents the characteristics of reported injury cases rather than occupational incidence rates. The absence of workforce denominators prevents estimation of relative risk among specific groups. Future studies incorporating the number of healthcare workers, working hours, clinical workload, and exposure frequency for each occupational category would provide more accurate estimates of occupational injury risk.

Overall, the findings highlight that reported occupational injuries in the Aseer Region occurred predominantly among younger healthcare workers, females, and nurses. These observations support the need for targeted occupational safety interventions focusing on frontline healthcare workers, including continuous safety education, competency-based training, adequate staffing, engineering controls, and promotion of a strong workplace safety culture. Such strategies may contribute to reducing preventable occupational injuries and improving healthcare worker protection.

Discussion the Second hypothesis:

The second null hypothesis proposed that there was no predominant pattern in the distribution of occupational injuries, affected body regions, injury severity, or initial healthcare utilization among healthcare workers in the Aseer Region, Saudi Arabia. The findings clearly demonstrated a non-random distribution of occupational injuries, characterized by a predominance of specific injury types, anatomical locations, severity categories, and patterns of healthcare utilization. Therefore, the second null hypothesis was rejected.

The present study revealed that wounds and lacerations were the most frequently reported occupational injuries, accounting for 73.0% of all reported cases. This finding indicates that direct mechanical trauma remains the

predominant occupational hazard among healthcare workers in the Aseer Region. The high frequency of wounds is consistent with the nature of healthcare activities, where workers are routinely exposed to sharp instruments, medical devices, and equipment during procedures such as injections, blood sampling, surgical interventions, wound care, and specimen handling. Similar patterns have been widely reported internationally, where injuries involving sharp objects and superficial trauma represent a major proportion of occupational injuries among healthcare personnel.

The predominance of wounds and lacerations may also reflect the high proportion of nurses and physicians in the study population, as these professional groups are frequently engaged in direct patient care activities involving invasive procedures and continuous handling of clinical instruments. Although many of these injuries are classified as minor, their occurrence represents an important occupational safety concern because some wounds may involve exposure to blood or body fluids and carry potential risks for transmission of occupational infections.

The anatomical distribution of injuries demonstrated that the upper extremities were the most commonly affected body region, accounting for 78.4% of reported cases. This finding is biologically plausible because healthcare workers rely extensively on their hands and arms to perform clinical procedures, making these areas particularly vulnerable to accidental injury. Similar findings have been reported in occupational health research, where the hands and fingers are consistently identified as the most frequently injured sites among healthcare workers due to their direct involvement in patient examination, medication preparation, injections, surgical procedures timely reporting, and effective initial management of occupational incidents within participating healthcare facilities. The availability of occupational health services and established reporting mechanisms may have contributed to rapid assessment, and handling of contaminated materials.

The predominance of upper extremity injuries highlights the importance of implementing targeted prevention strategies, including the use of safety-engineered devices, appropriate personal protective equipment, adherence to safe sharps disposal practices, and continuous competency-based training. Prevention programs should particularly emphasize practical skills related to handling sharp instruments and minimizing preventable exposure during routine clinical procedures.

Regarding injury severity, the current study demonstrated that most occupational injuries were classified as mild (69.6%), while moderate and severe injuries accounted for 26.3% and 4.1%, respectively. The predominance of mild injuries may indicate early recognition, timely reporting, and effective initial management of occupational incidents within participating healthcare facilities.

The availability of occupational health services and established reporting mechanisms may have contributed to rapid

assessment and intervention, thereby reducing the likelihood of complications and prolonged disability.

However, the presence of moderate and severe injuries, although less frequent, remains clinically important. These injuries may result in temporary work restrictions, prolonged treatment, psychological consequences, or potential long-term occupational impacts. Therefore, the relatively favorable severity profile should of injured healthcare workers received their initial evaluation through Occupational Health Clinics, whereas only 21.3% were managed initially in Emergency Departments. This pattern suggests the effective integration of occupational health services not reduce the emphasis on prevention, as even uncommon severe injuries can have substantial consequences for healthcare workers and healthcare systems.

