



Knowledge, Compliance Behaviors, and Associated Factors Regarding Needlestick Injuries Among Nursing Students in Palestine: A Cross-Sectional Study

Conocimientos, comportamientos de cumplimiento y factores asociados respecto a las lesiones por pinchazo de aguja entre estudiantes de enfermería en Palestina: un estudio transversal

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Submitted: 02-08-2026 | Revised: 12-09-2026 | Accepted: 05-10-2026 | Published: 06-10-2026

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ABSTRACT

Background: Needlestick injuries (NSIs) pose a critical occupational hazard for nursing students during clinical education. Knowledge of safety protocols and adherence to standard precautions are essential for preventing bloodborne pathogen exposure. This study aimed to evaluate knowledge levels regarding NSIs, safe procedural practices, and associated demographic and training factors among undergraduate nursing students in Palestine. **Methods:** A quantitative cross-sectional design was conducted among 365 undergraduate nursing students across four major universities in the southern West Bank. Data were gathered using a validated self-administered questionnaire measuring demographic characteristics, clinical training history, safety practices, and an 8-item NSI knowledge scale. Knowledge scores were categorized using Bloom's cutoff points (Poor $\leq 59\%$, Moderate 60–79%, High $\geq 80\%$). Independent sample t-tests, one-way ANOVA, and Pearson correlation coefficients were used to analyze factors associated with knowledge scores. **Results:** The mean age of participants was 20.82 ± 1.04 years; 80.5% were female, and 51.8% were in their fourth year of study. High adherence was reported for always wearing gloves (79.7%) and always avoiding needle recapping (73.4%). The mean knowledge percentage score was $79.18\% \pm 18.87\%$, with 55.6% categorized as High, 32.9% as Moderate, and 11.5% as Poor knowledge. Students demonstrated high knowledge regarding NSI definitions (92.1%) and proper sharps disposal (92.9%), but gaps were identified regarding sharps container maximum capacity (58.6%) and immediate handwashing with soap and water post-exposure (66.8%). Female students scored significantly higher in knowledge than male students (81.34% vs. 70.25%, $p < 0.001$). Furthermore, students who always wore gloves (80.46% vs. 74.16%, $p = 0.010$) and those who always avoided recapping needles (80.55% vs. 75.39%, $p = 0.021$) exhibited significantly higher knowledge scores. Laboratory training ($p = 0.103$), academic year ($p = 0.638$), and age ($p = 0.338$) were not significantly associated with knowledge levels. **Conclusion:** Palestinian nursing students demonstrate a generally high level of knowledge regarding NSIs, which positively correlates with essential safety behaviors. However, targeted educational interventions are necessary to address specific post-exposure protocol knowledge deficits and to enhance safety education among male nursing students.

Keywords: needlestick injuries; knowledge; safety precautions; nursing students; Palestine; occupational health.

