

Occupational Injuries and Medical Waste Handling Practices Among Hospital Cleaning Workers In Shendi Locality, Sudan: A Cross-Sectional Analytical Study

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Abstract

Background

Hospital cleaners involved in healthcare waste management are vulnerable to occupational injuries; however, data from Sudan are scarce. This study investigated the prevalence and determinants of occupational injuries among hospital cleaners in Shendi Locality, Sudan.

Methods

A hospital-based analytical cross-sectional study was conducted among 143 hospital cleaners working in healthcare facilities in Shendi Locality, Sudan. All eligible workers were included using a census approach. Data were collected using a structured interviewer-administered questionnaire and analyzed using descriptive statistics, chi-square tests and binary logistic regression. The associations were reported as adjusted odds ratios (AORs) with 95% confidence intervals (CIs); $p < 0.05$ was considered statistically significant.

Results

Among the 143 participants, 47.6% (95% CI: 39.4%–55.8%) reported experiencing at least one occupational injury within the preceding 12 months. A statistically significant variation in occupational injuries was observed across hospitals ($p < 0.001$). In multivariable logistic regression analysis, increasing age (AOR = 1.746, 95% CI: 1.001–3.046) and use of personal protective equipment (PPE) (AOR = 3.254, 95% CI: 1.264–8.377) was positively associated with reported occupational injury, potentially reflecting differences in occupational exposure intensity among workers. Conversely, longer working hours (AOR = 0.415, 95% CI: 0.177–0.972) and undergoing pre-employment medical examination (AOR = 0.186, 95% CI: 0.052–0.666) were associated with lower odds of injury.

Conclusion

Occupational injuries were highly prevalent among hospital cleaners in Shendi locality. Key occupational and institutional factors were associated with injury occurrence. Occupational health systems and waste management practices should be strengthened to improve safety.

Introduction:

Healthcare waste management is an essential component of infection prevention, occupational safety, and quality healthcare delivery, particularly because healthcare waste may expose workers to infectious materials, bloodborne pathogens, sharps injuries, chemical hazards, and other preventable occupational risks [1, 2, 3]. The World Health Organization emphasizes that safe management of wastes from healthcare activities is necessary to protect healthcare workers, patients, communities, and the environment from avoidable health hazards [2, 3]. Within healthcare facilities, cleaning workers and waste handlers are among the occupational groups most directly involved in collecting, segregating, transporting, and disposing of medical waste, placing them at continuous risk of exposure when infection prevention and control measures are weak or inconsistently applied [1, 4, 5, 6].

Hospital cleaning workers often perform essential but under-recognized duties that support infection prevention and environmental hygiene in healthcare settings [6, 7]. Evidence from Ethiopia and Ghana shows that healthcare cleaners and waste handlers may experience gaps in knowledge, access to personal protective equipment, waste segregation practice, training, supervision, and adherence to infection prevention procedures [4, 5, 6, 7, 8, 9]. Comparable studies in healthcare settings in sub-Saharan Africa have shown that occupational hazards among healthcare workers include needle-stick injuries, contact with blood and body fluids, chemical exposure, stress, and musculoskeletal injuries, with patterns of risk influenced by the work environment, safety culture, workload, and availability of protective resources [10, 11]. These findings imply that the safety of hospital cleaning workers is not only a matter of individual behavior but also of institutional systems for training, supervision, waste management, reporting, and occupational health protection [12, 13].

Medical waste management is still a serious public health problem, and sharp, contaminated materials, and unsafe disposal practices are at risk to the workers of blood-borne infections and other health hazards [6, 14]. A global systematic review and meta-analysis found a high burden of percutaneous injuries among healthcare workers and pointed out the importance of continued prevention efforts for needle-stick and sharp-related injuries [14]. Studies in Ethiopia have reported occupational needle-stick and sharps injuries among hospital healthcare workers and associated factors such as professional category, work experience, training, and safety practice [15]. Data also indicated that healthcare workers in Uganda and Ethiopia were not always adhering to standard precautions and infection prevention practices underscoring the importance of facility level interventions to improve safety behavior and reduce risks of exposure [11].

Medical care waste management and occupational injury are poorly documented in Sudan; however, the available data indicate serious safety problems in hospital settings [12, 16]. For example, injuries among medical waste workers have been reported in hospital settings in Khartoum State indicating that this occupational group is directly at risk in the handling of waste [17]. More recent evidence from Sudan has also emphasized the prevention of needle-stick injuries and sharps-related risks among healthcare workers, indicating that occupational exposure is a relevant concern in the Sudanese healthcare system [18]. Furthermore, a Sudanese case study on healthcare waste management underlined the need to improve waste handling systems, institutional accountability and environmental health practices within healthcare facilities [16]. These findings support the need for more localized evidence from different Sudanese settings, particularly among cleaning workers who are regularly involved in medical waste handling but are less often studied than clinical healthcare workers [17, 19, 20].