Another important finding was that 75.2% of injured healthcare workers received their initial evaluation through Occupational Health Clinics, whereas only 21.3% were managed initially in Emergency Departments. This pattern suggests the effective integration of occupational health services within participating healthcare facilities. Dedicated occupational health clinics play a crucial role in workplace injury management by facilitating standardized assessment, exposure risk evaluation, appropriate post-exposure prophylaxis, injury documentation, and follow-up monitoring.

The high utilization of occupational health services may also contribute to improved surveillance and reporting accuracy. However, because the study relied on reported occupational injuries, the possibility of underreporting cannot be completely excluded. Some minor injuries may not be formally reported, particularly when workers perceive them as insignificant or when they do not result in immediate functional impairment. Strengthening safety culture and encouraging upper extremities, generally mild injury severity, and primary management through occupational health services. These findings emphasize the need for continued investment in preventive occupational health strategies, particularly those targeting timely reporting remain essential components of occupational injury prevention.

Overall, the findings demonstrate that occupational injuries among healthcare workers in the Aseer Region follow a distinct epidemiological pattern characterized by a predominance of wounds and lacerations, concentration of injuries in the upper extremities, generally mild injury severity, and primary management through occupational health services. These findings emphasize the need for continued investment in preventive occupational health strategies, particularly those targeting sharp injuries, hand protection, safe clinical practices, and workforce safety training.

Although most injuries resulted in favorable short-term outcomes, the continued occurrence of preventable occupational incidents indicates the need for sustained institutional commitment to injury prevention.

Future interventions should incorporate regular occupational risk assessments, enhanced safety training, improved availability of safety-engineered equipment, and continuous monitoring of injury trends to reduce occupational hazards and promote a safer healthcare work environment.

Discussion the Third Hypothesis:

The findings of the present study indicate that occupational injuries among healthcare workers in the Aseer Region were generally associated with favorable short-term outcomes, with limited impact on work continuity and long-term occupational functioning. The high proportion of injured workers who did not require sick leave (84.4%) and the high rate of complete recovery (97.8%) suggest that most reported injuries were of limited severity or were effectively managed through timely occupational health evaluation and appropriate clinical interventions.

The predominance of absent or short-duration work leave may be attributed to the nature of the reported injuries, as superficial wounds and lacerations represented the most common injury types in this study. Such injuries are frequently managed through immediate first aid measures, risk assessment, post-exposure evaluation when required, and follow-up care, allowing healthcare workers to resume their professional duties without prolonged interruption.

The low frequency of permanent disability and mortality observed in this study reflects the overall favorable prognosis of occupational injuries among healthcare workers. Nevertheless, the presence of severe outcomes, even when uncommon, remains an important occupational health concern. These events highlight the importance of continuous hazard identification, implementation of effective preventive strategies, strengthening occupational injury surveillance systems, and ensuring timely access to specialized occupational health services.

Despite the favorable outcomes observed, the findings should be interpreted with consideration of potential underestimation of the overall occupational burden. The absence of documented sick leave does not necessarily indicate the absence of health consequences, as some occupational injuries may lead to outcomes that are not routinely captured in administrative records, including psychological distress, reduced work performance, presenteeism, temporary work restrictions, or modifications of clinical duties.

Overall, the results demonstrate that most occupational injuries among healthcare workers in the Aseer Region resulted in minimal disruption to work activities and favorable recovery outcomes. However, maintaining comprehensive occupational health programs remains essential to reduce preventable injuries, improve early management of exposure incidents, and ensure the continued safety and well-being of healthcare workers.