RESUMEN

Antecedentes: Las lesiones por punzada de aguja (INS) suponen un riesgo laboral crítico para los estudiantes de enfermería durante la educación clínica. El conocimiento de los protocolos de seguridad y el cumplimiento de las precauciones estándar son esenciales para prevenir la exposición a patógenos transmitidos por la sangre. Este estudio tuvo como objetivo evaluar los niveles de conocimiento sobre los INS, prácticas procedimentales seguras y factores demográficos y de formación asociados entre estudiantes de enfermería de grado en Palestina. **Métodos:** Se realizó un diseño cuantitativo transversal entre 365 estudiantes de enfermería de grado en cuatro universidades principales del sur de Cisjordania. Los datos se recopilaban mediante un cuestionario autoadministrado validado que midió características demográficas, historial clínico, prácticas de seguridad y una escala de conocimiento de INES de 8 ítems. Las puntuaciones de conocimiento se categorizaron usando los puntos de corte de Bloom (Pobre $\leq 59\%$, Moderado 60–79%, Alto $\geq 80\%$). Se utilizaron pruebas t de muestra independiente, ANOVA unidireccional y coeficientes de correlación Pearson para analizar factores asociados con las puntuaciones de conocimiento. **Resultados:** La edad media de los participantes fue de $20,82 \pm 1,04$ años; el 80,5% eran mujeres y el 51,8% estaban en su cuarto año de estudio. Se reportó una alta adherencia por llevar siempre guantes (79,7%) y evitar siempre el retapar con aguja (73,4%). La puntuación media de porcentaje de conocimiento fue del $79,18\% \pm 18,87\%$, con un 55,6% categorizado como Alto, 32,9% como Moderado y un 11,5% como Pobre conocimiento. Los estudiantes demostraron un alto conocimiento sobre las definiciones de INS (92,1%) y la correcta disposición de los punzantes (92,9%), pero se identificaron carencias respecto a la capacidad máxima de los recipientes punzantes (58,6%) y el lavado inmediato de manos con agua y jabón tras la exposición (66,8%). Las estudiantes mujeres obtuvieron puntuaciones significativamente más altas en conocimiento que los varones (81,34% frente a 70,25%, $p < 0,001$). Además, los estudiantes que siempre llevaban guantes (80,46% vs. 74,16%, $p = 0,010$) y aquellos que siempre evitaban las agujas de recapar (80,55% vs. 75,39%, $p = 0,021$) mostraron puntuaciones de conocimiento significativamente más altas. La formación en laboratorio ($p = 0,103$), el año académico ($p = 0,638$) y la edad ($p = 0,338$) no se asociaron significativamente con los niveles de conocimiento. **Conclusión:** Los estudiantes palestinos de enfermería demuestran un nivel generalmente alto de conocimiento sobre los INS, lo que se correlaciona positivamente con conductas esenciales de seguridad. Sin embargo, son necesarias intervenciones educativas específicas para abordar déficits específicos de conocimiento en protocolos post-exposición y para mejorar la educación en seguridad entre los estudiantes varones de enfermería.

Palabras clave: lesiones por pinchazo de aguja; conocimientos; precauciones de seguridad; estudiantes de enfermería; Palestina; salud laboral.

INTRODUCTION

Needlestick injuries (NSIs) are defined as penetrating wounds caused by hypodermic needles or other sharp instruments contaminated with blood, tissue, or body fluids[1]. These injuries represent a significant occupational hazard for healthcare workers globally, with approximately 384,000 incidents occurring annually in U.S. hospitals alone, of which nearly 236,000 are caused by hollow-bore needles[2]. NSIs expose individuals to more than 20 bloodborne pathogens, including hepatitis B virus (HBV), hepatitis C virus (HCV), and human immunodeficiency virus (HIV), creating substantial health risks that extend beyond the individual to affect healthcare systems and public health[3,4]. Beyond physical health consequences, occupational safety incidents impose significant psychological distress on healthcare workers, manifesting as anxiety, fear, stress, and post-traumatic stress symptoms[5].

Nursing students constitute a particularly vulnerable population for occupational sharp exposures due to their limited clinical experience, frequent handling of sharp instruments during skill acquisition, and variable adherence to infection control protocols[4,6]. The global prevalence of NSIs among nursing students has been estimated at 35.7%, underscoring the universal exposure risk during clinical education[7]. Research indicates that nursing students are highly vulnerable to both procedural errors and psychological distress during clinical placements, primarily due to limited clinical practice, lack of procedural confidence, and fear of negative evaluations from clinical preceptors[5]. In conflict-affected environments, students face additional contextual challenges, as academic and environmental stress can significantly impact their psychological health and cognitive focus during clinical procedures[8,9].

Adequate knowledge regarding biosafety measures, safe needle handling, and post-exposure management serves as a cornerstone for preventing occupational exposure and ensuring appropriate infection control practices[10,11]. Comprehensive theoretical and practical understanding of standard precautions enables students to recognize potential hazards, avoid high-risk practices such as needle recapping, and adhere to recommended disposal standards[12,13]. However, studies globally and regionally highlight persistent knowledge deficits and inconsistent safety compliance among nursing trainees, necessitating continuous evaluation of educational outcomes and safety competencies[6,10,11].