Shendi locality in River Nile State represents an important healthcare setting for studying occupational injuries and medical waste handling practices among hospital cleaning workers [20, 21]. The River Nile State Ministry of Health annual health facilities report provides local health facility information relevant to service delivery and health system organization in Shendi [20]. In addition, the designation of Al-Mak Nimer Hospital under the National Cardiac Surgery Center Initiative indicates the presence of specialized hospital services in the locality, which may increase the complexity and volume of healthcare activities requiring effective waste management and occupational safety measures [21]. In such settings, safe medical waste handling is particularly important because the expansion or specialization of healthcare services may increase workers' contact with contaminated materials, sharps, and other hazardous waste streams if waste management systems are not adequately implemented [1, 2, 3, 21]. Despite the growing body of literature on infection prevention, healthcare waste management, and occupational injuries in African healthcare settings, there remains a need for analytical studies focusing specifically on hospital cleaning workers in Sudanese localities outside major urban centers [5, 6, 12, 17]. Much of the available evidence focuses on healthcare workers in general or on clinical staff, while cleaning workers and waste handlers may receive less attention despite their direct role in waste collection, transport, and disposal [4, 5, 6]. Furthermore, local data are needed to identify the relationship between medical waste handling practices and occupational injuries within specific health system contexts, because risk factors may differ according to facility type, training opportunities, supervision, availability of protective equipment, and waste management infrastructure [13]. Cross-sectional analytical designs are appropriate for estimating the burden of occupational injuries and examining associations between exposure variables and outcomes in defined populations, if sampling, measurement, and statistical analysis are carefully planned [22]. Therefore, this study aimed to assess occupational injuries and medical waste handling practices among hospital cleaning workers in Shendi locality, Sudan [20, 21, 22]. In particular, the study aimed at finding out the prevalence of occupational injuries, describing medical waste management practices and identifying factors associated with occupational injuries among hospital cleaners [4, 5, 6, 17]. This study may provide local evidence that could help to inform infection prevention and control programs, occupational safety interventions, training strategies and healthcare waste management policies for hospitals in Shendi locality and similar settings in Sudan [1, 2, 3, 12, 13].

Methods

Study Design, Population, and Study

Study design

A hospital-based analytical cross-sectional study was conducted to assess occupational injuries and associated factors related to medical waste handling among cleaners' workers at hospitals of Shendi Locality, River Nile State, Sudan.

Study area

The study was carried out in Shendi Locality, River Nile State, Sudan. The locality is a main reference point for specialized medical services in the northern part of the country as it has Shendi Educational Hospital and Al-Mak Nimer Hospital [20]. The latter is equipped for advanced procedures such as cardiac surgery, while Shendi Hospital has a kidney center and a cancer research unit [21]. The presence of these specialized units, which generate hazardous medical waste, is likely to increase occupational risks to cleaners. The main aim of this study was to assess the occupational injuries and associated factors related to the handling of medical waste among cleaner workers at hospitals in Shendi Locality.

Study population

The study population comprised hospital cleaners involved in cleaning activities and/or in handling, collecting, transporting, or disposing of medical waste within the selected hospitals. Hospital cleaners are considered an important occupational group because they may have direct contact with waste bags, sharps, contaminated materials, and other healthcare-related hazards in the course of their work [1] [4] [5]. The study focused on workers who were available during data collection and agreed to participate.

Sample size

All cleaners working in hospitals in Shendi locality were the source population. A total number of hospital cleaners working in all hospitals of Shendi locality during the study period was 143, a census approach was employed and all eligible workers were included in the study.

Data collection tool:

Structured questionnaire given by the interviewer was used to gather data. After examining the relevant literature and adapting its contents to suit the needs of healthcare cleaners, the questionnaire was created [8] [5]. Data were collected using a structured questionnaire developed to assess socio-demographic characteristics, work-related factors, training, medical waste handling practices, use of personal protective equipment, supervision, medical examinations, vaccination, and occupational injuries. The questionnaire included items on hospital name, age, gender, educational level, daily working hours, training on safe medical waste handling, waste segregation, waste bag condition, overfilling, transportation, tying of bags, PPE use, disposal of used masks and gloves, unsafe hand compression of waste, needle-stick injury, cut injury, supervision, pre-employment medical examination, periodic medical examination, and vaccination status. These domains are consistent with previous healthcare waste management and occupational safety studies that assessed training, PPE, waste segregation, supervision, vaccination, and injury outcomes among healthcare workers and waste handlers. There were two alternative answers (yes or no) for each question. Previous research in the nation has demonstrated the validity and reliability of the questionnaire utilized in this study [8] [9].

Measurement of variables: The dependent variable was occupational injury. A combined variable named "any occupational injury" was created from two questionnaire items: history of needle-stick injury and history of cut injury during work. Workers who reported either needle-stick injury or cut injury were

classified as having an occupational injury, while workers who reported neither were classified as having no occupational injury. Independent variables included age group, gender, educational level, working hours, training status, place and duration of training, waste segregation, damaged bags, overfilled bags, ease of carrying waste bags, secure tying of bags, PPE use, unsafe hand placement inside waste bags, supervision, pre-employment medical examination, periodic medical examination, and vaccination status [4] [8]

Data analysis

Data was coded, entered, cleaned, and analyzed using SPSS version 23. Descriptive statistics were used to summarize categorical variables as frequencies and percentages. Chi-square tests were used to examine associations between categorical independent variables and occupational injury. Fisher's exact test was used when expected cell counts were small. Binary logistic regression was conducted to identify independent predictors of occupational injury, and adjusted odds ratios with 95% confidence intervals were reported. Variables were selected for the final regression model based on statistical relevance in bivariate analysis and theoretical importance from previous occupational health and healthcare waste studies. Statistical significance was considered at $p < 0.05$ [4] [19].

Ethical approval: The principles of the Helsinki Declaration were followed in the conduct of this investigation. The University of Shendi Ethical Review Board (IRB) granted ethical clearance. Prior to data collection, each health institution to be surveyed and the health authority received an official letter of support from the University of Shendi. The chief of each medical facility gave permission to carry out the study. Following an explanation of the study's goals, risks, and advantages, To maintain secrecy, all personal identifiers were eliminated. Additionally, only the lead investigator's password-protected computer was used to enter and evaluate the data.