Discussion the Fourth Hypothesis:

The findings of this study indicate that the distribution of occupational injuries varies across healthcare professional groups, suggesting that injury patterns may be influenced by differences in job responsibilities, clinical tasks, frequency of exposure, and work environments. However, these findings should be interpreted within the context of the study design, as they represent the distribution of reported injuries among affected healthcare workers rather than the actual risk of injury within each professional category.

Wounds were the predominant type of occupational injury across all professional groups, particularly among paramedical staff (79.7%), nurses (74.2%), and physicians (68.0%). This predominance may be explained by the routine handling of sharp instruments, medical equipment, and clinical materials during healthcare activities. The frequent use of needles, surgical instruments, and other sharp devices places healthcare workers at continuous risk of percutaneous injuries, which remain among the most commonly reported occupational hazards in healthcare settings.

Nurses accounted for the highest number of reported occupational injuries in this study. This finding is consistent with previous occupational health literature and may be attributed to the nature of nursing practice, including continuous direct patient contact, frequent invasive procedures, medication administration, blood sampling, and extended periods spent in clinical care areas. These factors increase opportunities for exposure to sharps injuries and other occupational hazards.

The greater occurrence of needlestick injuries and blood/body fluid exposures among nurses and physicians is consistent with their involvement in procedures associated with biological hazards, including injections, vascular access, blood collection, diagnostic interventions, and surgical procedures.

These findings emphasize the importance of maintaining effective sharps injury prevention programs, adherence to standard precautions, availability of safety-engineered devices, and continuous occupational health training targeted toward high-exposure professional groups.

The relatively higher number of reported occupational COVID-19 cases among physicians may reflect their increased involvement in diagnosing, treating, and managing patients with infectious diseases, particularly during periods of high community or hospital transmission. However, this observation should be interpreted cautiously, as infection risk is influenced by multiple factors, including clinical setting, duration of patient contact, infection prevention practices, use of personal protective equipment, and institutional policies.

Although differences in occupational injury patterns were observed among healthcare professions, these findings do not allow direct comparison of occupational risk between groups because the denominator data (the total number of workers in each professional category and their exposure time) were not available.

Future studies incorporating profession-specific incidence rates, exposure-adjusted measures, and multivariable analyses would provide a more accurate evaluation of occupational risk factors and identify groups requiring targeted preventive interventions.

Overall, the findings suggest that occupational injury profiles differ across healthcare professions, reflecting variations in clinical responsibilities and exposure characteristics. These results support the implementation of tailored occupational health strategies that address the specific hazards associated with different healthcare roles while strengthening injury surveillance and prevention programs.

Discussion the Fifth Hypothesis:

The fifth null hypothesis was partially rejected. The findings demonstrated that sociodemographic characteristics (age, Gender, and nationality) and healthcare profession were not significantly associated with the severity of reported occupational injuries among healthcare workers in the Aseer Region, Saudi Arabia ($P > 0.05$). In contrast, significant associations were identified between injury severity and both the type of occupational injury and the anatomical region affected ($P < 0.001$).

These findings suggest that the severity of occupational injuries is primarily determined by injury-related characteristics rather than by workers' demographic or professional attributes.

The absence of a significant association between age and injury severity indicates that chronological age alone may not be a major determinant of injury outcomes once an occupational injury has occurred.

Although younger healthcare workers may have increased exposure to certain hazards due to limited experience, older workers may also experience severe outcomes because of cumulative occupational exposure and involvement in complex clinical activities. Therefore, the relationship between age and injury severity may be influenced by other factors, such as work environment, exposure characteristics, injury mechanism, and access to timely medical management.

Similarly, Gender was not significantly associated with injury severity. This finding suggests that the clinical consequences of occupational injuries are more strongly related to the mechanism and nature of exposure rather than biological Gender. Although female healthcare workers represented a substantial proportion of showed no significant association with injury severity. This finding may indicate that occupational health practices, injury assessment procedures, and access to medical care are applied relatively consistently among Saudi and non-Saudi healthcare workers within the study injured workers in the present study, this pattern may largely reflect workforce composition, particularly the high representation of women in nursing and other patient-care roles, rather than an increased susceptibility to severe occupational injuries.