Literature Review International Evidence

Internationally, knowledge and adherence to biosafety protocols among nursing students represent critical determinants of occupational safety. A systematic review and meta-analysis encompassing 32 studies reported an overall NSI prevalence of 35.7% among nursing students, with higher rates in developing nations attributed to insufficient access to protective equipment and inadequate implementation of safety training [7]. In China, research among acupuncture practitioners revealed that 34.3% had experienced NSIs, with 46.0% remaining unreported, pointing to ongoing deficits in safety culture and knowledge of exposure protocols [14]. Similarly, studies in India documented variable safety compliance and knowledge gaps, with nursing students exhibiting disproportionately higher risk profiles during clinical rotations [11,15].

Knowledge deficits regarding NSI prevention and post-exposure management have been consistently documented across international settings. Research in Italy among 238 nursing students found that knowledge levels directly influenced risk perceptions, with second-year students demonstrating lower compliance with safety measures during drug administration[13]. In Turkey, a study of 280 nursing students revealed that carelessness and rushing were common contributing factors to sharp injuries, emphasizing the need for reinforced educational modules prior to clinical entry[6]. Furthermore, a systematic review across ten countries emphasized that lack of clear occupational safety training and fear of disclosure exacerbate psychological distress and hinder compliance with standard reporting procedures[5,16]. Additionally, research in specialized clinical domains underscores the prognostic and systemic value of standardized health practices and risk monitoring[17].

Regional Evidence

Within the Middle East, gaps in knowledge, safety practices, and compliance behaviors among healthcare personnel and students remain significant concerns. In Saudi Arabia, multiple studies have documented gaps in infection control knowledge and inconsistent safety practices among healthcare workers and students[18–20]. Among nursing students specifically, Al-Mugheed

et al.[10]identified that limited awareness and poor adherence to infection control measures significantly elevated exposure risks during clinical training.

In Oman, a survey of 167 nursing students revealed that unsafe practices, particularly recapping needles (59%), were prevalent despite formal education, highlighting a persistent gap between theoretical knowledge and clinical practice[12]. Research in Iran among 264 nurses demonstrated a direct relationship between clinical competence, theoretical understanding of safety protocols, and the incidence of occupational exposure in high-risk units[21]. Furthermore, systematic evidence from Egypt and Iran indicated that healthcare workers with lower safety knowledge experienced higher anxiety and stress following exposure events[5]. These regional findings confirm that strengthening knowledge and enforcing practical adherence to safety standards remain key priorities across Middle Eastern healthcare education.

Low and Middle-Income Countries and Palestine

In low- and middle-income countries (LMICs), resource limitations, heavy clinical workloads, and inconsistent training infrastructure compound occupational safety challenges[22]. A global meta-analysis of 87 studies reported a pooled NSI prevalence of 44.5% among healthcare workers, with significantly higher rates in resource-constrained environments[22]. Studies in Ethiopia and Uganda emphasized that lack of safety training and inadequate knowledge regarding post-exposure prophylaxis were major contributors to unsafe clinical environments[23,24].

In Palestine, the healthcare and higher education systems operate under unique structural constraints related to ongoing political instability, economic limitations, and resource scarcity. Research among emerging adults and students in the West Bank has documented elevated levels of anxiety, depression, and stress associated with prolonged conflict and academic pressure [8,9]. Stress from frequent academic examinations and clinical expectations has been shown to impact emotional well-being and behavioral focus [9]. Studies among Palestinian nursing students have highlighted variable adherence to personal protective equipment and knowledge gaps regarding occupational hazards [25–27]. Furthermore, research examining nursing practice in Palestine—including quality of life during conflict [28], electronic medical record utilization [29], clinical alarm safety [30], and chronic disease management [31,32]—demonstrates the complex clinical context in which Palestinian nurses and students operate. However, detailed evaluations of NSI knowledge domains and their direct associations with reported safety behaviors remain under-researched in the southern West Bank.