Results

Table 1 Shows the socio-demographic characteristics of the 143 cleaning workers included in the study. Most of the participants were from Elmaknemir Hospital, 35 workers (24.5%) followed by Shendi Educational Hospital, 34 workers (23.8%), and Almisktab Hospital, 20 workers (14.0%). Smaller proportions were from Hagar alasaal, 4 workers (2.8%), and Alshagalwa, 5 workers (3.5%). In terms of the age distribution, most cleaning workers were older adults. The largest age group was workers aged more than 45 years, 55 workers (38.5%), followed by those aged 36–45 years, 50 workers (35.0%). Workers aged 26–35 years represented 33 participants (23.1%), while only 5 workers (3.5%) were aged 15–25 years. This indicates that the cleaning workforce was dominated by the middle age and elderly workers. Most of the study participants were females, 119 workers (83.2%) while males were only 24 workers (16.8%). This shows that cleaning work in the studied hospitals was mainly done by female workers. Regarding educational level, most of the participants had basic education, 61 workers (42.7%) followed by Khalwa/Quranic school education, 55 workers (38.5%). Secondary education was reported by 26 workers (18.2%) while only one participant (0.7%) was a graduate. This indicates that most cleaning workers had little to moderate levels of formal education. Regarding daily working hours, most employees (86.7%) participated in 8 hours of work each day. A few workers participated in 12 hours of work each day, 8 workers (5.6%) while 11 workers (7.7%) participated in 16 hours of work each day. The findings in general suggest that most cleaning workers followed an 8-hour work schedule.

Among the 143 cleaning workers, 68 workers reported occupational injury, while 75 reported no injury. There was a statistically significant association between hospital name and occupational injury, $\chi^2 = 28.216$, $p < 0.001$. The highest injury proportions were reported among workers from Tumer Therapy Center and Alshagalwa where all workers reported injury. On the other hand, the Military hospital showed the lowest injury proportion, with 13.3% reporting injury. There was no statistically significant association between occupational injury and age group, gender, educational level or working hours per day.

Table 3 Percentages for Injury Yes, and "Injury No are row percentages. Pearson's chi-square test was used except for place of training, where Fisher's exact test is preferable because 50% of cells had expected counts less than 5.

Among the 143 cleaning workers, 106 workers (74.1%) reported receiving training on safe medical waste handling, while 37 workers (25.9%) had not received training. Occupational injury was reported by 51.9% of trained workers compared with 35.1% of untrained workers; however, this association was not statistically significant, $\chi^2 = 3.086$, $p = 0.079$.

Among trained workers, most received training inside the hospital, 99 workers (93.4%), while only 7 workers (6.6%) received training outside the hospital. The place of training was not significantly associated with occupational injury, Fisher's exact $p = 0.258$.

Training duration showed a statistically significant association with occupational injury, $\chi^2 = 7.114$, $p = 0.008$. Workers who received training for more than one day reported a higher injury proportion, 68.2%, compared with 41.9% among those who received one-day training. Training of newly recruited cleaning workers was not significantly associated with occupational injury, $\chi^2 = 2.002$, $p = 0.367$.

Table 4 Percentages for Injury Yes and Injury No are row percentages. Pearson's chi-square test was used. For variables with small, expected cell counts, such as secure tying of waste bags and PPE use, results should be interpreted cautiously.

Among the assessed medical waste handling practices, only the ability to easily carry and move waste bags was significantly associated with occupational injury, $\chi^2 = 8.579$, $p = 0.014$. Workers who reported that they could easily carry and move waste bags had a higher reported injury proportion, 56.4%, compared with workers who reported difficulty carrying waste bags, 30.0%, and those who reported that they could only sometimes carry bags easily, 30.8%. No statistically significant associations were found between occupational injury and medical waste segregation, bag/container damage, overfilling of waste bags, secure tying of waste bags, PPE use, or putting hands inside medical waste bags. Although workers who did not use PPE had a higher injury proportion, 53.4%, than those who used PPE, 42.7%, this association was not statistically significant, $\chi^2 = 2.027$, $p = 0.363$.

Among the occupational health protection measures, only pre-employment medical examination was significantly associated with occupational injury, $\chi^2 = 13.857$, $p < 0.001$). Workers who had undergone medical examination before employment reported a higher injury proportion, 66.1%, compared with 34.5% among those who had not been examined before employment. Follow-up and supervision were reported by 133 workers (93.0%), but supervision was not significantly associated with occupational injury (Fisher's exact test, $p = 0.748$). Periodic medical examination was also not significantly associated with occupational injury ($\chi^2 = 2.749$, $p = 0.097$), although injury was more common among workers who reported periodic examinations. Vaccination against infectious diseases was reported by 114 workers (79.7%) and was not significantly associated with occupational injury, $\chi^2 = 0.108$, $p = 0.742$.

The significant association between pre-employment medical examination and occupational injury should be interpreted carefully. Because this is a cross-sectional study, the findings do not prove that medical examinations cause injury. It may reflect that workers in higher-risk hospitals or high-exposure jobs were more likely to receive medical examination, or that workers with previous injuries were more likely to be medically assessed.