Nationality also showed no significant association with injury severity. This finding may indicate that occupational health practices, injury assessment procedures, and access to medical

care are applied relatively consistently among Saudi and non-Saudi healthcare workers within the study setting.

The implementation of standardized occupational health protocols and institutional safety procedures may contribute to reducing potential differences in injury outcomes related to nationality.

Healthcare profession was also not significantly associated with injury severity, despite nurses accounting for the largest proportion of reported occupational injuries. This distinction highlights the difference between injury frequency and injury severity. Nurses experience frequent occupational exposures due to their continuous patient contact, involvement in invasive procedures, medication administration, and specimen handling; however, once an injury occurs, its severity is more likely to be influenced by the injury mechanism, affected body region, and effectiveness of immediate management rather than by professional category itself.

In contrast, the significant association between injury type and severity is clinically plausible and consistent with occupational medicine principles. Injuries involving fractures, falls, musculoskeletal trauma, and occupational infectious exposures were more likely to result in moderate or severe outcomes compared with superficial wounds or minor sharps-related injuries. Such injuries may involve greater tissue damage, functional limitations, prolonged treatment requirements, or extended work restrictions, thereby contributing to increased severity.

The affected anatomical region was also strongly associated with injury severity. Injuries involving the head, neck, chest, abdomen, back, and respiratory system demonstrated greater severity compared with injuries affecting superficial areas or distal extremities. This finding can be explained by the potential involvement of vital organs, neurological structures, respiratory function, and overall physical capability.

Anatomical location is therefore an important predictor of clinical outcomes and recovery requirements following occupational injury.

Although needlestick injuries and superficial wounds were predominantly classified as mild in this study, their occupational significance should not be underestimated. Needlestick injuries may result in exposure to blood-borne pathogens, including hepatitis B virus, hepatitis C virus, and human immunodeficiency virus (HIV), in addition to causing considerable psychological stress during post-exposure evaluation and follow-up. Consequently, severity classification based solely on physical impairment may not fully capture the broader occupational and psychological burden associated with biological exposures.

From an occupational health perspective, these findings emphasize the importance of developing prevention strategies based on injury mechanisms and severity predictors rather than focusing solely on demographic or professional characteristics. Preventive measures should include strengthening sharps injury prevention

programs, improving fall prevention strategies, promoting safe patient handling practices, maintaining effective infection prevention measures, and ensuring rapid post-exposure evaluation and rehabilitation services for high-risk injuries.

Overall, the findings indicate that occupational injury severity among healthcare workers is primarily influenced by the characteristics of the injury itself, particularly the injury type and anatomical location, rather than by sociodemographic factors or professional category. These results provide important evidence for guiding risk-based occupational health interventions aimed at reducing severe injuries, minimizing functional impairment, and improving occupational safety among healthcare workers.

Discussion the Sixth Hypothesis:

Interpretation of the Regression Findings:

The findings of the multivariable analysis indicate that **the clinical characteristics of the injury are substantially more important than the personal characteristics of the injured worker in determining injury severity.** This distinction is important because demographic factors such as age and Gender may influence exposure opportunities, whereas the ultimate severity of an injury depends primarily on the mechanism of injury, the energy transferred during the incident, and the anatomical structures involved. Consequently, occupational health programs should focus not only on identifying high-risk worker groups but also on preventing high-severity injury mechanisms.

The relatively high adjusted odds ratios observed for **fractures, occupational infectious diseases, COVID-19 infection, and injuries involving the respiratory system or central body regions** highlight the need for risk-based prioritization within occupational health services. While superficial wounds constituted the majority of reported injuries, they generally resulted in mild outcomes and complete recovery. In contrast, less frequent injuries contributed disproportionately to the burden of moderate and severe cases. This finding illustrates an important epidemiological principle whereby the most common injuries are not necessarily those responsible for the greatest clinical burden.