Gaps in Literature and Study Aims

While occupational sharp hazards among nursing students have been widely studied globally, empirical evidence assessing specific knowledge domains, Bloom's knowledge classifications, and factors associated with NSI knowledge among nursing students in Palestine remains limited. Most available regional literature focuses on overall exposure rates without thoroughly evaluating specific knowledge gaps (e.g., sharps container fill limits, post-exposure hygiene) or how knowledge levels correlate with self-reported compliance practices such as glove use and recapping avoidance. Moreover, nursing students in the southern West Bank train across diverse university laboratories and hospital settings, making it essential to establish localized baseline data to inform nursing curricula.

Therefore, this study aimed to evaluate knowledge, safety compliance behaviors, and associated demographic and training factors regarding needlestick injuries among nursing students in Palestine. Specifically, the objectives were to: (a) Assess the level of knowledge regarding needlestick injuries among undergraduate nursing students using a standardized knowledge scale and Bloom's cutoff criteria; (b) Identify specific knowledge strengths and deficits across key NSI safety domains; (c) Evaluate self-reported safety practices, specifically glove usage and recapping avoidance; and (d) Determine demographic, training-related, and behavioral factors associated with NSI knowledge scores.

METHODS

Study Design and Setting

A quantitative, cross-sectional, descriptive design was employed to evaluate knowledge, safety practices, and associated factors regarding needlestick injuries among nursing students in Palestine. This design allows efficient collection of data from a target population at a single point

in time to assess knowledge levels and examine associations with demographic and behavioral characteristics[33]. The study was conducted in the southern region of the West Bank, Palestine, across four major universities offering accredited Bachelor of Science in Nursing programs: Palestine Polytechnic University, Hebron University, Bethlehem University, and Palestine Ahliya University. These institutions represent the primary centers for nursing education in the region, encompassing diverse student cohorts and clinical affiliation sites.

Population and Sampling

The target population comprised undergraduate nursing students enrolled in the four participating universities who had completed at least one clinical training course. Based on university registrar records, the total eligible population was approximately 2,420 students. The required sample size was calculated using the Raosoft® sample size calculator, assuming a 5% margin of error, a 95% confidence level, and a 50% response distribution. The minimum recommended sample size was 377 participants. To compensate for potential non-response or incomplete surveys, 450 questionnaires were distributed. Non-probability convenience sampling was utilized to recruit eligible students across academic years, lecture halls, and laboratory sessions.

Inclusion and Exclusion Criteria

Students were included if they: (a) were enrolled in a Bachelor of Nursing program at one of the four participating universities; (b) had completed at least one clinical training course; (c) were aged between 20 and 30 years; (d) were proficient in reading English; and (e) provided written informed consent. Students were excluded if they: (a) had prior professional healthcare experience (e.g., bridging students); (b) submitted incomplete questionnaires; or (c) were not currently enrolled in active academic study.

Instrumentation

Data were collected using a structured, self-administered questionnaire structured into two primary sections: Section 1: Demographics and Clinical Training Factors: Collected data on age, gender, academic year of study, completion of laboratory training, infection control training status, general safety training perception, and self-reported adherence to standard precautions (always wearing gloves during procedures with needles/sharps; always avoiding recapping used needles). Section 2: NSI Knowledge Scale: Adopted from the validated 8-item knowledge scale developed by Al-Mugheed et al. [10]. The scale evaluates essential NSI knowledge domains: definition of NSI (K1), recapping risk (K2), hepatitis B vaccination prevention (K3), safer devices and glove requirements (K4), bloodborne pathogen transmission (K5), maximum capacity of sharps containers (K6), immediate post-exposure washing with soap and water (K7), and proper sharps container disposal (K8). Items were answered as "True," "False," or "Not sure." Correct answers received 1 point, while incorrect or "Not sure" answers received 0 points. Total knowledge scores ranged from 0 to 8 points and were converted to percentage scores (0–100%). Bloom's cutoff points were applied to categorize overall knowledge: Poor ($\leq 59\%$), Moderate (60–79%), and High ($\geq 80\%$) [10]. The scale demonstrated good content validity, reviewed by a panel of three nursing faculty experts, and showed high internal reliability in pilot testing (Cronbach's $\alpha = 0.81$).