Note: AOR = adjusted odds ratio; CI = confidence interval. The dependent variable was occupational injury, coded as No = 0 and Yes = 1. The model included age, gender, working hours, training, training period, ability to carry and move waste bags, PPE use, periodic medical examination and pre-employment medical examination. These variables are expressed as questionnaire items on demographic characteristics, training, PPE, medical examination and waste handling practices.

A binary logistic regression was performed to determine the factors associated with occupational injury among cleaning workers. The model was statistically significant, $\chi^2 = 30.396$, $df = 9$, $p < 0.001$, indicating that the predictors as a set, included in the model, significantly improved the prediction of occupational injury. The Nagelkerke R² value suggested that the model explained about 33.3% of the variance in occupational injury and that the overall classification accuracy was 73.6%. The Hosmer–Lemeshow test was nonsignificant, $\chi^2 = 7.213$, $p = 0.514$, indicating that the model had acceptable fit. After adjustment, age group was borderline significantly associated with occupational injury, AOR = 1.746, 95% CI: 1.001–3.046, $p = 0.050$. Working hours per day were significantly associated with lower odds of occupational injury, AOR = 0.415, 95% CI: 0.177–0.972, $p = 0.043$. Use of personal protective equipment was significantly associated with occupational injury, AOR = 3.254, 95% CI: 1.264–8.377, $p = 0.014$. Pre-employment medical examination was significantly associated with lower odds of occupational injury, AOR = 0.186, 95% CI: 0.052–0.666, $p = 0.010$. Training status, duration of training, ability to carry and move waste bags, gender, and periodic medical examination were not statistically significant predictors of occupational injury in the adjusted model.

Discussion

The current study found a 47.6% (95% CI: 39.4%–55.8%) prevalence of occupational injuries among hospital cleaners handling healthcare waste, which indicates an important occupational health burden among waste handlers in Shendi locality. The prevalence of occupational injuries in the current study was higher than the 37% needle-stick injury rate among medical waste workers in Khartoum State hospitals [18], and slightly higher than the pooled prevalence of percutaneous injuries of 36.4% (95% CI: 32.9%–40.0%) reported in a comprehensive meta-analysis [14]. The present finding is close to a recent study from Eastern Sudan reporting a prevalence of 50.5% of needle-stick injuries among healthcare workers during the recent crisis [23]. Similar occupational exposure rates have been reported in several African countries where waste handlers and environmental service workers are often exposed to hazardous waste and contaminated sharps [15][24]. The findings imply that workers engaged in healthcare waste management in low-resource settings are particularly vulnerable to occupational injuries because of inadequate infection prevention measures, resource constraints and challenging working conditions [14]. Differences across studies could be explained by differences in workload, staffing levels, safety infrastructure and waste management practices.

The present study found significant variation in the prevalence of occupational injury between hospitals, which may suggest that institutional and organizational factors are more important in determining injury risk than individual worker characteristics. International standards for health care facilities to prevent occupational exposure to healthcare waste recommend the establishment of standardized procedures for segregation, collection, transportation, treatment and disposal of healthcare waste [2] [3]. The lack of uniform adherence to such standards across all hospitals may have contributed to the variation in injury prevalence. Similar institutional differences in occupational injury risk have been reported in Ethiopia and Uganda, where health care workers' occupational safety practices, supervision systems, and infection prevention measures significantly influenced their risk of workplace injury [3] [10]. The lower prevalence in the military hospital may be attributed to stronger organizational structures, more rigorous enforcement of occupational safety standards, and effective supervision systems.

These findings support a multifactorial framework for understanding occupational injuries in health care settings. Occupational injuries are not the result of a single exposure but instead are likely to occur through interactions among hazardous waste exposure, workplace organization, institutional safety culture, and compliance with preventive measures. Demographic characteristics, training, and PPE use may influence risk indirectly through their association with work assignments and cumulative exposure levels. Thus, the interpretation of occupational injury patterns should consider exposure-related factors, confounding variables, workload, supervision, and organizational practices and not only individual characteristics.

In bivariate analysis, age was not significantly associated with occupational injury but was borderline significant in the multivariable model. This association may be due to cumulative occupational exposure rather than age per se. Older workers are usually those with longer service durations and thus experience prolonged exposure to occupational hazards. Similar findings have been reported in Ethiopia and Kenya where longer work experience and repeated exposure to hazardous materials were associated with increased occupational injury risk [15] reported a high prevalence of sharp injuries among health care workers in Southeast Ethiopia (37.1%) which emphasizes the role of cumulative exposure. Mbaisi et al. [15] reported a 19% prevalence of percutaneous injuries among health care workers in Kenya, and the risk of injury was associated with prolonged exposure and difficult working environment. Studies have also reported a higher incidence of injuries in younger workers due to lack of experience and risk perception, and this suggests that the association between age and occupational injury is context specific and influenced by the working environment.

However, working hours were surprisingly associated with decreased odds of occupational injury (AOR=0.415, 95% CI: 0.177-0.972). Although this is counterintuitive, it might be due to differences in job allocation, accumulated experience, or the healthy worker effect. Workers who can work longer hours may be a healthier or more experienced subgroup that is less prone to injury. Due to the cross-sectional nature of the study, the interpretation of causality is limited, and further longitudinal studies are needed to elucidate this association. The dominance of female workers seen in the study reflects the composition of the workforce typically seen among cleaning and waste handling personnel working in healthcare facilities in Sudan and other African countries. Although gender was not significantly associated with occupational injury, the finding emphasizes the importance of addressing occupational safety among women working in lower-paid support roles in healthcare systems. Similar gender distributions have been reported among environmental service and waste-management workers in Ethiopia and Uganda [11] [10].

