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Occupational Needlestick and Sharps Injuries Among Nurses in Governmental Teaching Hospitals in Sana'a, Yemen: Burden, Underreporting, and Post-Exposure Management.

Dr. Jamal Mansour Al-Saidi[1], Dr. Abdul Salam Saeed Al-Aqel[2]

1. Faculty of Medicine and Health Sciences, Al Mahweet University.
2. Faculty of Medicine and Health Sciences, Sana'a University.

الإصابات المهنية بوخز الإبر والأدوات الحادة بين كادر التمريض في المستشفيات التعليمية الحكومية بأمانة العاصمة صنعاء، اليمن: العبء، وعدم التبليغ، والتدبير بعد التعرض

د. جمال منصور الصايدي[1]، د. عبدالسلام سعيد العاقل[2]

1. كلية الطب والعلوم الصحية جامعة المحويت.
2. كلية الطب والعلوم الصحية جامعة صنعاء

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Corresponding author*: *Jmms200n@yahoo.com

الملخص:

تُعد إصابات وخز الإبر والإصابات بالأدوات الحادة من أهم المخاطر المهنية التي يتعرض لها كادر التمريض، لما تسببه من أذى نسيجي مباشر، وضغط نفسي متكرر، واحتمال التعرض للعوامل الممرضة المنقولة بالدم، بما في ذلك فيروس التهاب الكبد B، وفيروس التهاب الكبد C، وفيروس العوز المناعي البشري.

هدفت هذه الدراسة إلى تقدير عبء الإصابات المهنية بوخز الإبر والأدوات الحادة بين كوادر التمريض العاملة في أربعة مستشفيات تعليمية حكومية بأمانة العاصمة صنعاء، ووصف أنماط الأدوات المسببة للإصابة، وظروف حدوثها، ومستوى الإبلاغ الرسمي عنها، والإجراءات المتبعة بعد التعرض، وحالة التطعيم ضد التهاب الكبد B، والتدابير المؤسسية المرتبطة بالتخلص الآمن من الأدوات الحادة. أُجريت دراسة مقطعية متعددة المراكز خلال عام 2023، وشملت 300 ممرض وممرضة تم اختيارهم بطريقة العينة العشوائية المنتظمة مع التوزيع التناسبي بين المستشفيات المشاركة. استُخدمت استبانة ذات صدق وثبات مقبولين لجمع بيانات التعرض خلال الاثني عشر شهرًا السابقة للدراسة، وعدد الإصابات، وأنواع الأدوات، والسياقات الإجرائية والبيئية المرتبطة بها، ومسارات التبليغ، والرعاية التالية للتعرض، وممارسات التخلص من الأدوات الحادة، وتوافر حاويات الأمان، والتطعيم ضد التهاب الكبد B. أظهرت

النتائج أن 268 مشاركًا من أصل 300 (89.3%) تعرضوا لإصابة واحدة على الأقل بأداة حادة ملوثة أو يحتمل تلوثها، مع تسجيل 3382 إصابة خلال سنة واحدة، منها 2321 وخزة إبرة و1061 إصابة بأدوات حادة أخرى. وكانت إبر الحقن أكثر الأدوات تسببًا في الإصابات، كما برزت إعادة تغطية الإبر أو ثنيها أو كسرها، وضعف الانتباه، وتحضير الأدوية الوريدية بوصفها أهم الظروف المرتبطة بالحدوث. كما تبين أن 63.4% من المصابين لم يبلغوا رسميًا عن الإصابات، وأن 68.7% لم يتلقوا أي رعاية بعد التعرض، في حين كان التطعيم ضد التهاب الكبد B منخفضًا بصورة مقلقة؛ إذ أفاد 20.7% فقط بتلقي أي جرعة من اللقاح، ولم يكمل السلسلة الثلاثية إلا 8.0% من العينة، كما أظهر التحليل الاستدلالي الاستكشافي وجود فرق بسيط ولكنه ذو دلالة إحصائية بين الجنسين في درجات المعرفة الخاصة بالأدوات الحادة لصالح الإناث (p=0.018)، إلى جانب وجود تباين مرتبط بالعمر والخبرة في الممارسات العامة للاحتياطات القياسية، وتشير هذه النتائج إلى أن المشكلة تتجاوز السلوك الفردي، وتستدعي استجابة مؤسسية متكاملة تشمل نظم تبليغ فعالة، وخدمات تقييم فوري بعد التعرض، وتغطية شاملة بالتطعيم، وتوحيد مواضع حاويات التخلص من الأدوات الحادة، وتعزيز المساءلة المؤسسية في بيئة المستشفيات التعليمية.

الكلمات المفتاحية: وخز الإبر، الأدوات الحادة، كادر التمريض، التعرض المهني، عدم التبليغ، التدبير بعد التعرض، التخلص من الأدوات الحادة، لقاح التهاب الكبد B، اليمن

Abstract:

Needlestick and sharps injuries remain among the most important occupational hazards facing nurses because they cause immediate tissue injury, recurrent psychological stress, and potential exposure to hepatitis B virus, hepatitis C virus, human immunodeficiency virus, and other blood-borne pathogens. This study aimed to estimate the burden of occupational needlestick and sharps injuries among nurses in four governmental teaching hospitals in Sana'a City, Yemen, and to describe the devices involved, injury circumstances, reporting behavior, post-exposure management, hepatitis B vaccination status, and institutional measures related to safe sharps disposal. A multicenter cross-sectional study was conducted in 2023 among 300 nurses selected by proportional allocation and systematic random sampling. Data were collected using a validated self-administered questionnaire that assessed exposure during the previous 12 months, cumulative injury counts, device categories, procedural and environmental circumstances, official reporting, post-exposure care, disposal practices, safety-container availability, and hepatitis B vaccination. Of the 300 participants, 268 (89.3%) reported at least one contaminated or potentially contaminated sharps injury during the preceding year, and a total of 3,382 injuries were reported, including 2,321 needlestick injuries and 1,061 injuries from other sharps. Injection needles were the most common devices involved, while recapping, bending, or breaking needles, inattention, and intravenous medication preparation emerged as the leading circumstances. Underreporting was substantial: 63.4% of exposed nurses had never officially reported their injuries, and 68.7% reported receiving no post-exposure healthcare. Hepatitis B vaccination coverage was also critically low, with only 20.7% reporting any vaccination and only 8.0% completing a three-dose schedule. Furthermore, exploratory inferential analysis revealed a modest but statistically significant sex difference in sharps-specific knowledge scores in favor of women (p=0.018), alongside age- and experience-related variations in general standard-precaution practices. Overall, the findings indicate that occupational sharps injury

in these teaching hospitals represents a major institutional safety problem that requires integrated reporting pathways, timely post-exposure services, improved vaccination coverage, standardized point-of-use sharps-disposal infrastructure, and stronger institutional accountability.

Keywords: needlestick injuries; sharps injuries; nurses; occupational exposure; underreporting; post-exposure management; sharps disposal; hepatitis B vaccination; Yemen.