The persistence of significant associations after multivariable adjustment further suggests that these relationships were **independent of differences in age, Gender, nationality, and professional category.** Therefore, interventions designed to reduce severe occupational injuries should prioritize hazards associated with specific injury mechanisms rather than demographic characteristics alone.

- Multivariable ordinal logistic regression analysis identified injury-related characteristics as the strongest independent predictors of occupational injury severity. After adjustment for potential confounding variables, injury type and affected body region remained significantly associated with increased injury severity, whereas age, gender, nationality, and healthcare profession were not independent predictors. Specifically, fractures, occupational infectious diseases, COVID-19

infection, fall-related injuries, ligament injuries, and injuries involving the respiratory system, chest, abdomen, back, head, neck, and lower limbs were associated with significantly greater odds of moderate-to-severe injury.

- These findings indicate that injury severity is driven primarily by the nature and anatomical location of the injury rather than by the demographic or occupational characteristics of healthcare workers.
- Overall, this study demonstrates that occupational injuries among healthcare workers in the Aseer Region were mainly characterized by superficial wounds involving the upper extremities, particularly among nurses and other healthcare professionals with frequent patient-care responsibilities. Although most injuries resulted in favorable recovery and limited occupational disruption, the occurrence of severe injuries, permanent disability, and fatalities highlights the ongoing need to strengthen occupational safety programs, enhance infection prevention and control practices, promote adherence to standard precautions, and implement targeted prevention strategies addressing high-risk injury mechanisms.

- Collectively, these findings provide robust epidemiological and analytical evidence to support occupational health planning and policy development in Saudi Arabia. By identifying the independent predictors of injury severity, the study offers practical guidance for prioritizing preventive interventions, strengthening occupational injury surveillance systems, improving risk assessment, and optimizing resource allocation to protect healthcare workers and promote safer healthcare workplaces.

Practical Implications for Occupational Health:

The results have several practical implications for healthcare administrators and occupational health policymakers. First, injury surveillance systems should classify occupational injuries not only according to frequency but also according to severity and potential long-term consequences. Such an approach would facilitate the identification of injury mechanisms requiring priority preventive interventions.

Second, healthcare facilities should strengthen preventive strategies targeting injuries associated with the greatest severity. These include implementing comprehensive fall-prevention programs, improving safe patient-handling practices through mechanical lifting devices and ergonomic interventions, reinforcing infection prevention and control measures, and ensuring rapid management of occupational infectious disease exposures. Continuous education and simulation-based safety training may further reduce the occurrence of high-severity occupational injuries.

Third, the findings support strengthening occupational health surveillance systems capable of identifying injury trends, monitoring injury severity, and evaluating the effectiveness of preventive interventions over time. Integrating surveillance data with hospital quality improvement programs may facilitate evidence-based decision-making and more efficient support the continued implementation of national occupational health strategies aimed at protecting healthcare workers. allocation of occupational health resources.

Implications for Healthcare Policy:

At the policy level, these findings support the continued implementation of national occupational health strategies aimed at protecting healthcare workers. The results are consistent with recommendations issued by the **World Health Organization (WHO)** and the **International Labour Organization (ILO)** advocating comprehensive occupational safety programs that combine hazard identification, engineering controls, administrative measures, personal protective equipment, and continuous surveillance.

Given the increasing complexity of healthcare delivery and the expanding range of occupational hazards, healthcare institutions should adopt integrated occupational risk management frameworks that address biological, mechanical, ergonomic, and environmental hazards simultaneously. establish temporal relationships between occupational exposures and injury severity. Studies incorporating detailed information on workload, staffing levels, years of professional experience, shift work, Such multidisciplinary approaches are likely to produce greater reductions in occupational injury severity than interventions focusing on a single hazard category.