Educational level was not significantly associated with occupational injury. This finding is consistent with previous studies which indicate that workplace conditions, organizational culture and occupational exposures are often more important in the occurrence of injury than formal educational attainment alone [11] [15]. Furthermore, the relatively homogeneous educational background of participants may have limited the ability to detect meaningful differences between educational groups. The association between occupational safety training and injury occurrence needs to be interpreted with caution. Although trained workers reported higher injury prevalence, the association was not statistically significant. This finding may be due to reverse causation, that is, workers in high-risk departments or workers who have previously sustained injuries are more likely to be offered training interventions. Similar observations have been reported in occupational health research where training programs are often implemented as corrective responses after injury events rather than as purely preventive measures [18]. The observation that workers receiving longer duration training also reported higher injury prevalence supports this explanation. Thus, the results should not be interpreted as evidence that training increases risk of injury but rather as an indication that training may be preferentially targeted towards workers already exposed to higher occupational hazards.

The adjusted analysis showed that use of PPE was significantly associated with higher odds of occupational injury (AOR = 3.254, 95% CI: 1.264–8.377). This finding initially appears to contradict well-established principles of occupational health which emphasize the importance of PPE as a protective measure [10]. However, this result is more likely explained by exposure intensity and reverse causality. Workers involved in high-risk tasks with unsegregated waste, sharps, and other hazardous materials are more likely to use PPE and to be injured. As such, PPE use may be a marker of higher occupational risk rather than a causal factor. Reverse causality may also be a factor, with workers who have experienced injuries in the past more likely to use PPE. Prior work in Sudan has shown the importance of the availability and appropriate and consistent use of PPE for its effectiveness [16], [18].

In the present study, most of the healthcare waste management practices studied were not statistically significantly associated with occupational injury, but this should not be taken to mean that they are of little importance. The small number of participants and the limited differences in healthcare waste management practices between the participating hospitals may have resulted in insufficient statistical power. Previous research in Sudan, for example, has shown that poor healthcare waste segregation, broken containers and healthcare waste management systems, in general, are responsible for considerable occupational hazards among waste handlers [16]. Similarly, the WHO guidelines identified poor segregation and unsafe transportation as the most significant determinants of occupational exposure [2], [3]. Thus, the lack of statistical significance may be due to methodological limitations or unmeasured institutional factors rather than the absence of a true relationship. A very important finding was the significant association between ease of carrying waste bags and occupational injury. Workers who regularly transport healthcare waste inevitably come into greater contact with possibly hazardous materials. Similar findings have been reported in Uganda, where Ndejo et al. [10] reported high rates of occupational hazards among waste handlers, including a prevalence of sharp injuries of 32.5%. Studies from Cameroon also highlighted the contribution of intense occupational exposure and limited access to post-exposure interventions in the increase of long-term health risks among cleaners [24]. Therefore, ease of carrying waste bags could be considered as a proxy indicator of exposure intensity rather than an independent causal factor. Causal inferences should be made with caution given the cross-sectional design of the study.

One of the key findings of the adjusted analysis was the protective effect of the pre-employment medical examination. Workers who underwent medical examinations before employment had significantly lower odds of having sustained an occupational injury. This finding is in agreement with international occupational health recommendations that advocate for the pre-placement medical examination to ensure that workers are physically fit to undertake their assigned tasks [12]. The association may also suggest that healthcare facilities with pre-employment screening have better occupational health systems in general. Similar findings have been reported in healthcare settings where comprehensive occupational health programs have improved worker safety outcomes [2] [10].

No significant association was found between occupational injury and periodic medical examinations, supervision and vaccination. However, these interventions remain essential elements of occupational health protection programs. WHO infection prevention and control frameworks stress that vaccination, medical surveillance, workplace monitoring and supervision should function together as part of a comprehensive occupational health system, not as isolated interventions [3] [13]. The lack of statistical significance in this study might therefore reflect the common application of these measures among participants, rather than their ineffectiveness.

In conclusion, the findings suggest that occupational injuries among hospital cleaners in Shendi locality are affected by a combination of occupational exposures and organizational factors and the associations identified in this study highlight the importance of strengthening the occupational health systems, improving healthcare waste management practices, the proper and consistent use of PPE, effective training programs, and regular pre-employment medical screening that have the potential to reduce the risks associated with occupational injuries among healthcare waste handlers in healthcare facilities across Sudan.

Strengths and limitations: This study has some strengths, including the focus on hospital cleaning workers, an important but often underrepresented occupational group in medical waste and infection control research, and the inclusion of workers from multiple hospitals and assessment of key factors including training, PPE use, waste handling practices, supervision, medical examination, vaccination and occupational injury. The use of chi-square/Fisher's

exact tests and logistic regression strengthened the analysis. However, study has its limitations. The cross-sectional design does not permit causal inferences. The data are based on self-reported information and are therefore subject to recall bias and social desirability bias. The sample size was rather small, and some categories had few cases. The study was conducted in only one community and therefore the generalizability of the findings is limited.

Declarations

Ethical approval: The principles of the Helsinki Declaration were followed in the conduct of this investigation. The University of Shendi Ethical Review Board (IRB) granted ethical clearance. Prior to data collection, each health institution to be surveyed and the health authority received an official letter of support from the University of Shendi. The chief of each medical facility gave permission to carry out the study. Following an explanation of the study's goals, risks, and advantages, To maintain secrecy, all personal identifiers were eliminated. Additionally, only the lead investigator's password-protected computer was used to enter and evaluate the data. The study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki, and ethical approval was obtained from ethics committee in Shendi University. Written informed consent was obtained from all participants.