Introduction

Needlestick and sharps injuries are a core occupational-safety problem in health care because they represent a direct biological pathway between contaminated blood, injured skin, and a potentially infected worker. The clinical significance of these injuries lies not only in the puncture event itself but also in the possible transmission of hepatitis B virus, hepatitis C virus, and human immunodeficiency virus, the need for urgent assessment, and the emotional burden of waiting for follow-up testing results *(Bouya et al., 2020; Centers for Disease Control and Prevention, 2025; World Health Organization, 2007).* For nurses, this risk is especially persistent because their routine work includes injections, intravenous medication preparation, blood sampling, cannulation, wound care, instrument handling, and disposal of contaminated materials, all of which bring them into repeated contact with needles and other sharps *(Cho et al., 2013; Hosseinipalangi et al., 2022; Powers et al., 2016).*

Sharps injuries are also common at a population level. Systematic reviews have shown that one-year pooled prevalence estimates among healthcare workers remain high internationally, even after decades of infection-prevention guidance and technological advances in device safety. *Bouya et al. (2020)* estimated a one-year global pooled prevalence of 44.5% and identified hypodermic needles as the most common device-related cause, while *Mengistu et al. (2021)* reported a worldwide one-year pooled prevalence of 32.4%; *Hosseinipalangi et al. (2022)* similarly estimated a global incidence of 43% and found that recapping, needles, general wards, nurses, and waste disposal were among the dominant risk patterns. These figures indicate that sharps injury has remained a durable systems problem rather than a solved technical issue *(Bouya et al., 2020; Hosseinipalangi et al., 2022; Mengistu et al., 2021).*

A second reason the issue deserves focused study is that the epidemiology of sharps injury does not stop at injury occurrence. The real occupational burden includes what happens immediately afterward: whether the event is reported, whether post-exposure evaluation occurs in time, whether source-patient and worker risk are assessed, whether hepatitis B immune status is known, whether HIV post-exposure prophylaxis is accessible when indicated, and whether the institution records the event in a way that supports prevention and surveillance *(Centers for Disease Control and Prevention, 2024c; Schillie et al., 2013; World Health Organization, 2024a, 2024b).* When injuries are not reported or not evaluated, both the worker and the hospital lose the opportunity for timely prophylaxis, counseling, documentation, and prevention learning *(Bahat et al., 2021; Behzadmehr et al., 2023).*

Underreporting is therefore not a minor administrative defect; it is a clinical and organizational failure. A systematic review by *Behzadmehr et al. (2023)* showed that unreported needlestick injuries remain widespread across settings and arise from recurring reasons such as low perceived risk, lack of awareness of procedures, time pressure, and distrust in institutional response. *Bahat et al. (2021)* likewise demonstrated that underreporting remains common even in hospital systems that already have training structures, and that reporting tends to decline as injuries become more frequent. This pattern is especially concerning in nursing environments because recurrent exposures can normalize risk and turn dangerous events into routine, silently tolerated occurrences *(Bahat et al., 2021; Behzadmehr et al., 2023; Powers et al., 2016).*

The prevention of sharps injury also depends on institutional design. Standard precautions remain the minimum infection-prevention baseline for all patient care and include safe injection practice, safe handling of contaminated equipment, proper disposal of sharps, hand hygiene, and the use of personal protective equipment when exposure is possible *(Centers for Disease Control and Prevention, 2024a; World Health Organization, 2007).* However, standard precautions are only effective when translated into practical environmental supports such as puncture-resistant sharps containers located near the point of use, written reporting protocols, occupational-health pathways, training reinforcement, safe workflow design, supervision, and organizational expectations that treat worker safety as a routine operational priority rather than an optional individual preference *(Centers for Disease Control and Prevention, 2024b; Powers et al., 2016; World Health Organization, 2014, 2022).*

Hospital waste management is particularly important in this respect. WHO guidance emphasizes that sharps disposal systems should be puncture resistant, readily accessible, standardized, and incorporated into broader waste-segregation systems, because poor disposal practices create a second wave of exposure after the initial procedure has ended *(World Health Organization, 2014)*. CDC sharps-safety guidance similarly frames prevention as a programmatic activity requiring leadership, surveillance, worker involvement, training, and environmental redesign, not merely reminders to be careful *(Centers for Disease Control and Prevention, 2024b).* In other words, the presence or absence of institutional preventive measures is part of the causal chain of injury, not a background administrative detail *(Centers for Disease Control and Prevention, 2024b; World Health Organization, 2014, 2022).*

Nurses working in teaching hospitals may be especially vulnerable to sharps injury. These facilities usually carry high patient turnover, a wide procedural mix, complex medication activity, emergency admissions, and large numbers of trainees. The work environment can therefore amplify interruption, crowding, haste, handoffs, and informal task-sharing, all of which increase exposure to procedural lapses and unsafe disposal patterns. At the same time, teaching hospitals shape the informal norms of future clinicians; unsafe practices may be learned through observation and repetition if they are not corrected at the system level *(Cho et al., 2013; Powers et al., 2016; World Health Organization, 2022).*

Studies from the Middle East and comparable low- and middle-income settings have repeatedly shown that knowledge of infection prevention does not always translate into consistent compliance. Cross-sectional studies among nurses and healthcare workers in Jordan, Saudi Arabia, China, Iraq, and Ethiopia have documented gaps between awareness of standard precautions and day-to-day implementation, especially when work pressure, supply inconsistency, and organizational culture are *unfavorable (Abalkhail et al., 2021; Al-Faouri et al., 2021; Da'seh et al., 2023; Senbato et al., 2024; Suliman et al., 2018; Wang et al., 2021).* This knowledge-practice gap matters for sharps injury because many injury-producing actions, such as recapping, delayed disposal, or hurried medication preparation, arise in precisely those moments when workflow pressure overrides safe routine *(Hosseinipalangi et al., 2022; Powers et al., 2016).*

The Yemeni context gives this problem added urgency. Years of economic strain, conflict, workforce pressure, and disruption to routine public-health systems have likely weakened occupational-health infrastructure and infection-prevention implementation in many facilities. Previous Yemeni studies have reported gaps in infection-control knowledge and practice among nurses and healthcare workers in Sana'a and other cities, suggesting that implementation challenges persist even when basic precaution concepts are familiar *(Almualm, 2021; Alrubaiee et al., 2017; Alwabr & Al-Salehi, 2022).* More recently, *Almoliky et al. (2024)* reported a very high prevalence of needlestick and sharps injury among nurses in Taiz, Yemen, further underscoring the occupational vulnerability of nursing staff in the national setting. Yet evidence from governmental teaching hospitals in Sana'a has remained limited, particularly evidence that integrates injury burden, reporting behavior, post-exposure management, and

institutional preventive measures in the same nursing sample *(Almoliky et al., 2024; Alrubaiee et al., 2017; Alwabr & Al-Salehi, 2022).*

This gap is important for practice and policy. Hospital managers need more than a simple prevalence estimate; they need to know whether injuries are recurrent or isolated, which devices and activities are most implicated, whether reporting systems are being used, whether injured nurses actually receive care, whether disposal pathways are standardized, and whether hepatitis B immunization is functioning as a pre-exposure line of defense. Without this information, prevention efforts risk being generic, fragmented, and insufficiently targeted *(Centers for Disease Control and Prevention, 2024b, 2024c; World Health Organization, 2014, 2024b).*

Accordingly, the present study was designed as a focused analysis of needlestick and sharps injuries among nurses in four governmental teaching hospitals in Sana'a City, Yemen. The study aimed to estimate the 12-month prevalence and recurrence of injuries, identify the devices and circumstances most commonly associated with injury, describe reporting behavior and post-exposure care, assess hospital measures related to sharps disposal and container placement, and document hepatitis B vaccination status in this high-risk workforce. By treating injury burden, response behavior, and institutional prevention as linked components of one safety system, the study sought to provide a manuscript directly useful for hospital leadership, occupational-health planning, and infection-prevention policy in a resource-constrained teaching-hospital environment *(Centers for Disease Control and Prevention, 2024b; World Health Organization, 2022).*

Methods

This study used a multicenter, facility-based cross-sectional design. The design was chosen to describe the current burden and profile of needlestick and sharps injuries and the related prevention environment among nurses working in governmental teaching hospitals. The reporting of methods and results was structured to remain compatible with the STROBE logic for observational research while preserving the level of operational detail expected in an occupational-health manuscript (von Elm et al., 2007).