Data Collection Process

Following ethical approval, administrative permissions were obtained from the deans and department heads at each university. Questionnaires were distributed in paper format during classroom lectures and laboratory sessions, and an electronic version via Google Forms was shared through official student groups to maximize access. Researchers were present during paper administration to answer procedural queries and collect completed forms on the same day. Data collection took place from October to November 2025. Out of 450 distributed questionnaires, 400 were returned, and 365 were fully completed and included in the final statistical analysis (net response rate of 81.1%).

Data Analysis

Data were analyzed using IBM SPSS Statistics version 26.0. Descriptive statistics (frequencies, percentages, means, standard deviations) were calculated for demographic characteristics, training variables, individual knowledge items, and Bloom's knowledge categories. Bivariate inferential statistics were conducted to determine factors associated with overall knowledge percentage scores.

Independent-samples t-tests were used for binary categorical variables (gender, lab training, glove use, recapping avoidance). One-way Analysis of Variance (ANOVA) was performed for variables with more than two categories (academic year). Pearson's correlation coefficient (r) was calculated to assess the relationship between age and continuous knowledge score. Statistical significance was established at $p < 0.05$ (two-tailed).

Ethical Considerations

Ethical approval was granted by the Institutional Review Board (IRB) of Palestine Polytechnic University. The study adhered strictly to the ethical standards of the Declaration of Helsinki. Participants were provided with written information detailing the study's purpose, voluntary participation, and freedom to withdraw at any time without academic consequence. Written informed consent was obtained prior to questionnaire administration. All data were anonymized, coded, and stored securely in password-protected electronic files accessible only to the principal research team.

RESULTS

Participant Characteristics

Table 1 summarizes the demographic and training-related characteristics of the 365 participating nursing students. The mean age was 20.82 years (SD = 1.04). The majority of participants were female (80.5%, $n = 294$) and enrolled in their fourth year of study (51.8%, $n = 189$). Most students reported completing laboratory training (84.4%, $n = 308$) and infection control training (57.3%, $n = 209$). Regarding standard safety precautions, 79.7% ($n = 291$) reported always wearing gloves during sharp procedures, and 73.4% ($n = 268$) reported always avoiding needle recapping. Regarding general safety training, 42.5% ($n = 155$) agreed and 9.6% ($n = 35$) strongly agreed that they had received adequate safety instruction.

Table 1: Demographic and training characteristics of nursing students (N = 365)

Variable	Category	n (%)
Age (years)	Mean $\pm$ SD	20.82 $\pm$ 1.04
Gender	Male	71 (19.5%)
Gender	Female	294 (80.5%)
Year of study	Second year	63 (17.3%)
Year of study	Third year	113 (31.0%)
Year of study	Fourth year	189 (51.8%)
Laboratory training	No	57 (15.6%)
Laboratory training	Yes	308 (84.4%)
Infection control training	No	156 (42.7%)
Infection control training	Yes	209 (57.3%)
Always wear gloves during sharp procedures	No	74 (20.3%)
Always wear gloves during sharp procedures	Yes	291 (79.7%)
Always avoid recapping used needles	No	97 (26.6%)
Always avoid recapping used needles	Yes	268 (73.4%)
General safety training perception	Strongly disagree	13 (3.6%)
General safety training perception	Disagree	86 (23.6%)
General safety training perception	Neutral	76 (20.8%)

Knowledge of Needlestick Injury

Table 2 presents the breakdown of correct and incorrect responses across the eight NSI knowledge items. Correct response rates were highest for proper disposal in a sharps container (K8: 92.9%) and the definition of NSI (K1: 92.1%), followed by awareness of safer devices and gloves (K4: 90.1%) and bloodborne pathogen transmission (K5: 87.9%).