Consent for publication: Not applicable

Competing interests: The authors declared no conflict of interest.

Author Contributions

Conceptualization; MH, and EA methodology; MH; software; MH validation, EA,MH, and AA; formal analysis; MH; investigation; EA; resources EA,MH, and AA data curation EA,MH, and AA writing original draft preparation EA,MH, and AA; writing review and editing MH, and AA; visualization, MA, and AA supervision EA; project administration; EA, and MH funding acquisition EA,MH, and AA .All authors have made substantial contributions, agreed to the selected journal for submission, and the final version has been reviewed and approved for publication. They also agree to take accountability and responsibility for the content of the manuscript.

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Data Availability Statement: The data supports the findings of this study are available upon request from the corresponding author, subject to institutional approval

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Tables

Table 1
Soci-demographic Characteristics of Cleaning Workers

Variable	Category	Frequency	Percent
Hospital Name	Elmaknemir	35	24.5
	Shendi Educational	34	23.8
	Hagar Alasaal	4	2.8
	Kaposhia	13	9.1
	Tumer Therapy center	9	6.3
	Alhowsh	8	5.6
	Military	15	10.5
	Almisiktab	20	14.0
	Alshagalwa	5	3.5
Age Groups	15 to 25 Year	5	3.5
	26 to 35 Year	33	23.1
	36 to 45 Year	50	35.0
	more than 45	55	38.5
Gender	Male	24	16.8
	Female	119	83.2
Educational Level	Khalwa	55	38.5
	Basic School	61	42.7
	Secondary	26	18.2
	Graduated	1	0.7
Working Hours\ Day	8 hours	124	86.7
	12 hours	8	5.6
	16 hours	11	7.7

Table 2
Association between socio-demographic and work-related characteristics and occupational injury among cleaning workers in Shendi Locality hospitals, Sudan (N = 143)

Variable	Category	Total n (%)	Injury Yes n (%)	Injury No n (%)	χ^2	p-value
Hospital name	Elmaknemir	35 (24.5)	13 (37.1)	22 (62.9)	28.216	< 0.001
	Shendi Educational	34 (23.8)	16 (47.1)	18 (52.9)		
	Hagar alasaal	4 (2.8)	3 (75.0)	1 (25.0)		
	Kaposhia	13 (9.1)	8 (61.5)	5 (38.5)		
	Tumer Therapy Center	9 (6.3)	9 (100.0)	0 (0.0)		
	Alhowsh	8 (5.6)	5 (62.5)	3 (37.5)		
	Military	15 (10.5)	2 (13.3)	13 (86.7)		
	Almisktab	20 (14.0)	7 (35.0)	13 (65.0)		
	Alshagalwa	5 (3.5)	5 (100.0)	0 (0.0)		
Age group	15–25 years	5 (3.5)	1 (20.0)	4 (80.0)	5.215	0.157
	26–35 years	33 (23.1)	15 (45.5)	18 (54.5)		
	36–45 years	50 (35.0)	20 (40.0)	30 (60.0)		
	More than 45 years	55 (38.5)	32 (58.2)	23 (41.8)		
Gender	Male	24 (16.8)	8 (33.3)	16 (66.7)	2.338	0.126
	Female	119 (83.2)	60 (50.4)	59 (49.6)		
Educational level	Khalwa/Quranic school	55 (38.5)	28 (50.9)	27 (49.1)	1.242	0.743
	Basic school	61 (42.7)	28 (45.9)	33 (54.1)		
	Secondary	26 (18.2)	12 (46.2)	14 (53.8)		
	Graduated	1 (0.7)	0 (0.0)	1 (100.0)		
Working hours per day	8 hours	124 (86.7)	61 (49.2)	63 (50.8)	1.967	0.374
	12 hours	8 (5.6)	4 (50.0)	4 (50.0)		
	16 hours	11 (7.7)	3 (27.3)	8 (72.7)		

Table 3
Association between training-related factors and occupational injury among cleaning workers in Shendi Locality hospitals, Sudan

variable	Category	Total n (%)	Injury Yes n (%)	Injury No n (%)	Test value	p-value
Received training on safe medical waste handling n = 143	Yes	106 (74.1)	55 (51.9)	51 (48.1)	$\chi^2 = 3.086$	0.079
	No	37 (25.9)	13 (35.1)	24 (64.9)		
Place of training n = 106	In hospital	99 (93.4)	53 (53.5)	46 (46.5)	Fisher's exact	0.258
	Out of hospital	7 (6.6)	2 (28.6)	5 (71.4)		
Duration of training n = 106	One day	62 (58.5)	26 (41.9)	36 (58.1)	$\chi^2 = 7.114$	0.008
	More than one day	44 (41.5)	30 (68.2)	14 (31.8)		
Newly recruited cleaning workers trained on medical waste handling	Yes	79 (55.2)	41 (51.9)	38 (48.1)	$\chi^2 = 2.002$	0.367
	No	37 (25.9)	14 (37.8)	23 (62.2)		
	Do not know	27 (18.9)	13 (48.1)	14 (51.9)		

Table 4

Association between medical waste handling practices and occupational injury among cleaning workers in Shendi Locality hospitals, Sudan (N = 143)