The study was conducted in 2023 in four governmental teaching hospitals in Sana'a City, Yemen: Al-Thawra General Hospital, Al-Jomhouri Teaching Hospital, Kuwait University Hospital, and Al-Sabeen Maternal and Child Hospital. These are high-volume public teaching institutions that provide secondary and tertiary care and carry a broad range of inpatient, procedural, emergency, surgical, and maternal-child services. Because they function as teaching hospitals, their safety practices influence not only current staff but also trainees and newly recruited personnel who acquire routine procedural habits in these settings *(Powers et al., 2016; World Health Organization, 2022).*

The target population consisted of nurses employed in the participating hospitals during the study period. The final sample comprised 300 nurses. Allocation was proportional to the nursing workforce size of each hospital, and systematic random selection was applied within the participating institutions. Hospital-specific enrollment was 100 nurses from Al-Thawra General Hospital, 70 from Al-Jomhouri Teaching Hospital, 60 from Kuwait University Hospital, and 70 from Al-Sabeen Maternal and Child Hospital. This distribution preserved multisite representation while maintaining a feasible sample for detailed questionnaire-based assessment.

Data were collected using a structured self-administered questionnaire developed from the study objectives and infection-prevention concepts relevant to standard precautions and occupational sharps exposure. The sharps-focused sections captured 12-month injury history, whether the instrument had previously been used on a patient or might have been used on a patient, the number of needlestick injuries and other sharps injuries, devices involved, injury circumstances, reporting behavior, post-exposure care, disposal practices, the location of safety containers, and hepatitis B vaccination history. The broader

instrument also included prevention-relevant behavioral domains related to sharps safety, permitting interpretation of injury patterns within a wider context of precaution knowledge, behavior, and belief patterns.

Content validity was established through expert review, and the questionnaire underwent piloting before implementation. Reliability testing in the source study showed acceptable internal consistency for the sharps-related domains, with Cronbach's alpha coefficients of 0.87. These values support the use of the instrument for descriptive occupational-health analysis in this setting.

The primary outcome for this manuscript was 12-month prevalence of injury from a sharp that had either been used on a patient or might previously have been used on a patient. Secondary outcomes included the frequency distribution of repeat injuries, the cumulative counts of needlestick and other sharps injuries, device categories involved, self-reported circumstances of injury, official reporting behavior, receipt and location of post-exposure care, disposal and container-placement practices, and hepatitis B vaccination uptake. Because the study focused on a nursing workforce, all prevalence estimates reflect the reported experience of participating nurses rather than mixed occupational categories.

Data analysis was performed with SPSS version 27.0. Descriptive analysis included frequencies, proportions, means, and standard deviations. For key binomial outcomes, 95% confidence intervals were calculated to communicate the precision of major estimates. The present manuscript prioritizes descriptive and practice-relevant findings because its central purpose was to characterize the injury burden and its institutional context rather than to construct a causal model from cross-sectional data. Where informative for prevention planning, hospital-specific mean injury counts and selected prevention-related behavioral indicators are also presented. Exploratory between-group comparisons of prevention-relevant composite scores were conducted with independent-samples t tests or one-way analysis of variance, as appropriate, and Pearson correlation coefficients were used to examine linear associations with age and years of experience.

Ethical and administrative approval for the original study was obtained from the relevant institutional and hospital authorities. Participation was voluntary, the questionnaire was self-administered, and confidentiality was maintained throughout data collection and analysis. The manuscript presents aggregate findings only and does not contain identifying information about individual participants. These procedures are consistent with the ethical handling of observational occupational-health research involving healthcare workers *(von Elm et al., 2007).*

Results

The study included 300 nurses drawn from four governmental teaching hospitals in Sana'a City. Women constituted 56.0% of the sample, the mean age was 32 +/- 7 years, and 85.0% were younger than 40 years. Most participants held a higher diploma (61.7%), 81.7% reported previous training on standard precautions, and the largest hospital-specific share came from Al-Thawra General Hospital (33.3%), followed by Al-Jomhouri Teaching Hospital and Al-Sabeen Maternal and Child Hospital (23.3% each) and Kuwait University Hospital (20.0%) (Table 1).

Table 1: ***Participant characteristics.***

Characteristic	Value
Female sex	168 (56.0%)
Mean age (years)	32 +/- 7 (range, 20-57)
Age < 40 years	255 (85.0%)

Characteristic	Value
Higher diploma	185 (61.7%)
Previous training on standard precautions	245 (81.7%)
Al-Thawra General Hospital	**100 (33.3%)**
Al-Jomhouri Teaching Hospital	**70 (23.3%)**
Kuwait University Hospital	**60 (20.0%)**
Al-Sabeen Maternal and Child Hospital	**70 (23.3%)**

The 12-month prevalence of injury from a sharp that had been used on a patient or might previously have been used on a patient was 89.3% (268/300; 95% CI [85.3%, 92.3%]). More specifically, 83.3% reported injury from a device known to have been used on a patient and an additional 6.0% reported injury from a device of uncertain previous patient use. Only 6.7% reported no contaminated or possibly contaminated sharps injury during the previous year; when injuries from clean devices were also considered, the proportion with complete absence of any sharp's injury was smaller still. These figures indicate that exposure was the rule rather than the exception in the participating hospitals (Table 2).

Table 2: ***Twelve-month burden and recurrence profile of needlestick and sharps injuries.***

Indicator	n or mean	% or comment
At least one contaminated or possibly contaminated sharps injury	268/300	89.3% (95% CI 85.3-92.3)
Injury from device known to have been used on a patient	250/300	83.3% (95% CI 78.7-87.1)
Injury from device of uncertain prior patient use	18/300	6.0%
No sharps injury during previous 12 months	20/300	6.7%
Total needlestick injuries reported	2,321	69.0% of all injuries
Total injuries from other sharps	1,061	31.0% of all injuries
Total injuries reported	3,382	Needlestick and other sharps combined
Five or more needlestick injuries among exposed nurses	183/268	68.3%
Two other-sharps injuries among exposed nurses	99/260	38.1%
Three other-sharps injuries among exposed nurses	42/260	16.2%
Five or more other-sharps injuries among exposed nurses	75/260	28.8%
Highest mean needlestick count by hospital	10.78	Al-Jomhouri Teaching Hospital
Highest mean other-sharps count by hospital	7.11	Al-Jomhouri Teaching Hospital

Note. Mean needlestick count across all hospitals = 8.66; mean count of other-sharps injuries = 4.08.