Conversely, the lowest proportion of correct responses was observed for the item on sharps container maximum capacity (K6: 58.6% correct; 41.4% incorrect/not sure) and immediate hand-washing with soap and water following exposure (K7: 66.8% correct; 33.2% incorrect/not sure).

Table 2: Knowledge of needle stick injury among nursing students (N = 365)

Item	True Answer	Correct n (%)	Incorrect n (%)
K1 – Definition of needle stick injury	True	336 (92.1%)	29 (7.9%)
K2 – Avoid recapping used needles (recapping is not recommended)	False	261 (71.5%)	104 (28.5%)
K3 – Hepatitis B can be prevented by vaccine	True	268 (73.4%)	97 (26.6%)
K4 – Safer devices and gloves are needed to avoid NSI	True	329 (90.1%)	36 (9.9%)
K5 – Bloodborne pathogens (HBV, HCV, HIV) are transmitted via NSI	True	321 (87.9%)	44 (12.1%)
K6 – 75% is the maximum capacity for a sharps container	True	214 (58.6%)	151 (41.4%)
K7 – Wash area with soap and water immediately after NSI	True	244 (66.8%)	121 (33.2%)
K8 – Dispose in a sharps container to reduce injury risk	True	339 (92.9%)	26 (7.1%)

Knowledge Level Categories Based on Bloom's Cutoff Points

Table 3 displays the distribution of overall knowledge levels according to Bloom's classification. The mean knowledge percentage score across all participants was 79.18% (SD = 18.87). Overall, 55.6% (n = 203) of students achieved a High knowledge level ($\geq 80\%$), 32.9% (n = 120) demonstrated Moderate knowledge (60–79%), and 11.5% (n = 42) scored in the Poor knowledge category ($\leq 59\%$).

Factors Associated with Knowledge of Needle Stick Injury

Table 4 presents bivariate analysis results examining associations between demographic/training factors and total knowledge scores. Female students demonstrated significantly higher mean knowledge scores than male students (81.34% vs. 70.25%, $t = -4.564$, $p < 0.001$). Furthermore, students who reported always wearing gloves during sharp procedures scored significantly higher than those who did not (80.46% vs. 74.16%, $t = -2.585$, $p = 0.010$). Similarly, students who reported always avoiding needle recapping attained significantly higher knowledge scores (80.55% vs. 75.39%, $t = -2.324$, $p = 0.021$). No statistically significant differences in knowledge were observed based on laboratory training completion ($p = 0.103$) or academic year of study ($F = 0.450$, $p = 0.638$). Age showed no significant correlation with overall knowledge score ($r = -0.050$, $p = 0.338$).

Table 3: Knowledge level categories based on Bloom's cutoff points (N = 365)

Knowledge Level	Score Range (%)	Frequency (n)	Percentage (%)
Poor	$\leq 59\%$	42	11.5%
Moderate	60–79%	120	32.9%
High	$\geq 80\%$	203	55.6%
Total	0–100%	365	100.0%

Table 4: Factors associated with knowledge of needle stick injury among nursing students (N = 365)

Variable	Category	Frequency (n)	Mean (%)	SD	Test Statistic	P-Value
Gender	Male	71	70.25	23.28	$t = -4.564$	<0.001
Gender	Female	294	81.34	16.99	$t = -4.564$	<0.001
Laboratory training	No	57	75.44	18.74	$t = -1.633$	0.103
Laboratory training	Yes	308	79.87	18.84	$t = -1.633$	0.103
Always wear gloves	No	74	74.16	21.23	$t = -2.585$	0.010
Always wear gloves	Yes	291	80.46	18.03	$t = -2.585$	0.010
Always avoid recapping	No	97	75.39	17.81	$t = -2.324$	0.021
Always avoid recapping	Yes	268	80.55	19.08	$t = -2.324$	0.021
Year of study	Second year	63	77.38	21.87	$F = 0.450$	0.638

Variable	Category	Frequency (n)	Mean (%)	SD	Test Statistic	P-Value
Year of study	Third year	113	80.20	18.65	F = 0.450	0.638
Year of study	Fourth year	189	79.17	17.96	F = 0.450	0.638
Age	Continuous (years)	365	—	—	r = -0.050	0.338