Variable	Category	Total n (%)	Injury Yes n (%)	Injury No n (%)	χ^2	p-value
Medical waste separated from ordinary waste	Yes	90 (62.9)	45 (50.0)	45 (50.0)	0.583	0.445
	No	53 (37.1)	23 (43.4)	30 (56.6)		
Bags/containers tear or become damaged	Yes	69 (48.3)	30 (43.5)	39 (56.5)	0.887	0.346
	No	74 (51.7)	38 (51.4)	36 (48.6)		
Waste bags filled beyond capacity	Yes	30 (21.0)	15 (50.0)	15 (50.0)	0.957	0.620
	No	85 (59.4)	42 (49.4)	43 (50.6)		
	Sometimes	28 (19.6)	11 (39.3)	17 (60.7)		
Can easily carry and move waste bags	Yes	94 (65.7)	53 (56.4)	41 (43.6)	8.579	0.014
	No	10 (7.0)	3 (30.0)	7 (70.0)		
	Sometimes	39 (27.3)	12 (30.8)	27 (69.2)		
Waste bags tied securely during transportation	Yes	129 (90.2)	63 (48.8)	66 (51.2)	0.881	0.644
	No	11 (7.7)	4 (36.4)	7 (63.6)		
	Sometimes	3 (2.1)	1 (33.3)	2 (66.7)		
Use of personal protective equipment during medical waste handling	Yes	82 (57.3)	35 (42.7)	47 (57.3)	2.027	0.363
	No	58 (40.6)	31 (53.4)	27 (46.6)		
	Sometimes	3 (2.1)	2 (66.7)	1 (33.3)		
Put hand inside medical waste bags/containers	Yes	65 (45.5)	31 (47.7)	34 (52.3)	0.001	0.976
	No	78 (54.5)	37 (47.4)	41 (52.6)		

Table 5

Association between occupational health protection measures and occupational injury among cleaning workers in Shendi Locality hospitals, Sudan, N = 143

Variable	Category	Total n (%)	Injury Yes n (%)	Injury No n (%)	Test value	p-value
Follow-up and supervision provided	Yes	133 (93.0)	64 (48.1)	69 (51.9)	Fisher's exact	0.748
	No	10 (7.0)	4 (40.0)	6 (60.0)		
Medically examined before employment	Yes	59 (41.3)	39 (66.1)	20 (33.9)	$\chi^2 = 13.857$	< 0.001
	No	84 (58.7)	29 (34.5)	55 (65.5)		
Subjected to periodic medical examinations	Yes	49 (34.3)	28 (57.1)	21 (42.9)	$\chi^2 = 2.749$	0.097
	No	94 (65.7)	40 (42.6)	54 (57.4)		
Received vaccination against infectious diseases	Yes	114 (79.7)	55 (48.2)	59 (51.8)	$\chi^2 = 0.108$	0.742
	No	29 (20.3)	13 (44.8)	16 (55.2)		

Table 6

Binary logistic regression analysis of factors associated with occupational injury among cleaning workers in Shendi Locality hospitals

Predictor variable	B	AOR	95% CI for AOR	p-value
Age group	0.557	1.746	1.001–3.046	0.050
Gender	1.218	3.381	0.857–13.342	0.082
Working hours per day	-0.879	0.415	0.177–0.972	0.043
Received training on safe medical waste handling	0.273	1.314	0.286–6.036	0.725
Duration of training	0.847	2.333	0.838–6.497	0.105
Ability to carry and move waste bags	-0.435	0.648	0.370–1.134	0.129
Use of personal protective equipment	1.180	3.254	1.264–8.377	0.014
Periodic medical examination	0.780	2.181	0.590–8.060	0.242
Medical examination before employment	-1.681	0.186	0.052–0.666	0.010
Table.6 Model summary: Omnibus $\chi^2 = 30.396$, df = 9, p < 0.001. Nagelkerke $R^2 = 0.333$. Hosmer–Lemeshow $\chi^2 = 7.213$, df = 8, p = 0.514. Overall classification accuracy = 73.6%. Included cases = 143				