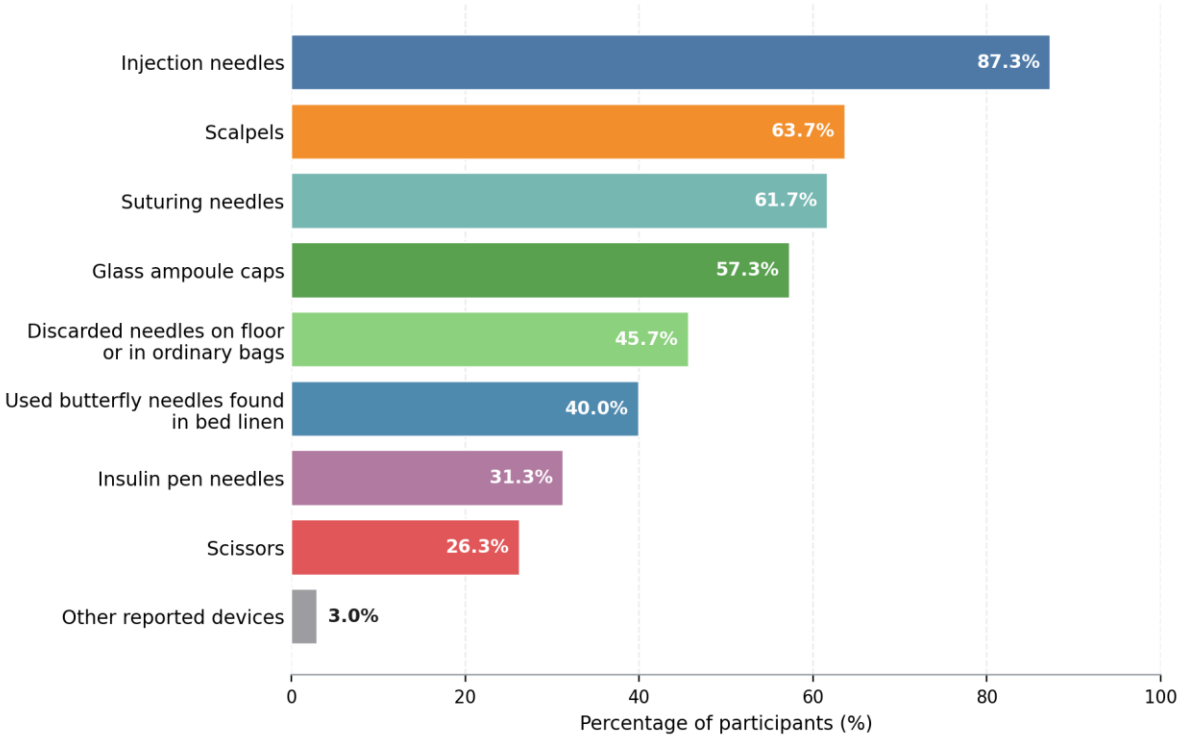
The cumulative intensity of exposure was also striking. Across the 300 nurses, a total of 3,382 injuries were reported during the preceding 12 months, including 2,321 needlestick injuries and 1,061 injuries from other sharps. Thus, needlestick injuries accounted for 69.0% of all reported injuries and

other sharps for 31.0%. When hospital-specific means were examined, Al-Jomhouri Teaching Hospital showed the highest mean counts for both needlestick injuries (10.78) and other sharps injuries (7.11), while the overall sample means were 8.66 and 4.08, respectively. This pattern suggests both a high overall hazard and meaningful interfacility variation in injury intensity (Table 2).

Recurrent exposure was common. Among nurses reporting needlestick injuries, 5.2% experienced one needlestick injury, 9.3% experienced two, 14.6% experienced three, 2.6% experienced four, and 68.3% reported five or more. For injuries caused by other sharps, 12.3% reported one episode, 38.1% reported two, 16.2% reported three, 4.6% reported four, and 28.8% reported five or more. These distributions indicate that the occupational hazard was not limited to sporadic accidents; instead, many nurses experienced repeated exposure over the course of a single year (Table 2).

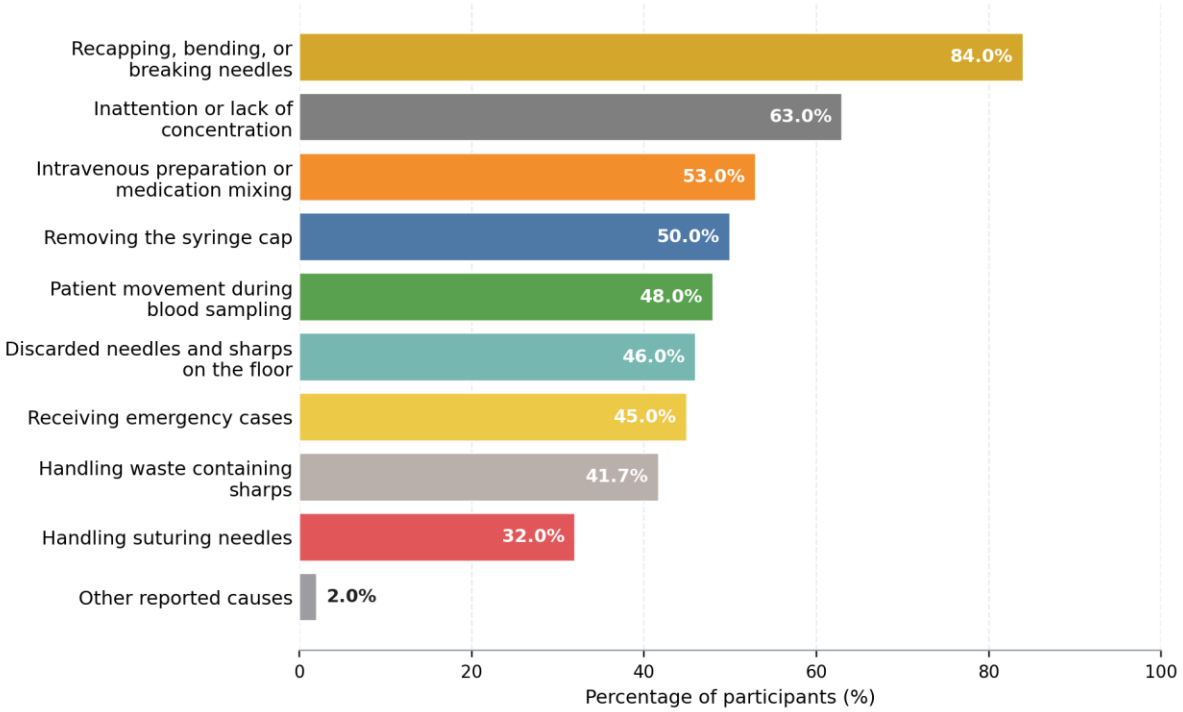
Injection needles were the most commonly implicated devices, accounting for 87.3% of reported injuries, followed by scalpels (63.7%), suturing needles (61.7%), and glass ampoule caps (57.3%). Other notable sources included discarded needles found on the floor or in ordinary bags (45.7%), used butterfly needles found in bed linen (40.0%), insulin pen needles (31.3%), and scissors (26.3%), indicating that the burden of injury extended beyond routine bedside injection to include procedural and waste-related hazards (Figure 1).

Figure 1. Devices most frequently implicated in needlestick and sharps injuries among study participants.



Regarding the circumstances of exposure, recapping, bending, or breaking needles was the most frequently reported cause (84.0%), followed by inattention or lack of concentration (63.0%) and intravenous preparation or medication mixing (53.0%). Additional commonly reported contexts included removing the syringe cap (50.0%), patient movement during blood sampling (48.0%), discarded needles and sharps on the floor (46.0%), receiving emergency cases (45.0%), handling waste containing sharps (41.7%), and handling suturing needles (32.0%). Collectively, these findings indicate that sharps injuries were closely linked to everyday nursing activities, unsafe disposal practices, and environmental hazards within the hospital setting (Figure 2).

Figure 2. Circumstances associated with exposure to needlestick and sharps injuries among study participants.



Note. Multiple responses were allowed for both device types and reported injury circumstances.

Reporting behavior was limited. Among nurses who had experienced contaminated or potentially contaminated sharps injury, 63.4% had never officially reported any of their injuries. Only 16.0% reported one event, 10.1% reported two events, 8.6% reported three events, and 1.9% reported more than three. Thus, despite the high burden of repeated exposure, formal reporting remained absent for most affected nurses, indicating major attrition in the institutional surveillance pathway (Table 3).