DISCUSSION

This study evaluated knowledge levels, safety compliance behaviors, and associated demographic/training factors regarding needlestick injuries among 365 undergraduate nursing students in Palestine. The overall knowledge score was high (mean = 79.18%, SD = 18.87), with 55.6% of students meeting Bloom's high knowledge threshold ($\geq 80\%$). Students showed robust knowledge regarding basic definitions (92.1%) and proper sharps container disposal (92.9%). However, critical knowledge gaps were identified regarding sharps container fill capacity (58.6%) and immediate post-exposure soap-and-water washing (66.8%). Knowledge scores were significantly higher among female students compared to males (81.34% vs. 70.25%, $p < 0.001$) and among students who reported consistent adherence to glove use ($p = 0.010$) and recapping avoidance ($p = 0.021$). Academic year, laboratory training completion, and age were not significantly associated with knowledge scores.

The participant sample was predominantly female (80.5%) and fourth-year nursing students (51.8%), mirroring gender distributions in Palestinian nursing education and broader regional contexts[12,25,27]. Self-reported compliance with safety precautions was relatively high, with 79.7% always wearing gloves and 73.4% always avoiding needle recapping. These compliance figures are comparable to reported rates in Oman[12] and Saudi Arabia[10], but exceed rates observed in earlier Palestinian surveys[27]. The finding that 26.6% of students continue to recap needles is concerning, as recapping remains a leading contributor to preventable sharp injuries worldwide[6,12]. In the Palestinian context, persistent recapping behaviors may be driven by clinical workload pressures, time constraints during busy clinical shifts, or informal practices modeled by senior staff in hospital wards[9,10].

The high overall mean knowledge score (79.18%) aligns with findings from Saudi Arabia[10] and Oman[12], where nursing students demonstrated moderate-to-high general awareness of occupational hazards. This high knowledge level reflects ongoing efforts by Palestinian universities to integrate infection control concepts into nursing curricula. Students scored exceptionally well on basic conceptual questions, such as identifying NSI definitions (92.1%) and recognizing the importance of sharps containers (92.9%) and protective gear (90.1%).

However, specific gaps were evident regarding tactical safety protocols. Only 58.6% knew that 75% represents the maximum safe capacity for sharps containers, and only 66.8% correctly identified immediate soap-and-water washing as the initial post-exposure action. Overfilling sharps disposal boxes creates severe risk for overspill injuries, while immediate post-exposure hygiene is crucial for reducing pathogen load[34]. Similar knowledge deficiencies regarding post-exposure management have been reported in India[11] and Saudi Arabia[20]. These results indicate that while students understand broad safety principles, curricula must place greater emphasis on specific practical guidelines and immediate post-exposure management steps.

Female students achieved significantly higher knowledge scores than male students (81.34% vs. 70.25%, $p < 0.001$). This finding is consistent with research in India[11] and Saudi Arabia[10], where female health science students consistently demonstrated greater engagement with biosafety protocols and higher scores on safety knowledge assessments. Potential explanations include differences in study habits, academic preparation, or clinical learning engagement. Given that male nursing students represent a growing segment of the healthcare workforce in Palestine, educational institutions should design targeted refresher training to ensure equal safety competency across genders.

A central finding of this study is the significant positive association between NSI knowledge scores and self-reported adherence to safety practices. Students who always wore gloves scored significantly higher in knowledge than those who did not (80.46% vs. 74.16%, $p = 0.010$), as did students who consistently avoided recapping needles (80.55% vs. 75.39%, $p = 0.021$). This supports theoretical frameworks such as the Health Belief Model, which posit that higher knowledge and threat perception foster protective health behaviors [13]. When students understand the biological mechanics of disease transmission and prevention, they are more likely to internalize standard precautions. However, as noted in previous Palestinian studies among critical care nurses [30], theoretical knowledge alone does not guarantee flawless execution, reinforcing the need for con-

tinuous skill evaluation and active supervision in clinical environments.