References

1. Ibáñez-Cruz AJA, Vergara-Florián AME, Algoner WC. Hospital solid waste management strategies to prevent healthcare-associated infections from occupational exposure to bloodborne pathogens and improve occupational safety. *Front Public Health*. 2025;13:1499463.
2. Prüss A et al. Safe management of wastes from health-care activities., 2014, Accessed: Jun. 15, 2026. [Online]. Available: <https://iris.who.int/bitstream/handle/10665/85349/9789241548564-per.pdf>
3. Organization WH. Universal water, sanitation, hygiene, waste and electricity services in all health care facilities to achieve quality care: global framework for action 2024–2030, 2024, Accessed: Jun. 15, 2026. [Online]. Available: <https://iris.who.int/bitstreams/ec2293c9-ba8b-426f-8534-8d6ce5ba095d/download>
4. Tesfaye AH, Mekonnen TH, Desye B, Yenealem DG. Infection Prevention and Control Practices and Associated Factors Among Healthcare Cleaners in Gondar City: An Analysis of a Cross-Sectional Survey in Ethiopia, *Risk Manag. Healthc. Policy*, vol. Volume 16, pp. 1317–1330, Jul. 2023, 10.2147/RMHP.S419110
5. Affordofe M, et al. Knowledge and practice of solid healthcare waste management among waste handlers in hospitals in Southern Ghana: a qualitative study. *BMC Public Health*. Feb. 2025;25(1):702. 10.1186/s12889-025-21874-6.
6. Tolera ST, Gobena T, Assefa N, Geremew A, Toseva E. Occupational injuries and associated factors among sanitary workers in public hospitals, eastern Ethiopia: A modified Poisson regression model analysis. *PLoS ONE*. 2024;19(11):e0310970.
7. Bayleyegn B, Mehari A, Damtie D, Negash M. <pknowledge, among="and=" associated="at=" attitude="comprehensive=" ethiopia<="factors=" gondar="healthcare=" hospital,="hospital-acquired=" infection="northwest=" of="on=" p<="practice=" prevention="specialized=" university="workers="> </pknowledge>. *Infect Drug Resist*. Jan. 2021;14:259–66. 10.2147/IDR.S290992.
8. Tadesse B, Alene Z, Girma S, Demissie D. Infection prevention compliance and associated factors among healthcare workers in Addis Ababa, Ethiopia: A facility-based cross- sectional study. Jul. 2025.
9. Markos T, Sinkie SO, Garedew MG. Compliance with infection prevention practices and associated factors among health professionals in the public hospitals of Kembata Tembaro Zone, south Ethiopia. *Health Sci J*. 2021;15(7):1–9.
10. Ndejjo R et al. Occupational Health Hazards among Healthcare Workers in Kampala, Uganda, *J. Environ. Public Health*, vol. 2015, pp. 1–9, 2015. 10.1155/2015/913741
11. Reda AA, Fisseha S, Mengistie B, Vandeweerd J-M. Standard precautions: occupational exposure and behavior of health care workers in Ethiopia. *PLoS ONE*. 2010;5(12):e14420.
12. Machida S. Guidelines on occupational safety and health management systems (ILO-OSH 2001). *Afr Newsl Occup Health Saf*. 2001;11:68–9.
13. Organization WH. Global strategy on infection prevention and control. World Health Organization, 2024. Accessed: Jun. 15, 2026. [Online]. Available: [https://books.google.com/books?hl=en&lr=&id=kooHEQAAQBAJ&oi=fnd&pg=PR4&dq=World+Health+Organization.+ \(2024\).+Global+strategy+on+infection+prevention+and+control.+World+Health+Organization.%E2%80%8F&ots=Tc0w1KkhzT&sig=a8K0Xkbjc3qesYX0xL](https://books.google.com/books?hl=en&lr=&id=kooHEQAAQBAJ&oi=fnd&pg=PR4&dq=World+Health+Organization.+ (2024).+Global+strategy+on+infection+prevention+and+control.+World+Health+Organization.%E2%80%8F&ots=Tc0w1KkhzT&sig=a8K0Xkbjc3qesYX0xL)
14. Auta A, et al. Global prevalence of percutaneous injuries among healthcare workers: a systematic review and meta-analysis. *Int J Epidemiol*. 2018;47(6):1972–80.
15. Bekele T, Gebremariam A, Kaso M, Ahmed K. Factors associated with occupational needle stick and sharps injuries among hospital healthcare workers in Bale Zone, Southeast Ethiopia. *PLoS ONE*. 2015;10(10):e0140382.
16. Hassan AA, Tudor T, Vaccari M. Healthcare waste management: A case study from Sudan. *Environments*. 2018;5(8):89.

17. Eltayeba IE, Magdahb EA, Abdelelaha ME, Errami M. The Prevalence of injuries among Medical Waste Workers in Khartoum State Hospitals, Sudan (2013–2016), *Appl. J. Environ. Eng. Sci.*, vol. 4, no. 1, p. J-Envir, 2018.
18. Hamed FJM et al. Improving Knowledge of Needle-Stick Injury Prevention: A Two-Cycle Clinical Audit From Sudan, *Cureus*, vol. 17, no. 11, 2025, Accessed: Jun. 15, 2026. [Online]. Available: <https://www.cureus.com/articles/422214-improving-knowledge-of-needle-stick-injury-prevention-a-two-cycle-clinical-audit-from-sudan.pdf>
19. Janay AI, Kilic B, Unal B. Healthcare workers' compliance with COVID–19 prevention and control measures at De Martino Hospital, Mogadishu, Somalia: a cross-sectional study. *BMC Infect Dis.* Sep. 2024;24(1):1046. 10.1186/s12879-024-09819-7.
20. River Nile State Ministry of Health. Annual Health Facilities Report. Shendi (Sudan): River Nile State Ministry of Health. 2022. pp. 45–7.
21. Sudan Federal Ministry of Health. National Cardiac Surgery Center Initiative. Al-Mak Nimer Hospital Designation. Khartoum: Federal Ministry of Health; 2023. Report No.: MOH/CS/2023/015.
22. Daniel WW, Cross CL. *Biostatistics: a foundation for analysis in the health sciences*. John Wiley & Sons, 2018. Accessed: Jun. 07, 2026. [Online]. Available: <https://books.google.com/books?hl=en&lr=&id=PON1DwAAQBAJ&oi=fnd&pg=PR7&dq=39.+Daniel+WW,+Cross+CL.+Biostatistics:+A+Foundation+for+Analysis+in+the+Health+Sciences.+>
23. Ganim M et al. 521 Sharp Risks in a Time of Crisis: A Study of Needle-Stick Injuries in Eastern Sudan's Healthcare Sector—a Cross-Sectional Study, *Br. J. Surg.*, vol. 112, no. Supplement_10, pp. znaf128–023, 2025.
24. Aminde LN, et al. Awareness and low uptake of post exposure prophylaxis for HIV among clinical medical students in a high endemicity setting. *BMC Public Health.* Dec. 2015;15(1):1104. 10.1186/s12889-015-2468-9.