Table 3: ***Reporting behavior and post-exposure management.***

Indicator	n (%)	Comment
Never officially reported the injury event(s)	170 (63.4)	Marked underreporting
Reported one event	43 (16.0)	Limited use of reporting system
Reported two events	27 (10.1)	Low repeat reporting
Reported three events	23 (8.6)	Low repeat reporting
Reported more than three events	5 (1.9)	Rare sustained reporting
Did not receive post-exposure healthcare	206 (68.7)	Major follow-up gap
Received care through infection-control unit	162 (54.0)	Most common formal care pathway
Received care through emergency department	65 (21.7)	Secondary formal pathway
Received care through a familiar physician	63 (21.0)	Informal or semi-formal pathway
Received care through outpatient clinic	15 (5.0)	Less common pathway

Note. Care destinations were reported as multiple responses. Percentages for reporting are based on exposed nurses.

Post-exposure management was also limited. Most participants (68.7%) stated that they did not receive post-exposure healthcare after sharps injury. Among reported care destinations, the infection-control department or unit was the most frequently identified source of care (54.0%), followed by the emergency department (21.7%), consultation with a familiar physician such as a relative or colleague (21.0%), and the outpatient clinic (5.0%). The use of informal personal contacts as a care route suggests that, even when care was sought, response pathways were not always standardized or fully institutionalized (Table 3).

The environmental and disposal findings suggested partial preventive infrastructure but inconsistent standardization. Most nurses reported using a designated sharps box for disposal (78.0%), yet 52.0% also reported using plastic containers, 15.7% reported disposal in garbage baskets, and 7.0% reported disposal in ordinary waste bags. Safety boxes were reported to be available on medication carts by 75.0% of participants, in all procedure rooms by 61.3%, and in all patient rooms by 53.7%. Far fewer participants reported container availability in dirty utility rooms (14.7%) or wash areas (7.0%). Thus, a preferred disposal route existed, but safer placement and full standardization were incomplete (Table 4).

Table 4: ***Institutional preventive measures related to disposal and safety-container placement.***

Measure	n (%)	Interpretation
Disposed sharps in designated safety box	234 (78.0)	Preferred disposal route present but incomplete
Disposed sharps in plastic containers	156 (52.0)	Common substitute practice
Disposed sharps in garbage basket	47 (15.7)	Unsafe residual practice
Disposed sharps in ordinary waste bags	21 (7.0)	Unsafe residual practice
Safety boxes available on medication carts	225 (75.0)	Important but not universal
Safety boxes available in all procedure rooms	184 (61.3)	Partial standardization
Safety boxes available in all patient rooms	161 (53.7)	Partial standardization
Safety boxes available in dirty utility rooms	44 (14.7)	Limited placement
Safety boxes available in wash rooms	21 (7.0)	Limited placement

Note. Disposal methods and locations were based on participant report; multiple responses were allowed.

Hepatitis B vaccination coverage was low. Only 62 nurses (20.7%, 95% CI [16.5%, 25.6%]) reported receiving any hepatitis B vaccination, while 238 (79.3%) reported no vaccination. Among the 62 vaccinated participants, 19 had received one dose, 16 had received two doses, 24 had received three doses, and 3 reported more than three doses. When expressed relative to the full sample, only 8.0% had completed a three-dose series and 1.0% had received more than three doses. Given the very high burden of sharps exposure in the same sample, this represents a major missed layer of occupational protection (Table 5).

Table 5: ***Hepatitis B vaccination status.***

Vaccination status	n	%
Any hepatitis B vaccination	62	20.7 (95% CI 16.5-25.6)
No hepatitis B vaccination	238	79.3
One dose	19	6.3 of total sample; 30.6 of vaccinated
Two doses	16	5.3 of total sample; 25.8 of vaccinated
Three doses	24	8.0 of total sample (95% CI 5.4-11.6); 38.7 of vaccinated
More than three doses	3	1.0 of total sample; 4.8 of vaccinated

Note. A completed three-dose schedule was uncommon despite very high exposure burden.

Selected prevention-relevant behavioral indicators further contextualized the exposure burden. Although 74.7% of participants achieved a good sharps-related knowledge level and 52.0% achieved a good sharps-related practice level, only 18.0% demonstrated positive sharps-related attitudes or beliefs. At item level, direct disposal of used sharps in safety boxes was strong, but nonrecapping knowledge and practice remained imperfect and endorsement of several protective beliefs was weak. These findings suggest that environmental risk and injury recurrence operated alongside incomplete behavioral and attitudinal support for safe sharps handling (Table 6).

Table 6: ***Selected prevention-relevant behavioral indicators related to sharps safety.***

Indicator	Value	Interpretation
Good sharps-related knowledge level	74.7%	Knowledge stronger than behavior and attitudes
Good sharps-related practice level	52.0%	Moderate and incomplete
Positive sharps-related attitudes/beliefs	18.0%	Marked attitudinal weakness
Knowledge: do not recap needles after use	57.0% answered correctly	Substantial gap
Practice: immediately discard used sharps in safety boxes	93.0% favorable	Strong performance
Practice: avoid recapping used needles	66.0% favorable	Persistent gap
Attitude: do not separate needle from syringe before disposal	49.0% favorable	Weak endorsement
Attitude: sharps injury is a major route of blood-borne disease	82.0% favorable	Risk awareness present

To present the descriptive results in a directly reviewable format, the main study outcomes are additionally summarized as frequencies and percentages in Table 7.

Table 7: ***Frequency-and-percentage summary of the main descriptive findings.***

Descriptive finding	Frequency (n)	Percentage (%)
Female participants	168	56.0

Participants aged <40 years	255	85.0
Participants with at least one contaminated or possibly contaminated sharps injury	268	89.3
Injured participants who never officially reported the event	170	63.4
Participants who did not receive post-exposure healthcare	206	68.7
Participants reporting disposal in a designated sharps box	234	78.0
Participants who had received any hepatitis B vaccination	62	20.7
Participants who had completed a 3-dose hepatitis B schedule	24	8.0

Note. Percentages are based on the total sample (N=300), except the reporting indicator, which is based on participants who experienced sharps injury (n=268).

Figures 3 and 4 present the proportional distribution (percentages) of the key behavioral, reporting, post-exposure, vaccination, and infrastructure indicators identified in this study.

Figure 3. Percentage distribution of good-level achievement across prevention-relevant Practice. The figure contrasts the proportion of participants reaching the good-level threshold for general standard precautions and for sharps-specific precautions.