Future Research Directions:

Future research should employ prospective longitudinal designs to establish temporal relationships between occupational exposures and injury severity. Studies incorporating detailed information on workload, staffing levels, years of professional experience, shift work, fatigue, safety climate, compliance with infection prevention measures, and use of personal protective equipment would provide a more comprehensive understanding of factors contributing to severe occupational injuries.

Additionally, multicenter national studies involving healthcare facilities across different regions of Saudi Arabia would improve the generalizability of findings and permit estimation of profession-specific injury incidence rates using appropriate denominator data. Future investigations should also evaluate the economic burden of occupational injuries, including healthcare costs, productivity losses, compensation expenditures, and long-term disability, to support cost-effective occupational health interventions.

Accordingly, **the sixth null hypothesis was partially rejected**, as several injury-related variables remained statistically significant independent predictors of occupational injury severity following multivariable adjustment, whereas sociodemographic and occupational characteristics did not.

Summary of Study Findings:

- The present study investigated the epidemiological characteristics, patterns, severity, and outcomes of reported occupational injuries among healthcare workers in the Aseer Region, Saudi Arabia, based on 806 documented occupational injury cases.
- The findings demonstrated that occupational injuries were predominantly reported among younger healthcare workers, with a mean age of 31.8 ± 7.9 years. The highest proportion of injured workers was observed among those aged 25–30 years (37.3%). Females represented the majority of reported cases (69.1%), while Saudi nationals accounted for 67.9% of injured workers. Most affected healthcare workers had diploma-level qualifications (71.6%), and nurses represented the largest occupational group involved (57.7%), followed by physicians (22.1%).
- Regarding injury characteristics, wounds and lacerations were the most frequently reported occupational injuries, accounting for 73.0% of cases. The upper extremities were the most commonly affected anatomical region (78.4%). Most injuries were classified as mild (69.6%), whereas severe injuries represented a small proportion of cases (4.1%). The majority of injured workers initially received care through Occupational Health Clinics (75.2%), indicating the important role of occupational health services in the initial management and follow-up of workplace injuries.
- The study revealed generally favorable occupational outcomes following injury. Most healthcare workers (84.4%) did not require work absence, and 97.8% achieved complete recovery and returned to their previous occupational roles without permanent impairment. Partial disability (1.6%), permanent total disability (0.1%), and mortality (0.5%) were rare, demonstrating that most reported occupational injuries had limited long-term occupational consequences.
- The distribution of injury patterns differed across healthcare professional groups. Wounds were the predominant injury type among all occupational categories. Nurses accounted for the highest proportion of reported injuries and showed the greatest frequency of wounds, needlestick injuries, blood and body fluid exposures, and infectious disease-related exposures. Physicians contributed substantially to reported COVID-19-related occupational infections and wound injuries. These findings reflect differences in clinical responsibilities and exposure opportunities; however, comparisons of occupational risk between professions should be interpreted cautiously because profession-specific incidence rates could not be calculated.
- Inferential analysis demonstrated that injury severity was not significantly associated with age, Gender, nationality, or healthcare profession ($P > 0.05$). In contrast, significant associations were identified between injury severity and both

the type of occupational injury and the affected anatomical region ($P < 0.001$). Moderate and severe injuries were more frequently observed among fractures, fall-related injuries, ligament injuries, occupational infectious diseases, and injuries involving major anatomical regions such as the head, neck, chest, abdomen, back, respiratory system, and lower limbs. In comparison, wounds and needlestick injuries were predominantly classified as mild injuries.