Interestingly, completion of laboratory training ($p = 0.103$), academic year of study ($p = 0.638$), and age ($p = 0.338$) were not significantly associated with NSI knowledge scores. The lack of significant variation across academic years (2nd year: 77.38%, 3rd year: 80.20%, 4th year: 79.17%) suggests that basic biosafety knowledge is acquired early in the nursing curriculum (during 2nd year fundamental courses) and remains stable throughout subsequent years. Similar patterns were reported by Al Qadire et al.[12] in Oman. However, this finding contrasts with Kim & Moon[35] in South Korea, who found significant knowledge growth in senior years. The absence of a significant effect for laboratory training indicates that standard classroom instruction and simulation labs may focus heavily on procedural mechanics rather than reinforcing underlying biosafety knowledge, highlighting an opportunity for curricular refinement.

Limitations

Several limitations should be considered when interpreting these findings. First, the cross-sectional design restricts inferences regarding temporal causality between knowledge scores and clinical behaviors. Second, self-reported data regarding glove usage and recapping avoidance may be subject to social desirability bias or recall bias, potentially overestimating compliance. Third, convenience sampling across four universities in the southern West Bank may limit the generalizability of findings to other geographical areas of Palestine or different health discipline programs. Fourth, observational audits of clinical practices were not conducted, which would provide an objective measure of procedural compliance alongside survey responses.

Implications and Recommendations

For Academic Institutions

- Refine Curricular Focus: Nursing faculties should update infection control modules to address specific knowledge gaps, particularly sharps container capacity rules (75% limit) and standardized immediate post-exposure procedures.
- Targeted Education: Implement dedicated educational workshops for male nursing students to close the identified gender gap in biosafety knowledge.
- Reinforce Simulation Training: Integrate active biosafety scenarios and no-recapping drills into pre-clinical simulation laboratories prior to hospital placements.
- Stress-Support Integration: Integrate coping and anxiety-management strategies into clinical preparation, considering the high background academic and contextual stress faced by Palestinian students [8,9].

For Healthcare Institutions

- Enhanced Clinical Supervision: Hospital preceptors and clinical instructors must closely monitor nursing students during sharp-handling procedures to ensure theoretical knowledge translates into compliance.
- Point-of-Care Equipment: Ensure adequate provision of sharps disposal containers placed directly at points of care to eliminate the temptation to recap needles or transport unsheathed sharps.
- Clear Exposure Pathways: Display clear, visual post-exposure management flowcharts (including immediate soap-and-water washing) in all clinical utility rooms accessible to students.

For Policy and Future Research

- Standardized National Guidelines: Health and higher education ministries should formulate standardized occupational safety competencies required for all nursing students prior to clinical entry.
- Future Research: Longitudinal and observational studies are recommended to track changes in safety knowledge and actual bedside behaviors over time across all regions of Palestine.

CONCLUSION

This study provides valuable baseline evidence regarding needlestick injury knowledge and safety compliance among nursing students in Palestine. The findings demonstrate a generally

high level of knowledge (mean = 79.18%), with over half of students categorized in Bloom's high knowledge bracket. Significantly higher knowledge was demonstrated by female students and by students who consistently adhere to glove use and avoid needle recapping. However, critical deficits in practical safety rules—such as sharps container capacity limits and post-exposure hygiene—highlight clear targets for educational enhancement. Closing these knowledge gaps through targeted educational interventions, enhanced pre-clinical simulation, and supportive clinical supervision is vital for fostering a culture of safety and protecting future nursing professionals in Palestine.

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ACKNOWLEDGMENTS

We express our sincere gratitude to all the nursing students from Palestine Polytechnic University, Hebron University, Bethlehem University, and Palestine Ahliya University who participated in this study. We also thank the academic deans, department heads, and faculty members for their cooperation and assistance during data collection.

FUNDING

This research received no specific grant or financial support from any funding agency in the public, commercial, or non-profit sectors.

CONFLICT OF INTEREST

The authors declare that they have no competing interests.

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