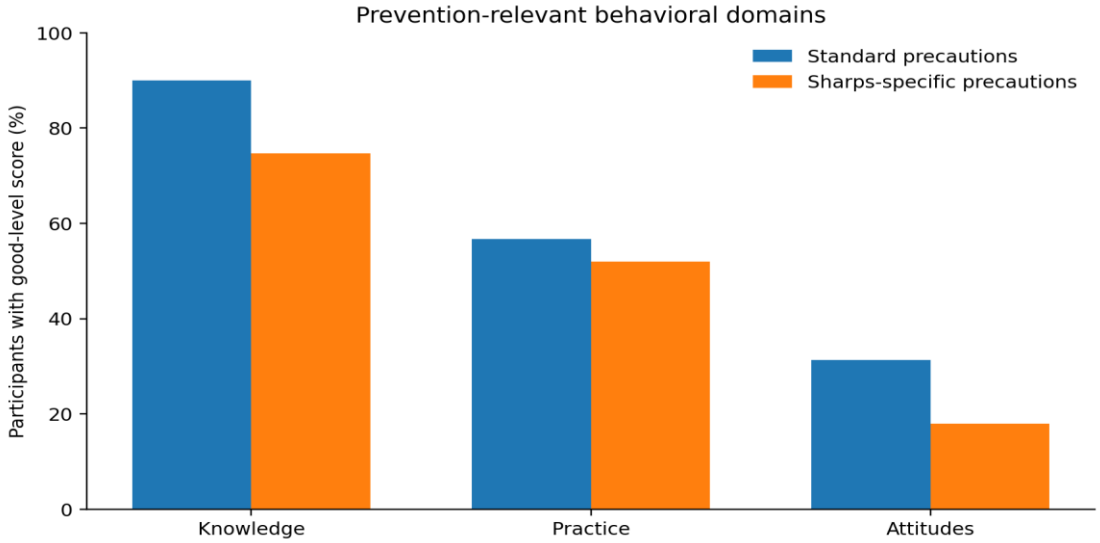
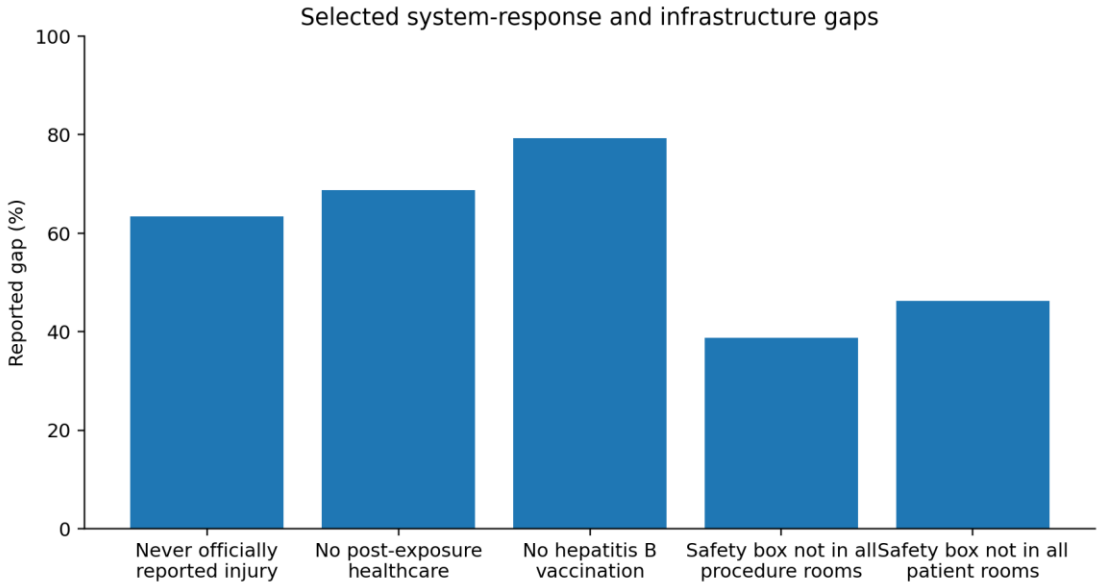


Figure 4. Percentage distribution of selected system-response and infrastructure gaps identified by the study. Values for safety-box deficits represent the complement of reported availability in all procedure rooms and all patient rooms.



To make the relationship between demographic characteristics and nurses' safety-related behavior explicit, Table 8 summarizes the statistically notable associations between selected participant factors and prevention-relevant behavioral indicators.

Table 8. Associations between demographic characteristics and prevention-relevant behavior among nurses.

Demographic variable	Behavioral / prevention-related indicator	Main pattern observed	P value
Sex	Sharps-specific knowledge	Women had slightly higher mean knowledge scores than men (2.64 +/- 0.31 vs 2.56 +/- 0.34).	0.018
Age group	General standard-precaution practice	Practice scores varied across age groups, with the lowest mean in the 50-60-year group (3.76 +/- 0.69).	0.001
Years of experience	General standard-precaution practice	Practice scores differed across experience strata; the highest mean was observed in the 30-40-year group (4.26 +/- 0.28).	<0.001
Hospital	General knowledge and attitudes	Hospital-level differences were observed for general standard-precaution knowledge and attitudes, suggesting institutional heterogeneity.	0.036; 0.009
Age / years of experience	Sharps-specific knowledge, practice, and attitudes	No meaningful linear correlation was detected for age or years of experience with sharps-specific composite scores.	>0.05 for all

Note. Sex comparisons used independent-samples t tests. Age group, educational level, hospital, and years-of-experience comparisons used one-way analysis of variance. Correlation estimates for age and years of experience were not statistically significant for sharps-specific knowledge, practice, or attitudes.

Because the principal focus of this Study is occupational needlestick and sharps **injuries**, Table 9 provides a sharps-specific summary of demographic associations, with emphasis on the statistically

significant findings and the variables that were not significantly associated with sharps-related knowledge, **practices**, or attitudes.

Table 9. Demographic correlates of sharps-specific knowledge, practice, and attitudes among nurses.

Demographic variable	Sharps-specific knowledge	Sharps-specific practice	Sharps-specific attitudes/beliefs	Interpretation
Age group	p=0.796	p=0.170	p=0.444	No statistically significant association across sharps-specific domains.
Sex	p=0.018	p=0.093	p=0.972	Only sharps-specific knowledge differed significantly, in favor of women.
Educational level	p=0.722	p=0.107	p=0.284	No statistically significant association.
Hospital	p=0.163	p=0.324	p=0.124	No statistically significant sharps-specific hospital effect.
Years of experience	p=0.580	p=0.570	NS	No statistically significant association; the exact p value for sharps-specific attitudes by years of experience was not reported in the source table.

Note. NS indicates not statistically significant at the 0.05 level. The source analysis identified sex as the only demographic factor significantly associated with the sharps-specific knowledge score; no significant associations were observed for sharps-specific practice or sharps-specific attitudes/beliefs across the remaining demographic variables.

Discussion

This focused analysis indicates that the occupational burden of sharps injury among nurses in governmental teaching hospitals in Sana'a City was exceptionally high, recurrent, and associated with multiple downstream gaps. The principal message of the study is that sharps injury in this setting should be understood as a systems problem extending from routine procedural behavior to reporting, post-exposure management, environmental design, and biological preparedness. This interpretation is consistent with contemporary infection-prevention thinking, which emphasizes that healthcare-worker safety emerges from the interaction of worker behavior, workflow design, surveillance, leadership, and access to protective systems rather than from knowledge alone (Centers for Disease Control and Prevention, 2024b; Powers et al., 2016; World Health Organization, 2022).

The observed 12-month prevalence of 89.3% is substantially higher than the pooled figures reported in international syntheses. Bouya et al. (2020) estimated a one-year global pooled prevalence of 44.5%, Mengistu et al. (2021) estimated 32.4%, and Hosseinipalangi et al. (2022) reported a global incidence of 43%. Even allowing for methodological variation across studies, the estimate in the present study places the participating hospitals at the upper end of the published range and indicates that occupational exposure in these facilities cannot be regarded as routine background risk. The comparison suggests a setting with marked structural vulnerability rather than simple random variation around a global average (Bouya et al., 2020; Hosseinipalangi et al., 2022; Mengistu et al., 2021).