- Overall, this study demonstrates that occupational injuries among healthcare workers in the Aseer Region were mainly characterized by superficial wounds involving the upper extremities, particularly among nurses and other healthcare professionals with frequent patient-care responsibilities. Although most injuries resulted in favorable recovery and limited occupational disruption, the occurrence of severe injuries, permanent disability, and fatalities highlights the ongoing need to strengthen occupational safety programs, enhance infection prevention and control practices, promote adherence to standard precautions, and implement targeted prevention strategies addressing high-risk injury mechanisms.
- The findings provide valuable evidence to support occupational health planning and policy development and contribute to improving workplace safety and healthcare worker protection in Saudi Arabia.
- The multivariable ordinal logistic regression analysis demonstrated that **injury type and affected body region were the only independent predictors of occupational injury severity**, whereas age, gender, nationality, and healthcare profession were not independently associated with injury severity after adjustment for potential confounding variables. These findings indicate that the severity of occupational injuries among healthcare workers is determined predominantly by the characteristics of the injury itself rather than by workers' demographic or occupational profiles.

15. Strengths of the Study:

- This study has several important strengths that enhance the value and applicability of its findings. First, the study included a relatively large number of documented occupational injury cases ($N = 806$ healthcare workers), allowing a comprehensive evaluation of occupational injury patterns and outcomes within the Aseer Region.
- Second, the study provided a multidimensional assessment of occupational injuries by examining injury characteristics, including injury type, affected anatomical region, severity, healthcare utilization, work absence, recovery status, disability, and return-to-work outcomes. This comprehensive approach allowed evaluation of both the clinical and occupational consequences of workplace injuries.

- Third, the inclusion of multiple healthcare professional categories, including nurses, physicians, paramedical staff, dental professionals, administrative personnel, and other healthcare workers, enabled assessment of differences in injury patterns across occupational groups with varying exposure profiles.
- Fourth, the use of appropriate statistical methods, including descriptive analyses, Pearson's chi-square test, Fisher's exact test, and regression-based approaches where applicable, strengthened the evaluation of associations between injury characteristics and potential predictors.
- An additional strength of this study is its focus on healthcare workers, a population exposed to diverse occupational hazards, including biological, mechanical, physical, and ergonomic risks. Furthermore, the study contributes valuable regional epidemiological evidence from the Aseer Region, Saudi Arabia, where published data regarding occupational injury patterns, severity, and outcomes remain limited.
- Unlike studies focusing solely on injury occurrence, this research evaluated broader occupational consequences, including work disruption, recovery outcomes, disability, and return-to-work status. The identification of injury characteristics associated with greater severity also provides useful evidence for developing targeted prevention strategies.
- Finally, the use of documented occupational injury records from healthcare facilities provides real-world evidence regarding reported workplace injuries and supports evidence-based planning of occupational health services.
- Overall, the strengths of this study include its relatively large sample size, comprehensive evaluation of occupational injury characteristics and outcomes, inclusion of diverse healthcare professional groups, rigorous analytical approach, and contribution of region-specific evidence from Saudi Arabia. These findings can support occupational health policy development and targeted interventions aimed at improving healthcare worker safety.

Limitations of the Study:

- This study has several limitations that should be considered when interpreting the findings. First, the retrospective design relied on routinely reported occupational injury records; therefore, the accuracy and completeness of the findings were dependent on the quality of available documentation. Missing information, incomplete records, or variations in reporting practices could not be independently verified.
- Second, the study included only officially reported occupational injuries. Consequently, minor injuries, near-miss events, and incidents that were not reported through formal occupational health systems may have been missed,

potentially resulting in underestimation of the actual burden of occupational injuries.