The result is also consistent with the broader warning signal emerging from Yemen. *Almoliky et al. (2024)* reported a very high prevalence of needlestick and sharps injury among nurses in public hospitals in Taiz, Yemen, showing that intense occupational exposure is not confined to one city or institution. Taken together, the Sana'a and Taiz findings suggest that sharps injury among Yemeni nurses may reflect a broader systems issue involving resource constraints, overloaded service environments,

inconsistent preventive infrastructure, and underdeveloped occupational-health response mechanisms *(Almoliky et al., 2024; World Health Organization, 2022).*

Another notable finding is the sheer recurrence of exposure. More than two-thirds of those with needlestick injury reported five or more needlestick injuries in the previous year, and other-sharps injuries were also frequently repeated. This matters because recurrence changes the interpretation of risk. A single injury might be discussed as an isolated lapse; repeated injury indicates that the environment and workflow repeatedly generate exposure opportunities. Recurrent injury also increases the chance that at least one event will involve a contaminated source, delayed reporting, inadequate wound care, or missed prophylaxis, thereby compounding the clinical significance of what might otherwise be dismissed as routine punctures *(Bahat et al., 2021; Behzadmehr et al., 2023; Centers for Disease Control and Prevention, 2024c).*

The cumulative count of 3,382 injuries makes the same point in another way. A high prevalence estimate could theoretically arise from many workers sustaining one minor event each; that is not what these data show. Instead, the dataset reflects repeated injuries concentrated within a single year, with needlestick injuries alone accounting for more than two-thirds of all reported events. This level of cumulative exposure implies repeated workflow failures, repeated contact with unsafe environments, or both, and it strongly supports the need for hospital-level surveillance systems that monitor not only whether injury occurs but how often it recurs and where recurrences cluster *(Centers for Disease Control and Prevention, 2024b; World Health Organization, 2022).*

The device pattern is also epidemiologically coherent. Injection needles were the most common source of injury, followed by scalpels, suturing needles, and glass ampoule caps. *Bouya et al. (2020)* similarly found that hypodermic needles were the most common device-related cause of injury globally, while *Hosseinipalangi et al. (2022)* identified needles as the dominant device category in pooled analyses. The Sana'a findings extend that literature by showing that, in nursing practice, the injury burden is not confined to needle insertion alone; it also encompasses wound closure instruments, medication-preparation materials, and sharps that remain hazardous after the original procedure has ended *(Bouya et al., 2020; Hosseinipalangi et al., 2022; World Health Organization, 2014).*

The circumstances of injury help explain why the problem persisted. Recapping, bending, or breaking needles was by far the most common reported circumstance, followed by inattention, intravenous preparation, patient-handling activities, and discarded sharps in the environment. This pattern closely mirrors the broader literature: *Hosseinipalangi et al. (2022)* identified recapping as the most prominent pooled cause, and CDC guidance continues to treat recapping avoidance and immediate safe disposal as core prevention principles *(Centers for Disease Control and Prevention, 2024b; Hosseinipalangi et al., 2022).* From a behavioral perspective, recapping is not only an incorrect technique; it is often a visible sign of deeper systems issues such as containers being too far away, workflow being rushed, hands being occupied, or staff adapting unsafe habits to local constraints *(Powers et al., 2016; World Health Organization, 2014).*

The prominence of inattention and concentration lapses should also be interpreted structurally rather than moralistically. In busy hospital practice, inattention may reflect cognitive overload, multitasking, interruptions, fatigue, overcrowding, or normalization of risk under time pressure. Teaching hospitals intensify many of these conditions because they combine service delivery with supervision, training, and frequent turnover of learners. Previous work has shown that sharps injuries are associated with department type, workload, and contextual features of nursing work, and the present results are consistent with that explanation *(Cho et al., 2013; Powers et al., 2016; Senbato et al., 2024).*

One of the most concerning findings was underreporting. Nearly two-thirds of injured nurses had never officially reported the event, despite the very high exposure burden. This proportion exceeds the 46% reported by Bahat et al. (2021) and is consistent with the broader systematic evidence showing that

a large share of needlestick injuries remains invisible to formal institutional systems (Bahat et al., 2021; Behzadmehr et al., 2023). In practical terms, underreporting means that hospitals underestimate their hazard burden, managers lose the data needed to target prevention, and nurses may miss the clinical pathway required for timely risk assessment and prophylaxis (Centers for Disease Control and Prevention, 2024c; World Health Organization, 2024a).

Underreporting is especially dangerous when injuries recur. The literature suggests that repeated exposure can reduce the likelihood of reporting because workers become accustomed to injury, judge the event as insignificant, or conclude that reporting does not produce useful action. The Sana'a data fit that interpretation: repeated injury and nonreporting coexisted in the same workforce. This combination points to a potentially normalized unsafe culture in which sharps injury is anticipated but not systematically acted upon, a situation that sharply weakens both worker protection and institutional learning *(Bahat et al., 2021; Behzadmehr et al., 2023; World Health Organization, 2022).*

The supplementary subgroup analysis adds interpretive nuance to the descriptive findings. The observation that women scored slightly higher than men on sharps-specific knowledge, while practice variation was more evident across age and experience strata, suggests that knowledge alone was not the main limiting factor. In this setting, translation of knowledge into routine safe behavior was likely constrained by workload, supervision, workflow design, and the practical availability of safety infrastructure.

The hospital-level differences in general knowledge and attitudes are also important because they point toward modifiable institutional effects rather than immutable worker characteristics. Uneven training intensity, local reporting culture, container placement, and supervision quality may explain why safety performance differed across facilities. In teaching hospitals especially, such heterogeneity can reproduce unsafe norms across students and junior staff unless prevention standards are standardized and actively audited.

The finding that 68.7% of injured nurses did not receive post-exposure care deepens the concern. Current HBV exposure guidance from the CDC emphasizes rapid assessment of immune status, source risk, and the need for post-exposure management according to vaccination and serologic status, while WHO's 2024 HIV post-exposure prophylaxis guidance underscores the time-sensitive nature of appropriate assessment and prophylaxis access (Centers for Disease Control and Prevention, 2024c; Schillie et al., 2013; World Health Organization, 2024a). When most injured nurses receive no formal care, the post-exposure component of prevention remains seriously underperforming, even when the initial injury has already occurred.

The pattern of care destinations is also instructive. The infection-control unit was the most frequently named source of care, but a substantial proportion of participants relied on the emergency department or on informal consultation with a familiar physician. Informal care seeking may partly reflect convenience, trust, or speed; however, it also suggests that post-exposure pathways were not universally standardized, visible, or trusted. Effective sharps programs require a designated pathway that is known in advance, immediately accessible, and linked to testing, documentation, counseling, and follow-up rather than ad hoc personal decision-making *(Centers for Disease Control and Prevention, 2024b, 2024c; World Health Organization, 2024a).*

Institutional preventive measures showed a mixed picture. On the positive side, most nurses reported access to designated sharps boxes and many reported that containers were available on medication carts and in procedure rooms. On the negative side, a large proportion also reported disposal in plastic containers, garbage baskets, and ordinary waste bags. According to WHO guidance, safe sharps waste management depends on puncture-resistant containers, clear segregation, and appropriate placement close to the point of generation; residual disposal in ordinary garbage streams is incompatible

with safe waste principles and creates avoidable secondary exposure risks for staff and cleaners *(Centers for Disease Control and Prevention, 2024b; World Health Organization, 2014).*

Container placement deserves particular attention. A container can exist in principle yet still fail in practice if it is not within immediate reach at the moment of injection, line insertion, medication preparation, or bedside disposal. CDC sharps-safety resources explicitly treat location and environmental design as part of prevention programming, because workers often improvise unsafe workarounds when the correct disposal route is inconvenient *(Centers for Disease Control and Prevention, 2024b).* The present findings are compatible with that logic: medication-cart placement was reported more often than universal patient-room or procedure-room coverage, suggesting that access may still be uneven at the exact points where sharps become hazardous. At Ministry of Health level, this should be translated into a unified sharps-injury policy package that standardizes immediate reporting, risk assessment, post-exposure follow-up, and documentation requirements across all governmental teaching hospitals.