- Third, the absence of denominator data for each healthcare professional category limited the ability to calculate profession-specific injury incidence rates or compare the relative risk of occupational injuries between nurses, physicians, paramedical staff, and other occupational groups.
- Fourth, because the study included only injured healthcare workers, a non-injured comparison group was not available. Therefore, potential risk factors associated with the occurrence of occupational injuries could not be fully evaluated.
- Additionally, detailed information regarding workplace-related factors, including workload, staffing levels, years of professional experience, training history, compliance with safety practices, availability and, which may vary according to institutional documentation procedures. The study also focused primarily on immediate occupational outcomes and did not assess long-term consequences such as psychological effects, chronic pain, reduced work utilization of personal protective equipment, and specific environmental hazards, was not available in the existing records. These factors may influence both injury occurrence and severity.
- Furthermore, some variables, including injury severity classification and occupational outcomes, were based on recorded clinical and occupational assessments, which may vary according to institutional documentation procedures. The study also focused primarily on immediate occupational outcomes and did not assess long-term consequences such as psychological effects, chronic pain, reduced work performance, or quality of life following injury.
- Finally, some injury categories had relatively small numbers of cases, limiting the statistical power of subgroup comparisons. Residual confounding due to unmeasured factors, such as clinical experience, specific job duties, and exposure frequency, cannot be completely excluded.
- Despite these limitations, the study provides valuable real-world evidence regarding reported occupational injuries among healthcare workers and contributes important regional data to support occupational health planning in Saudi Arabia.

Eligibility Criteria:

Inclusion Criteria:

Healthcare workers were eligible for inclusion if they met all of the following criteria:

- Were officially employed in one of the participating Ministry of Health hospitals in the Aseer Region during the study period.

- Had a documented occupational injury or occupational disease reported through the hospital Occupational Health or Employee Health reporting system.
- Had complete records containing essential study variables, including sociodemographic characteristics, healthcare profession, injury type, affected body region, injury severity, and occupational outcome.
- Sustained the occupational injury within the predefined study period.

Exclusion Criteria:

Records were excluded if they met any of the following criteria:

- Duplicate reports referring to the same occupational injury event.
- Records with incomplete or missing essential variables required for analysis.
- Injuries not related to occupational exposure or workplace activities.
- Reports involving students, interns, trainees, volunteers, visitors, or contractors who were not officially employed by the participating hospitals.
- Records containing inconsistent or unverifiable information that could not be confirmed from available databases.
- Sample Size and Statistical Power
- Because this study was designed as a multicenter retrospective observational study, all eligible occupational injury cases reported during the study period were included. The final sample consisted of 806 healthcare workers.
- A formal sample size calculation was not performed because the study adopted a census approach, including all available eligible cases rather than selecting a sample from the target population. This approach maximized the use of available data and provided comprehensive information regarding reported occupational injuries within the study setting.

Sample Size and Statistical Power:

- This multicenter retrospective observational study adopted a census approach by including all eligible occupational injury cases reported during the predefined study period. A total of 806 healthcare workers met the study eligibility criteria and were included in the analysis.
- A formal sample size calculation was not performed because the study did not involve sampling from a target population. Instead, all available eligible cases were analyzed, maximizing the use of existing data and providing comprehensive information on reported occupational injuries within the participating hospitals.

Conclusion:

- This study provides a comprehensive assessment of the epidemiological characteristics, patterns, severity, and outcomes of reported occupational injuries among healthcare workers in the Aseer Region, Saudi Arabia. Occupational injuries were predominantly characterized by wounds and lacerations involving the upper extremities, particularly among nurses and other healthcare professionals with frequent direct patient contact. Although most injuries were mild and resulted in complete recovery without prolonged work absence, severe injuries, permanent disability, and fatalities, although infrequent, remain important occupational health concerns.
- The study demonstrated that injury severity was primarily associated with injury-specific characteristics, particularly the type of occupational injury and the affected anatomical region, whereas sociodemographic characteristics and healthcare profession were not significantly associated with injury severity. These findings suggest that prevention strategies should prioritize high-risk injury mechanisms and anatomical sites rather than focusing solely on specific worker groups.
- Overall, the findings provide valuable regional evidence to support occupational health policy development and strengthen workplace safety initiatives in Saudi Arabia. Continued investment in occupational safety programs, infection prevention and control, safe patient handling practices, sharps injury prevention, staff training, and comprehensive occupational injury surveillance systems is essential to reduce preventable injuries and enhance the health, safety, and well-being of healthcare workers.

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