The hepatitis B vaccination findings indicate a further systems gap. Only one in five nurses reported any HBV vaccination, and only 8.0% of the entire sample reported a completed three-dose schedule. In a workforce with extremely high sharps-exposure prevalence, this level of incomplete immunization is difficult to justify from an occupational-health perspective. HBV vaccination is one of the most effective pre-exposure protections available to healthcare personnel, and both CDC and WHO guidance treat vaccination status as central to post-exposure management and long-term worker safety (Centers for Disease Control and Prevention, 2024c; Schillie et al., 2013; World Health Organization, 2024b). Low vaccination coverage therefore makes each sharps injury potentially more consequential than it would be in a protected workforce.

The selected prevention-related behavioral indicators help explain why high injury prevalence coexisted with some awareness of safe practice. Good sharps-related knowledge was more common than good sharps-related practice, and positive sharps-related attitudes were much rarer. This pattern is consistent with the broader infection-prevention literature showing that knowledge is necessary but not sufficient for consistent safe behavior. Studies in Jordan, Saudi Arabia, China, and Ethiopia have described similar gaps between understanding of standard precautions and actual compliance in clinical environments shaped by workload, supply, supervision, and institutional culture *(Abalkhail et al., 2021; Al-Faouri et al., 2021; Senbato et al., 2024; Wang et al., 2021).* In the context of sharps injury, this means that training must be coupled with environmental design, observation, feedback, and accountability if it is to meaningfully reduce injury events *(Centers for Disease Control and Prevention, 2024b; Powers et al., 2016).*

Teaching hospitals have a special responsibility in this regard. Because these institutions train students, interns, and junior staff, unsafe sharps practices can be socially transmitted through apprenticeship and routine observation. Conversely, well-designed safety systems can influence an entire generation of clinicians. WHO's global IPC framework treats organizational culture, leadership commitment, and facility systems as fundamental components of infection prevention, and the present findings show why that systems perspective is especially important in educational hospitals *(World Health Organization, 2022).* These operational steps should be embedded in written protocols, supported by visible reporting forms or electronic reporting pathways, and reviewed regularly by hospital leadership and the Ministry of Health infection-prevention program.

From a management perspective, the findings support a set of linked interventions rather than isolated educational messages. Hospitals need a clear written protocol for immediate reporting and response, visible points of contact for post-exposure management, standardized point-of-use disposal infrastructure, regular audit of container availability and replacement, active feedback on injury surveillance data, and vaccination documentation systems. Training remains necessary, but it should focus not only on knowledge transmission; it should also address recapping avoidance, disposal

workflow, emergency-case handling, and the expectation that every injury is reportable and clinically actionable *(Centers for Disease Control and Prevention, 2024a, 2024b, 2024c; World Health Organization, 2014, 2024a, 2024b).* Vaccination policy should also be expanded beyond selective uptake to an actively monitored catch-up program for all nurses and other exposed clinical, technical, and support staff, with documentation of dose completion and linkage to occupational-health records.

The study also has strengths. It analyzed nurses only rather than mixing occupational groups, thereby yielding a profession-specific picture of risk. It drew participants from four major governmental teaching hospitals, quantified both prevalence and cumulative injury counts, and incorporated reporting behavior, post-exposure care, environmental disposal measures, and HBV vaccination into the same analytic frame. This combination gives the manuscript practical value for occupational-health planning because it moves beyond prevalence alone to examine what hospitals actually do, or fail to do, before and after exposure.

Several limitations should nevertheless be acknowledged. The data were self-reported and may therefore be affected by recall error or social desirability bias. The cross-sectional design does not permit causal inference, and the study was limited to four governmental teaching hospitals in Sana'a City, so the findings should not automatically be generalized to private hospitals, primary care facilities, or rural settings. In addition, the study did not directly observe disposal behavior or independently verify vaccination status. These constraints are common in workforce surveys and should be considered when interpreting the magnitude and mechanisms of the reported associations *(von Elm et al., 2007).*

Even with these limitations, the manuscript provides a clear warning signal. The data do not describe a workforce with occasional accidental puncture in an otherwise functional safety system; rather, they describe a workforce living with repeated sharps exposure, partial environmental safeguards, frequent nonreporting, weak formal follow-up, and low HBV immunization. This combination is precisely the profile in which preventable occupational infections and avoidable staff distress are most likely to persist. Accordingly, the study supports a shift from fragmented reactive management toward integrated sharps-safety programming in governmental teaching hospitals (Centers for Disease Control and Prevention, 2024b; World Health Organization, 2022).

Conclusion

Needlestick and sharps injuries among nurses in the participating governmental teaching hospitals in Sana'a were extraordinarily common, highly recurrent, and closely linked to underreporting, inadequate post-exposure care, incomplete hepatitis B vaccination, and inconsistent institutional preventive measures. Injection needles dominated the injury profile, but the burden also involved scalpels, suturing needles, ampoule caps, and improperly discarded sharps, indicating that exposure risk was distributed across procedures, environments, and waste pathways.

Overall, occupational sharps injury in these hospitals is best understood as a major systems-level safety problem rather than a set of isolated individual mistakes. Prevention requires a comprehensive response: point-of-use sharps containers, strict elimination of recapping practices, standardized and nonpunitive reporting systems, immediate post-exposure evaluation pathways, stronger supervision and audit, and institutionalized hepatitis B vaccination for nursing staff. In a teaching-hospital setting, strengthening these systems is not only a worker-protection priority but also a professional training obligation, because the safety culture experienced by today's nurses and trainees will shape the practices of tomorrow's workforce (Centers for Disease Control and Prevention, 2024b, 2024c; Schillie et al., 2013; World Health Organization, 2014, 2022, 2024a, 2024b).

Practice Implications

For hospital administrators, the findings justify the creation of a monitored sharps-safety program with named responsibility, monthly injury surveillance review, ward-level feedback, and visible response timelines after reported exposure *(Centers for Disease Control and Prevention, 2024b; World Health Organization, 2022).*

For infection-prevention teams, the priority actions are immediate point-of-use disposal, repeated competency-based training around recapping avoidance and medication-preparation workflow, and a 24-hour post-exposure pathway that workers know before an injury occurs *(Centers for Disease Control and Prevention, 2024a, 2024b, 2024c; World Health Organization, 2024a).*

For occupational-health policy, hepatitis B vaccination should be treated as a routine employment protection requirement for exposed nursing staff, with documentation, catch-up campaigns, and linkage to post-exposure decision-making *(Centers for Disease Control and Prevention, 2024c; Schillie et al., 2013; World Health Organization, 2024b).*

For the Ministry Health and environmental , these findings support a national policy package that mandates immediate reporting of every needlestick and sharps injury, standardizes post-exposure assessment and follow-up across governmental hospitals, ensures uninterrupted point-of-use access to puncture-resistant sharps containers, implements repeated competency-based training for nurses and supervisors, and expands hepatitis B vaccination coverage with documentation of dose completion for all exposed healthcare personnel.

Declarations

Ethics approval and consent to participate. Ethical and administrative approval for the original study was obtained from the relevant institutional and hospital authorities. Written informed consent was obtained from all participants prior to data collection.

Consent for publication. Not applicable.

Availability of data and materials. The dataset is not publicly available because of institutional restrictions but may be available from the corresponding author on reasonable request.

Competing interests. The authors declare no competing interests.

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Author contributions. The original study was conceived, conducted, and drafted by the **first author under academic supervision from the second author.**

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